International Fishmeal & Oil Manufacturers Association

I. EFFECT OF DIETARY FISH MEAL OR FISH OIL ON BROILERS CHALLENGED WITH VIRULENT INFECTIOUS BRONCHITIS VACCINATION - TRIAL AT LINCOLNSHIRE COLLEGE OF AGRICULTURE

II. FEEDING FISH MEAL AND FISH OIL TO INCORPORATE OMEGA-3 FATTY ACIDS IN POULTRY MEAT - EFFECT ON MEAT LIPID COMPOSITION AND MEAT QUALITY

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EXTENDED SUMMARY

I. EFFECT OF DIETARY FISH MEAL OR FISH OIL ON BROILERS CHALLENGED WITH VIRULENT INFECTIOUS BRONCHITIS VACCINATION - TRIAL AT LINCOLNSHIRE COLLEGE OF AGRICULTURE

BACKGROUND

A broiler trial was carried out in a commercial broiler house at the Lincolnshire College of Agriculture. Standards of hygiene were regarded as adequate and typical of a commercial unit rather than of the high standard of many research facilities with high labour input.

To challenge these birds a virulent infectious bronchitis vaccination (IB) (H52) recommended for adult birds but considered too severe for young birds, was given to chicks of 17 days of age. It is known to produce a strong reaction in young growing birds.

Details of the birds weight gain, feed intake and conversion and veterinary records were taken. In addition, to provide more information about the birds' reaction to the IB vaccination, feed intake was measured daily or at two to three day intervals following this vaccination. Blood samples were taken from birds on each treatment (12) on three occasions during the trial to follow antibody titres for IB and Newcastle disease to check immunity and the likelihood birds had been challenged. Detailed veterinary records were kept, including post-mortems on any birds that died.

The diets used were designed to reflect typical commercial broiler diets balanced for energy, protein and total amino acids for each of the three phases - starter, grower and finisher, for each treatment.

Further details of the trial facilities, data recorded and diets, etc., are given in the report which follows (Appendix 1). Analyses of the fish meal and composition of the fish oil are given in Tables 1, 2 and 3.

RESULTS OF THE TRIAL

MORTALITY

Overall mortality of around 10% was higher than usual for the Lincolnshire unit. Some commercial units reach or even exceed this mortality level. The virulent IB vaccination appeared to produce a strong reaction and a secondary respiratory infection which was not treated with antibiotics.

Mortality was lowest on the control treatment (without fish meal or fish oil) and the difference was statistically significant (see Appendix 1, Table 2, page 1.7). Higher mortality with fish meal and fish oil feeding was not expected. The statistical treatment of these results needs further examination in relation to pen effects.

In spite of the high mortality, weight gain was significantly higher for the fish meal fed birds; feed conversion was also significantly better for the fish meal fed birds (Appendix 1, Table 2, page 1.7). For the fish oil fed birds, growth and feed conversion were similar to the controls. However, in formulating the diets the energy value of fish oil was over-estimated by around 10%. As approximately 5% of dietary energy came from this source, the energy content of this diet may have been around 0.5% lower than that of the other diets. Had dietary energy been equated, growth and feed conversion may have been improved for this treatment.

Following vaccination, feed intake was better with fish meal and fish oil treatments (Appendix 1, Table 3, page 1.9 and Figure 2, page 1.10). The better feed intake may account for the better weight gain the fish oil fed birds.

BLOOD TITRES

The blood titres indicated no difference in immunity between treatment groups, though replication was insufficient for satisfactory statistical analysis (Appendix 1, Table 5, page 1.14).

It is interesting to note that the Newcastle disease titres suggest cross contamination at the hatchery or during transit as the birds were not vaccinated against this disease (vaccination could have accounted for the titre). The combined challenge of Newcastle disease and the infectious bronchitis vaccination may have been much more severe than expected and resulted in the high mortality (see Appendix 1, Table 2, page 1.7 and Discussion and Conclusions, page 1.12).

RECOMMENDATIONS

It is recommended that this trial is repeated using a less severe disease challenge. The repeat trial should be done at the Lincolnshire unit with diets balanced for protein and energy. In balancing energy, the lower energy value for fish oil relative to soyabean oil should be taken into account. However, in view of the efforts to market fish oil in poultry diets, new work should be done to evaluate the energy value of fish oil at a recognised centre of excellence for this type of work.

In repeating the trial, it should be followed by a more comprehensive study of carcass quality. Numbers of birds to be used for this purpose should be sufficient for satisfactory statistical analysis. Whilst the treatment levels of fish meal and fish oil should be the same as in the first trial, consideration should be given to using two types of fish meal and fish oil, e.g. South American and European.

II FEEDING FISH MEAL AND FISH OIL TO INCORPORATE OMEGA-3 FATTY ACIDS IN POULTRY MEAT - EFFECT ON MEAT LIPID COMPOSITION AND MEAT QUALITY

Following the above feeding trial in which broilers received diets with no marine products (control), 10% fish meal or 2% fish oil, the meat from these birds was made available to study its fat composition and flavour, although the trial was not primarily designed for this purpose. Arrangements were made with the University of Bristol's Division of Food Animal Science to analyse this meat and subject it to evaluation by a professional taste panel after cooking. A brief report of the work by the Bristol group is given in Appendix 2.

Manipulating fat composition of poultry meat through feeding fish meal and/or fish oil has been demonstrated in numerous trials (Barlow and Pike, 1991). However, in so doing the risk of producing off-flavours in the meat is a concern. The Association recommended that broiler diets in the finishing stages should contain no more than 0.8% fish lipids, setting a maximum of 8% to 10% fish meal (Technical Bulletin number 4).

Since the earlier review (Barlow and Pike, 1991), it has been shown that by boosting dietary vitamin E, up to 2% fish oil could be fed to broilers without affecting meat quality (Miller and Huang, 1993).

In the feeding trial at Lincolnshire Agricultural College the birds were fed diets supplemented with 100iu/kg of vitamin E. The fish meal used was a prime quality Chilean meal, treated with antioxidant during processing. The fish oil was an antioxidant stabilised menhaden oil high in omega-3 fatty acids. It was from the same batch used in the trials at the University of California, Davis. Details of their composition are given in Tables 1, 2 and 3.

REARING OF THE BIRDS

Details of the rearing of the birds are given in the report on the Lincolnshire trial in Appendix 1. For the meat quality work the samples used were breast meat taken from the birds used at the end of the study (30 per treatment) for carcass meat yield analysis. They were selected by taking one bird from each pen selected to be approximately average size for the pen. The breast was removed from these birds and stored in a deep freeze for about six months. Further details of methods used are given in Appendix 2.

EATING QUALITY OF THE CHICKEN MEAT

As the number of samples available for this work was not considered optimum for satisfactory statistical analysis, this work was done as a preliminary assessment. Approximately twice as many birds would have been required to satisfy requirements for satisfactory statistical analysis.

The results from the taste panel indicate that the dietary treatments had no adverse effect on meat quality. In general the chicken breast meat was of good eating quality with low values for abnormal flavour intensity and high values for tenderness. It should be noted that these results were obtained on meat that had been deep frozen for six months. If residual lipids from fish meal or oil treatments tended to undergo flavour reversion through oxidation, this is more likely to happen during prolonged storage.

The results from this trial are sufficiently encouraging to justify repeating the work on a larger scale, noting the recommendation to vacuum pack the breasts.

MEAT LIPID COMPOSITION - OMEGA-3 FATTY ACID CONTENT

Lipids were extracted from a sample of cooked breast meat prepared for the taste work (internal pectoralis muscle). Skin was excluded though some drip loss may have been included. Lipids were extracted by the Folch *et al* (1957) procedure. Further details of the methods used are given in Appendix 3.

The lipid and moisture content of the muscle is shown in Table 4. Lipid content ranged from 2.3% to 4.0%. The composition of the lipids are shown in Tables 2 and 3, the long chain (C_{20}+) fatty acid content being given in Table 4. The composition is given as mg fatty acid per 100g meat.

The fish meal and fish oil dietary treatments resulted in increased omega-3 fatty acid content as expected. However, the 'control' birds which received only vegetable oil had a surprisingly high content of longer chain (C_{20}+) omega-3 fatty acids. This must have been produced by the C_{18}:3 omega-3 fatty acid in the soyabean oil being chain elongated. Chain elongation is more likely to occur in the later stages of growth. Nevertheless, levels of C_{20}+ omega-3 fatty acids were significantly higher for the fish meal and oil treatments, the total being 137.9 and 171.2mg per 100g meat respectively compared with 77.4mg in the controls.

It is interesting to note the slightly higher values resulting from 2% fish oil in the diet compared with 10% fish meal. The fish meal provides only half the lipid, yet the omega-3 content in the meat was around 80% of that from fish oil. This may reflect the higher concentration of omega-3 fatty acids in the lipid in fish meal due to its higher content of phospholipids.

Comparing the lipid content of the breast meat with that found by other workers, the Bristol results showed high content - 2.3% to 4.0%. Miller and Huang (1993) found 1.3% and 1.1% and Ratnayake *et al* (1989) found 0.9%. Sinclair and O'Dea (1987) found 1.4% and Ang and Lyon (1990) give a value of 1.2% in cooked breast meat. Lipid from skin and possibly adipose tissue also may have been picked up, possibly in the drip loss - see Appendix 2. The high content of C_{20}:4 n-6 supports this explanation. Consequently the absolute values for the lipid and fatty acid content of the meat from these analyses cannot be taken as representative of the breast meat. It is recommended that in further work, both cooked and uncooked breast meat without skin is analysed. This was not possible in the present work.

RECOMMENDATIONS FOR FURTHER WORK

The current work was preliminary. Results were sufficiently encouraging to justify repeating the work on a larger scale to give a more satisfactory statistical assessment of treatments.

The high omega-3 fatty acid content of the control birds, as mentioned, may have come partly from soyabean oil; there may have also been a contribution from the tallow, the other source of fat used if it partly originated from poultry. Future work should include fatty acid analysis of dietary fats.

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TABLE 1

FISH MEAL[1] ANALYSIS FOR BIOGENIC AMINES

(mg free base per kg [ppm])

Tyramine	22
Putrescine	39
Cadaverine	65
Histamine	49

[1]Chilean 'prime' fish meal

TABLE 2

FISH MEAL ANALYSIS (CHILEAN PRIME MEAL) - FATTY ACID COMPOSITION OF EXTRACTED LIPIDS

Results from FIRI:

As % of total fatty acid method esters:

Total saturates	32.7
Total monoenes	20.9
Total polyunsaturated	40.3
Total n-3	37.4
Ethoxyquin in meal	108mg/kg
Ethoxyquin quinolone in meal	18mg/kg

Results from Torry:

n-3 fatty acids as % of total fatty acids in lipid extracted	45.4

TABLE 3

ANALYSIS OF FISH (MENHADEN) OIL

Free fatty acids	0.11%
Moisture	0.12%
Iodine value	188
Colour	6.75
Cold test	5.5 hours

Fatty acid analysis as % of oil:

Total saturates	25.5
Total monoenes	21.8
Total polyunsaturated	42.6
Total n-3	33.6
Total n-6	2.7

TABLE 4

CHICKEN BREAST MUSCLE FATTY ACIDS AS % BY WEIGHT OF TOTAL FATTY ACIDS

Fatty Acid	Control	Treatment Fish Meal (10%)	Fish Oil (2%)	SED	P
C12:0	0.41[a]	0.44[a]	0.30[b]	0.02	<.001***
C14:0	0.87[a]	0.93[a]	1.32[b]	0.05	<.001***
C16:0	22.9	23.5	23.3	0.69	0.85
C16:1 n-7	4.5	5.2	4.9	0.48	0.44
C18:0	8.0	7.7	8.2	0.34	0.36
C18:1 n-9	29.4	29.9	27.2	1.13	0.09
C18:1 n-7	2.6	2.7	2.4	0.20	0.41
C18:2 n-6	19.3[a]	16.5[b]	16.6[b]	0.97	0.03*
C18:3 n-3	1.9[a]	1.5[b]	1.7[b]	0.12	0.03*
C20:1	0.44	0.43	0.49	0.03	0.09
C20:2 n-6	0.50	0.38	0.41	0.06	0.17
C20:3 n-6	0.68	0.57	0.53	0.09	0.29
C20:4 n-6	2.0	1.5	1.3	0.27	0.08
C20:5 n-3	0.66	1.0	1.7	0.06	<.001
C22:4 n-6	0.40[a]	0.22[b]	0.16[b]	0.05	.002**
C22:5 n-3	0.87[a]	1.12[a]	1.83[b]	0.18	.001***
C22:6 n-3	1.2[a]	2.9[b]	3.5[b]	0.40	<.001***
ΣC20,C22 n-3	2.7	5.0	7.0		<.001***
Ratio $\frac{\Sigma \text{ n-3}}{\Sigma \text{ n-6}}$	0.20	0.34	0.49		

[a,b,c] Numbers within a line with different superscript letters differ significantly, P <0.05. E N C E S

APPENDIX 1

AN INVESTIGATION UNDERTAKEN ON BEHALF OF THE INTERNATIONAL FISH OIL AND MEAL MANUFACTURERS ASSOCIATION LOOKING AT THE INCLUSION OF FISHMEAL OR FISH OIL IN THE FEED OF BROILER CHICKENS BETWEEN 0 AND 44 DAYS OF AGE

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OBJECTIVES

The aim of the study was to evaluate the inclusion of either fishmeal or fish oil in the diets of broilers across the starter, grower and finisher feeds with particular emphasis on physical performance, carcass yield and response to vaccination.

STOCK

The batch comprised of 4320 sexed, Ross broiler chicks supplied by Mayfield chicks Limited. At the end of the trial (49 days) the birds were processed by Penwood Country Chicken Limited.

On arrival, all papers from the trays were put into a plastic bin bag and were sent for salmonella testing. There was one dead chick on arrival.

ACCOMMODATION

The birds were distributed across the 72 pens in the rearing house as shown in Figure 1. The pens were stocked at 60 birds to a pen for both sexes and bird numbers per pen were checked within 24 hours of the start of the trial. Each pen measured 5 x 7 feet (1.54m x 2.15m) providing 0.58 sq. ft. of growing space per bird (18.1 birds per square metre). Pens were separated by wood and wire divisions. Each pen had a single tube feeder and a bell type drinker. White wood shavings were used for litter. The house was heated by means of a gas fired, hot air heater.

EXPERIMENTATION

The birds were used for a replicated, nutrition trial on behalf of The International Fish Oil and Meal Manufacturers Association. There were three treatments. A treatment and feed schedule is shown in table 1.

TABLE 1

TREATMENT AND FEED SCHEDULE

Treatment	Diet	Fishmeal	Fish oil
1	FMS/G1	-	-
2	FMS/G2	10%	-
3	FMS/G3	-	2%

FIGURE 1

DISTRIBUTION OF TREATMENTS IN THE GROWING SHED

P18 T3M	P19 T1M	P54 T2F	P55 T1F
P17 T2F	P20 T3M	P53 T2M	P56 T3M
P16 T3F	P21 T2F	P52 T1F	P57 T3F
P15 T2M	P22 T1F	P51 T3M	P58 T1M
P14 T1F	P23 T3F	P50 T3F	P59 T2F
P13 T1M	P24 T2M	P49 T1M	P60 T2M
P12 T2F	P25 T1F	P48 T1F	P61 T3M
P11 T2M	P26 T2F	P47 T2M	P62 T1M
P10 T1F	P27 T2M	P46 T3M	P63 T2M
P9 T3F	P28 T3F	P45 T2F	P64 T3F
P8 T3M	P29 T1M	P44 T3F	P65 T1F
P7 T1M	P30 T3M	P43 T1M	P66 T2F
P6 T2M	P31 T1F	P42 T2M	P67 T3M
P5 T3M	P32 T2F	P41 T3F	P68 T2F
P4 T1F	P33 T3F	P40 T1M	P69 T2M
P3 T2F	P34 T1M	P39 T2F	P70 T1F
P2 T1M	P35 T3M	P38 T3M	P71 T3F
P1 T3F	P36 T2M	P37 T1F	P72 T1M
STORE			STORE

Where included, fishmeal replaced soyabean meal and fish oil replaced soyabean oil.

Each treatment was fed to the relevant pens as shown in figure 1. There were twenty-four replicate pens of birds (12 female, 12 male) per treatment. Therefore, there were 72 pens in total in the trial.

FEEDING

The trial diets were manufactured by Farm Nutrition Limited. Formulations were prepared in collaboration with IFOMA. Feed was delivered in clearly labelled bags. The feeding programme for all treatments was based on starter, grower and a standard finisher diet from day old to 44 days. Diet formulations, specifications and laboratory analyses of the finished feeds alongside calculated values are shown in appendix 1.

All diets were fed ad libitum and diet changes took place at the same time (age) across all treatments. The labelling was checked on the bags before feeding.

A routine feed weighback was undertaken for each pen at 10, 37 and 44 days and also at more regular intervals during the period following the vaccination (see later). A weekly check of feed stocks was undertaken to reconcile feed used with feed delivered. Approximately 0.600 tonnes of each starter diet and 4.200 tonnes of each grower diet were manufactured. A total of 4.250 of the standard finisher feed was made.

LIGHTING

The birds received the following light pattern:

0 to day 44	23.5h light

VACCINATIONS AND MEDICATIONS

The birds received soluble vitamins for two days after arrival. A virulent IB vaccination (H52) via the drinking water was given at 17 days of age. No further vaccinations were given during the trial. Blood samples were taken on day 16 prior to the vaccination and again on day 33 and at the end of the trial for testing for ND and IB titres along with mycoplasma, chick anaemia agent, TRT and gumboro disease in the final samples. On each occasion twelve separate blood samples were taken per treatment and these were taken from the same twelve pens each time.

General comments about the birds welfare and general health were also noted as and when appropriate in the crop diary which was kept to record general information and observations about the progress of the trial.

RECORDING

The quantity of food supplied and daily mortality and culls for each of the pens was recorded for the entire growing period. All dead and cull birds were weighed. Any drinker floods that occurred were noted as was any feed wastage if it occurred.

Body weights and litter scores

All the birds from each pen were manually weighed on days 2, 10, 33 and 44. At the time of weighing, care was taken to minimise bird damage. Also, when handling birds at 44 days of age the presence of any hock lesions was noted in a sample of 20 birds per pen and any scoring higher than 3 using the procedure established by ADAS were noted for reporting at the end of the trial.

The litter condition in each pen was scored on days 21 and 42 on the basis of 1 (good) to 5 (bad).

Additional feed weighbacks

During the trial additional feed weighbacks to those mentioned above were undertaken across all pens to assess the effects of the vaccination on feed intake. Residual feed was weighed for each pen prior to the vaccination on day 17. The procedure was repeated 24h later and again for four further 24h-periods after that. Further weighbacks were completed after an additional 48h and then again 7 days later. Final weighbacks were undertaken after further 5-day, 2-day and 7-day periods. This provided accurate, replicate feed intake data for twelve "sub-periods" over the period of the trial.

Carcass meat yield analysis

At the end of the study 30 birds (15 males, 15 females) were taken from each treatment by selecting at least one bird per pen and were weighed, wing banded and killed for meat yield analysis.

After killing and plucking the birds were weighed again to give New York Dressed weight and were then chilled over night. They were then eviscerated and dissected according to the WPSA method for arriving at a meat yield analysis.

Environmental factors

The following factors were recorded daily:

1) minimum and maximum house temperatures;
2) brooder heat;
3) use of fans;
4) area of ventilation inlet opening.

RESULTS

The results are summarised in tables 2, 3, 4, 5 and 6 and figures 2 and 3. Table 2 summarise the performance of the birds for the treatment groups within the study. Table 3 and figure 2 summarise the results of the detailed feed intake data during the period of the vaccination and table 4 the results of the meat yield analyses. Table 5 summarises the results of the blood tests and table 6 results of post mortem examinations. The data were analysed using the GENSTAT program to test treatment differences for statistical significance.

The chicks were negative for salmonella on arrival and the terminal blood test showed no signs of any disease challenge during the study (see appendix 2). The average minimum house temperature during the study was 22.3 deg C and the average maximum 26.5 deg C. Corresponding outside temperatures were 7.0 and 18.7 deg C. Results of the analyses of the trial diets showed them to be within acceptable tolerances of the calculated values.

Performance

Mortality was highest for the males ($p<0.001$) and lowest on diet 1 the control treatment ($p=0.01$).

Feed consumption per bird housed was most for the males ($p<0.001$). On a survivor basis it was also greatest for the males ($p<0.001$) and least for the control treatment ($p=0.002$). There was also variation amongst replicates with replicate 2 being low ($p<0.001$).

Final liveweight and weight gain were least for replicate 2 ($p<0.001$), most for the males ($p<0.001$) and most for treatment 2, the fishmeal group ($p<0.001$). Total weight of chicken produced was least for replicate 2 ($p=0.001$) and most for the males ($p=0.001$) and there was an interaction between bird sex and diet ($p=0.038$).The weight of females produced was least for the fish oil group (treatment 3) but the weight of males produced was greatest for the same treatment.

Feed conversion when based on either liveweight or weight gain was poorest on treatment 3 (fish oil group) and there were differences between replicates ($p=0.048$). When feed conversion was based on total weight of chicken produced it was poorest for the females ($p<0.001$) and there was a significant treatment effect ($p<0.001$) with the best feed conversion resulting from the fishmeal diet and the worst from the fish oil diet. There was a significant replicate effect ($p=0.005$).

Litter condition was affected by bird sex ($p=0.005$) and diet ($p<0.001$). Litter was poorest in the male pens and the control diet and was best where fishmeal was included in the diet. Male

TABLE 2

THE EFFECTS OF INCLUDING FISHMEAL OR FISH OIL IN THE DIET ON THE PERFORMANCE OF BROILERS BETWEEN 0 AND 44 DAYS OF AGE

	Control			Treatment Fishmeal			Fish oil		
	Male	Female	Overall	Male	Female	Overall	Male	Female	Overall
Mortality (%)	9.07	6.11	7.59	12.84	9.90	11.37	13.29	6.69	9.99
Culls (%)	0.14	0.14	0.14	0.14	0.00	0.07	0.14	0.28	0.21
Feed cons/bird/housed (kg)	4.315	3.778	4.047	4.229	3.777	4.003	4.180	3.860	4.020
Feed cons/survivor (kg)	4.755	4.033	4.394	4.863	4.198	4.530	4.835	4.154	4.495
Final liveweight (kg)	2.378	2.004	2.191	2.427	2.074	2.250	2.330	2.026	2.178
Liveweight gain (kg)	2.324	1.951	2.137	2.372	2.019	2.195	2.276	1.972	2.124
Total weight prod.(kg)	134.522	114.930	124.726	134.238	116.132	125.185	129.461	116.303	122.882
FCR based on l'weight	2.000	2.014	2.007	2.005	2.024	2.015	2.076	2.052	2.064
FCR based on gain	2.046	2.070	2.058	2.052	2.079	2.066	2.125	2.108	2.116
FCR based on wt. produced	1.917	1.973	1.945	1.880	1.944	1.912	1.943	1.987	1.965
Av. litter score	3.21	3.15	3.18	2.94	2.67	2.80	3.17	2.94	3.05
Hock lesions (%)	67.9	58.8	63.3	72.1	56.7	64.4	80.0	61.7	70.8

FCR = kg feed per kg weight or gain

birds had the most hock lesions (p=0.01).

There were no other significant treatment effects on performance.

Detailed feed weighback data

The twelve periods over which weighbacks were undertaken varied in length and so the data have been expressed and analysed on an average intake per surviving bird per day basis (see table 3 and figure 2). The vaccination took place immediately at the end of period 3.

The data were analysed as a split plot with the pens being regarded as main plots and the data for the different periods within the pens as the sub-plots. The overall effects of sex and diet were considered as main plot treatments and the differences between periods and their interactions with sex and diet as sub-plot treatments. Data for pen 32 (treatment 2, female) for periods 10 and 11 were identified as being outliers and were excluded.

The increase in feed intake with time was greatest for the male birds ($p<0.001$) and the pattern with time differed between the three treatment groups ($p<0.001$). In particular, intake increased more for treatments 2 (fishmeal) and treatment 3 (fish oil) than for the control group between periods 3 and 4 (straight after the vaccination). Feed intake on treatment 3 then decreased for periods 5 and 6 and intakes for all three treatment groups were similar to each other again by period 9 (see figure 2).

Meat yield analysis

The data were analysed as a completely randomised three diet, two sex factorial assuming the fifteen birds of each sex to be replicates although strictly speaking there were only twelve true replicates by sex per treatment.

With the exceptions of fat and breast skin, yield was greatest ($p<0.001$) from the male birds for all parameters. Fat yield was greatest for the females ($p=0.007$) and there was a suggestion ($p=0.054$) of a treatment effect with treatments 2 and 3 yielding more than treatment 1 an effect which appeared strongest in the males (interaction $p=0.098$).

There was a suggestion that for breast meat ($p=0.057$) and breast skin ($p=0.08$) there was a treatment effect with treatment 2 (fishmeal) giving a higher yield than treatment 3 (fish oil). Treatment 2 produced the greatest yield of wing meat ($p=0.04$).

TABLE 3

MEASURED FEED INTAKES (g/survivor/day) DURING TWELVE PERIODS IN THE TOTAL GROWING CYCLE INCLUDING A PERIOD WHEN A VACCINATION WAS GIVEN

Period no.	No. of days	Treatment									Mean
		Control			Fishmeal			Fish oil			
		Male	Female	Overall	Male	Female	Overall	Male	Female	Overall	
1	10	32	31	32	32	31	32	31	30	31	31
2	5	66	60	63	67	60	63	65	59	62	63
3	1	71	77	74	71	79	75	73	76	74	75
4	1	103	87	95	107	93	100	112	91	102	99
5	1	101	86	94	106	91	98	101	88	95	96
6	1	101	90	95	101	89	95	99	88	94	95
7	1	106	95	101	113	95	104	115	105	110	105
8	2	110	95	103	111	96	103	106	97	102	103
9	7	132	114	123	135	121	128	135	120	127	126
10	5	164	135	149	160	138	149	159	139	149	149
11	2	156	137	146	154	131	143	153	136	145	145
12	7	165	138	152	162	141	152	161	139	150	151

Note: the vaccination was given at the end of period 3

Figure 2

Average daily feed consumption (g/survivor/day) during nine "periods" for the three treatments in the study

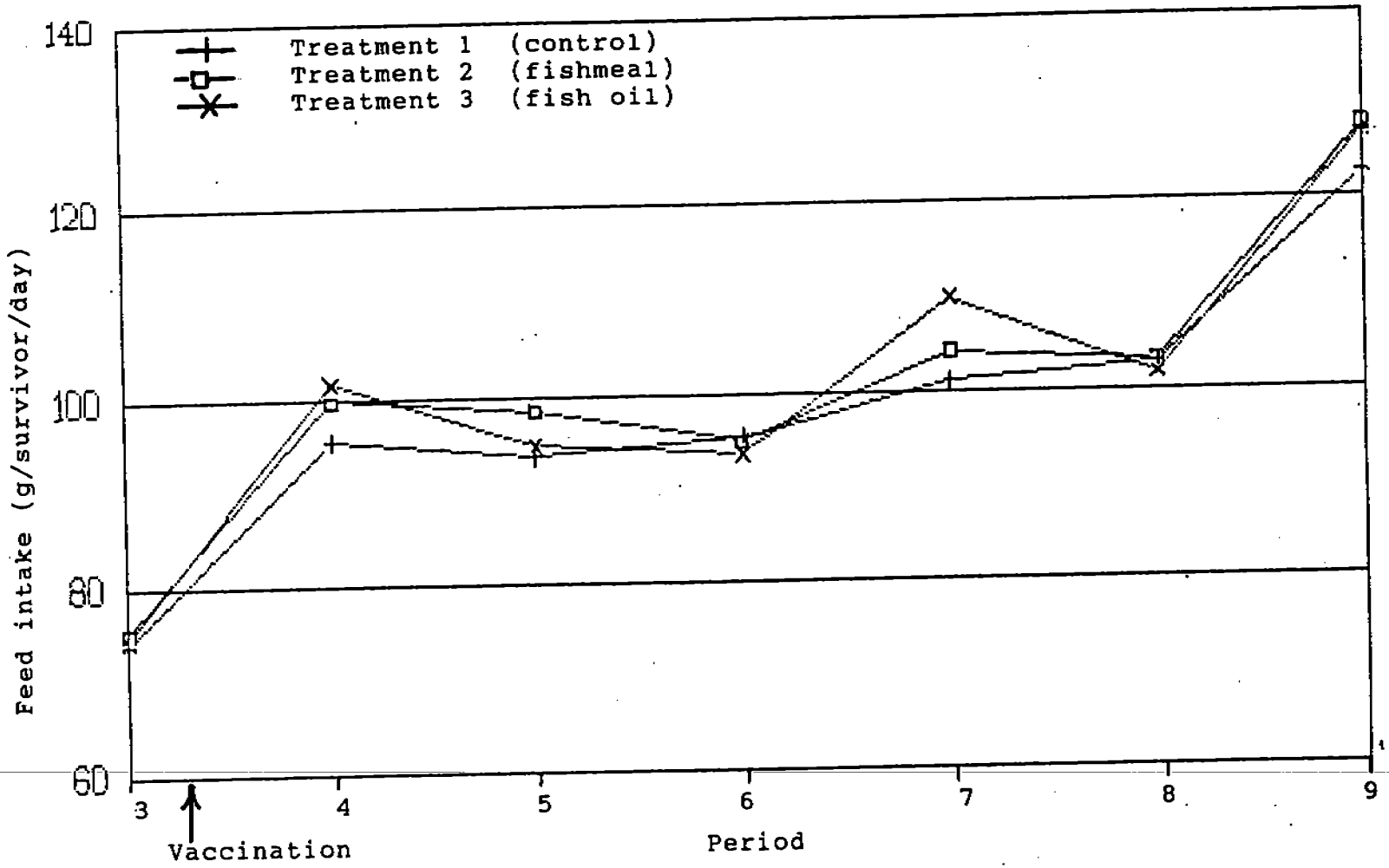


TABLE 4

RESULTS OF MEAT YIELD ANALYSIS OF 30 BIRDS PER TREATMENT

	Control treatment					
	Male		Female		Overall	
	Weight (g)	% evisc. weight	Weight (g)	% evisc. weight	Weight (g)	% evisc. weight
Live weight	2475		2067		2271	
NYD weight	2124		1784		1954	
Eviscerated wt	1623		1355		1489	
Breast meat	377	23.2	317	23.4	347	23.3
Breast skin	40	2.5	40	2.9	40	2.7
Thigh	264	16.3	209	15.4	236	15.9
Drumstick	274	16.9	210	15.5	242	16.3
Wing	179	11.1	151	11.1	165	11.1
Giblets	140	8.6	116	8.6	128	8.6
Fat	27	1.7	43	3.1	35	2.4
Carcass	429	26.4	369	27.2	399	26.8
Waste	385		316		350	

	Fishmeal treatment					
	Male		Female		Overall	
	Weight (g)	% evisc. weight	Weight (g)	% evisc. weight	Weight (g)	% evisc. weight
Live weight	2525		2152		2339	
NYD weight	2155		1853		2004	
Eviscerated wt	1647		1410		1529	
Breast meat	382	23.2	332	23.5	357	23.4
Breast skin	41	2.5	43	3.0	42	2.8
Thigh	262	15.9	216	15.3	239	15.6
Drumstick	275	16.7	219	15.5	247	16.2
Wing	190	11.6	155	11.0	173	11.3
Giblets	141	8.6	121	8.6	131	8.6
Fat	39	2.4	47	3.4	43	2.8
Carcass	432	26.2	379	26.9	405	26.5
Waste	383		330		356	

	Fish oil treatment					
	Male		Female		Overall	
	Weight (g)	% evisc. weight	Weight (g)	% evisc. weight	Weight (g)	% evisc. weight
Live weight	2440		2053		2246	
NYD weight	2088		1753		1920	
Eviscerated wt	1591		1323		1457	
Breast meat	353	22.2	307	23.2	330	22.7
Breast skin	39	2.5	35	2.7	37	2.6
Thigh	251	15.8	205	15.5	228	15.7
Drumstick	272	17.1	212	16.0	242	16.6
Wing	178	11.2	149	11.3	164	11.2
Giblets	137	8.6	119	9.0	128	8.8
Fat	39	2.4	39	2.9	39	2.7
Carcass	429	27.0	352	26.6	390	26.8
Waste	379		322		351	

Waste = viscera less giblets, head, feet, neck skin etc

DISCUSSION AND CONCLUSIONS

The sex effects identified in the data as being significant could have been anticipated.

The administration of H52 infectious bronchitis vaccine had a marked effect producing a strong reaction and secondary infection which was not treated with antibiotics. Figure 3 shows the trend for mortality for the three treatment groups by week, expressed as average losses per pen as bird numbers. Following the vaccination in week 3 a marked rise in mortality occurs and particularly in treatments 2 (fishmeal) and 3 (fish oil). Mortality was clearly decreasing as the trial progressed but the low value for week 7 is indicative of the fact that it was a "short" week (two days).

Mortality was higher in treatments 2 and 3. The blood titres (table 5) could not be analysed statistically because of the difficulties with replication i.e. bleeding the same birds from each treatment on each occasion and for some tests, blood samples were pooled within treatment groups. The results of the blood tests did not suggest a marked difference in immunity between the three treatment groups, but a more detailed veterinary interpretation is required to confirm this. The presence of Newcastle disease titres suggests a cross contamination at the hatchery or during transit as the birds were not vaccinated against the disease.

Birds were submitted for post mortem examinations and the results of these are summarised in table 6 and detailed in appendix 2. The number of birds examined reflects the trend for mortality across the treatment groups. There was no indication of any field disease challenge (as distinct from a vaccine challenge) including gumboro disease or TRT against which the birds were not vaccinated. The virulent vaccination appears to have triggered a respiratory distress followed by a secondary bacterial infection leading to mortality resulting from heart failure in some birds. The majority of birds examined showed lung problems of some sort. Gizzard lesions were apparent in a number of birds examined particularly from treatment 2 the fishmeal group. However, it should be noted that one in three of the birds examined from the control group also showed evidence of gizzard lesions. Overall, the lesions were not so severe that they affected performance or caused a problem in the processing plant.

In terms of physical performance characteristics there was evidence that including fishmeal in the diet improved liveweight and feed conversion when expressed on the basis of total weight of chicken produced. The greater weight gain may have contributed to the increased mortality. Had this not occurred, it is likely that the overall performance of this group would have been superior for most parameters measured. The use of fish oil did not seem to

Figure 3

Weekly mortality by treatment expressed as average losses per pen

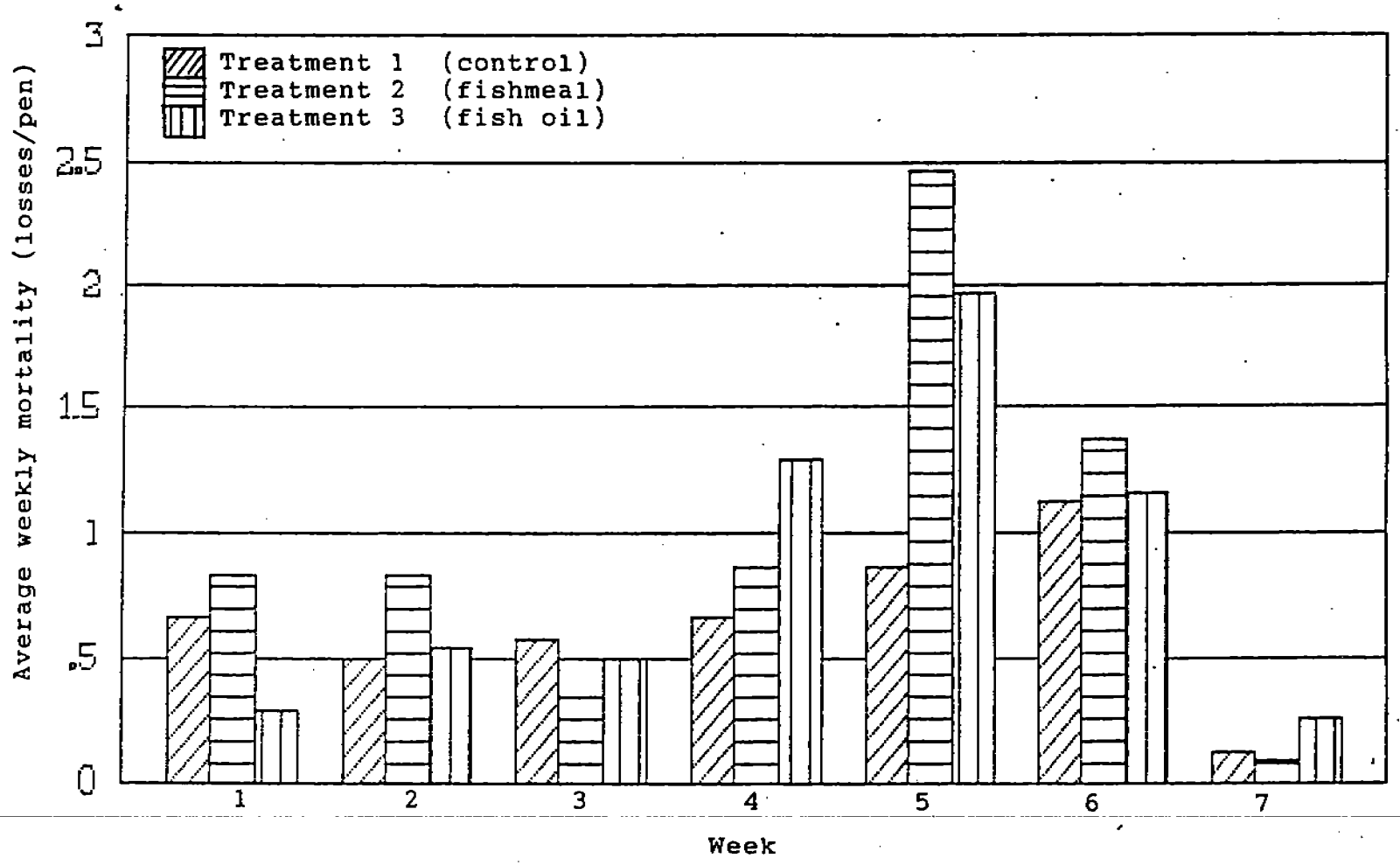


TABLE 5

AVERAGE BLOOD TITRES FOR NEWCASTLE DISEASE, INFECTIOUS BRONCHITIS AND VARIANT IB 793B SUMMARISED BY AGE AND TREATMENT (see appendix 2)

Treatment	Newcastle disease			Infectious bronchitis			IB variant 793B	
	16 days	33 days	43 days	16 days	33 days	43 days	33 days	43 days
Control	4.0	3.6	2.8	3.8	5.7	7.3	0.9	2.5
Fishmeal	3.9	3.3	3.0	3.7	5.5	6.7	0.6	3.0
Fish oil	4.2	2.8	3.1	2.9	5.3	7.3	1.6	3.2

TABLE 6

SUMMARISED RESULTS OF THE POST MORTEM EXAMINATIONS
(see appendix 2)

	Control		Treatment Fishmeal		Fish oil	
No. birds exam.	12		31		12	
Diagnosis	No. birds	%	No. birds	%	No. birds	%
Tracheitis	3	25.0	12	38.7	6	50.0
Airsacculitis	1	8.3	1	3.2	0	0.0
Bacterial infection	5	41.7	19	61.3	9	75.0
Pneumonia	5	41.7	12	38.7	4	33.3
Lung congestion /oedema	6	50.0	26	83.9	9	75.0
Heart failure	3	25.0	16	51.6	3	25.0
Abnormality of Bursar	5	41.7	9	29.0	8	66.7
Abnormality of bone marrow	0	0.0	2	6.5	2	16.7
Gizzard lesions	4	33.3	15	48.4	3	25.0

Note: a single bird could show more than one diagnosis so the total of the bird number columns will not equal the number of birds examined.

be as beneficial as the use of fishmeal.

The specific feed intake data indicated a marked effect of the vaccination with a reduction in feed consumption after period 3. There was a suggestion of a "delayed reaction" in the treatment 3 (fish oil) group but clear evidence that the fishmeal treatment maintained feed consumption better than the other groups. Whether this is a palatability effect or some other factor is not clear.

There were few significant beneficial effects of treatment on meat yield. Why the fishmeal group had larger wings is not clear but it was a real effect. Although breast meat yield tended to be lower for the fish oil group, there was no difference between the control and fishmeal groups.

APPENDIX 1

Formula [1059] Name: FMS1 Control Updated: 21-APR-94

Sell: 0.000 Margin: 0.000 %Cst: 0.00 Batch size [Kg]: 600.000
Cost: 0.000 Tonnes: 0.000 %Mar: 0.00 Group: 1047 Type:

Raw Material		%	Kg	Tonnes
43 Wheat 11% @ 76kg/hl	*	59.1667	355.000	0.000
416 Field beans	*	5.0000	30.000	0.000
423 Soya 48 Hipro	*	27.5000	165.000	0.000
474 Meat & Bone 50/10	*	2.5000	15.000	0.000
703 Limestone	*	0.2333	1.400	0.000
706 Salt	*	0.2083	1.250	0.000
709 Triphos	*	1.0417	6.250	0.000
710 Sodium Bicarbonate	*	0.1500	0.900	0.000
712 DL-Methionine	*	0.2833	1.700	0.000
713 Lysine HCl	*	0.1667	1.000	0.000
802 Soya Bean Oil	*	2.8333	17.000	0.000
812 Farmfat 55	*	0.8333	5.000	0.000
1636 Poultry Breeder P137	*	0.2500	1.500	0.000
1905 Vit E 50	*	0.0150	0.090	0.000
1924 Choline Chloride 50%	*	0.0400	0.240	0.000
1942 Elancoban Premix	*	0.0500	0.300	0.000
1983 Retardox	*	0.0250	0.150	0.000
Total:		100.2966	601.780	0.000

Analysis

[VOLUME]:	100.0000	METH :	0.6064
OIL EE :	4.8373	M+C :	0.9549
PROTEIN :	22.1863	MEP :	12.7825
FIBRE :	3.1199	C18:2 :	2.2177
ASH :	5.5625	VIT A :	14.9556
CALCIUM :	0.8952	VIT D3 :	3.9882
PHOS :	0.7423	VIT E :	99.7042
AVPHOS :	0.4490	SELEN :	0.1496
SALT :	0.3291	BIOTIN :	0.1745
SODIUM :	0.1778	POTASS :	0.8812
CHLORIDE:	0.1509	C18:3 :	0.4973
TLYSINE :	1.3072	DEB :	246.7032
AVLYSINE:	1.1344	C18:0 :	0.1198

Formula [1060] Name: FMS2 Fishmeal Updated: 21-APR-94

Sell: 0.000 Margin: 0.000 %Cst: 0.00 Batch size [Kg]: 600.000
Cost: 0.000 Tonnes: 0.000 %Mar: 0.00 Group: 1047 Type:

Raw Material		%	Kg	Tonnes
43 Wheat 11% @ 76kg/hl	*	67.5000	405.000	0.000
416 Field beans	*	5.0000	30.000	0.000
423 Soya 48 Hipro	*	12.5000	75.000	0.000
474 Meat & Bone 50/10	*	2.0000	12.000	0.000
481 Coloso Chilean fish meal	*	10.0000	60.000	0.000
703 Limestone	*	0.4000	2.400	0.000
706 Salt	*	0.0417	0.250	0.000
710 Sodium Bicarbonate	*	0.6667	4.000	0.000
712 DL-Methionine	*	0.1667	1.000	0.000
713 Lysine HCl	*	0.0367	0.220	0.000
802 Soya Bean Oil	*	0.8333	5.000	0.000
812 Farmfat 55	*	1.2500	7.500	0.000
1636 Poultry Breeder P137	*	0.2500	1.500	0.000
1905 Vit E 50	*	0.0150	0.090	0.000
1924 Choline Chloride 50%	*	0.0400	0.240	0.000
1942 Elancoban Premix	*	0.0500	0.300	0.000
1983 Retardox	*	0.0250	0.150	0.000
Total:		100.7750	604.650	0.000

Analysis

[VOLUME]:	100.0000	METH :	0.6049
OIL EE :	3.6724	M+C :	0.9265
PROTEIN :	22.3929	MEP :	12.7766
FIBRE :	2.8453	C18:2 :	1.1810
ASH :	5.4796	VIT A :	14.8846
CALCIUM :	0.8959	VIT D3 :	3.9692
PHOS :	0.6842	VIT E :	99.2310
AVPHOS :	0.4494	SELEN :	0.1488
SALT :	0.3379	BIOTIN :	0.1737
SODIUM :	0.3273	POTASS :	0.6821
CHLORIDE:	0.1532	C18:3 :	0.2461
TLYSINE :	1.2993	DEB :	247.0936
AVLYSINE:	1.1243	C18:0 :	0.1186

Formula [1061] Name: FM53 Fish oil Updated: 21-APR-94

Sell: 0.000 Margin: 0.000 %Cst: 0.00 Batch size [Kg]: 600.000
Cost: 0.000 Tonnes: 0.000 %Mar: 0.00 Group: 1047 Type:

	Raw Material		%	Kg	Tonnes
43	Wheat 11% @ 76kg/hl	*	59.1667	355.000	0.000
416	Field beans	*	5.0000	30.000	0.000
423	Soya 48 Hipro	*	27.5000	165.000	0.000
474	Meat & Bone 50/10	*	2.5000	15.000	0.000
703	Limestone	*	0.2333	1.400	0.000
704	Salt	*	0.2083	1.250	0.000
709	Triphos	*	1.0417	6.250	0.000
710	Sodium Bicarbonate	*	0.1500	0.900	0.000
712	DL-Methionine	*	0.2833	1.700	0.000
713	Lysine HCl	*	0.1667	1.000	0.000
802	Soya Bean Oil	*	0.8333	5.000	0.000
812	Farmfat 55	*	0.8333	5.000	0.000
833	Menhaden oil	*	2.0000	12.000	0.000
1636	Poultry Breeder P137	*	0.2500	1.500	0.000
1905	Vit E 50	*	0.0150	0.090	0.000
1924	Choline Chloride 50%	*	0.0400	0.240	0.000
1942	Elancoban Premix	*	0.0500	0.300	0.000
1983	Retardox	*	0.0250	0.150	0.000
		Total:	100.2966	601.780	0.000

Analysis

[VOLUME]:	100.0000	METH :	0.6044
OIL EE :	4.8174	M+C :	0.9548
PROTEIN :	22.1864	MEP :	12.7825
FIBRE :	3.1199	C18:2 :	1.1807
ASH :	5.5625	VIT A :	14.9556
CALCIUM :	0.8952	VIT D3 :	3.9882
PHOS :	0.7423	VIT E :	99.7043
AVPHOS :	0.4490	SELEN :	0.1496
SALT :	0.3291	BIOTIN :	0.1745
SODIUM :	0.1778	POTASS :	0.8812
CHLORIDE:	0.1509	C18:3 :	0.2407
TLYSINE :	1.3072	DEB :	246.7014
AVLYSINE:	1.1344	C18:0 :	0.1482

Formula [1062] Name: FM61 Control Updated: 21-APR-94

Sell: 0.000 Margin: 0.000 %Cst: 0.00 Batch size [Kg]: 2150.000
Cost: 0.000 Tonnes: 0.000 %Mar: 0.00 Group: 1047 Type:

	Raw Material		%	Kg	Tonnes
43	Wheat 11% @ 76kg/hl	*	61.1628	1315.000	0.000
423	Soya 48 Hipro	*	22.3256	480.000	0.000
432	Farm Nut Soy - Dry Extru	*	6.3953	137.500	0.000
474	Meat & Bone 50/10	*	2.3256	50.000	0.000
703	Limestone	*	0.2558	5.500	0.000
704	Salt	*	0.2209	4.750	0.000
709	Triphos	*	1.0930	23.500	0.000
710	Sodium Bicarbonate	*	0.0465	1.000	0.000
712	DL-Methionine	*	0.2093	4.500	0.000
713	Lysine HCl	*	0.1512	3.250	0.000
802	Soya Bean Oil	*	2.3256	50.000	0.000
812	Farmfat 55	*	3.2558	70.000	0.000
1636	Poultry Breeder P137	*	0.2500	5.375	0.000
1905	Vit E 50	*	0.0151	0.325	0.000
1924	Choline Chloride 50%	*	0.0400	0.860	0.000
1942	Elancoban Premix	*	0.0500	1.075	0.000
1983	Retardox	*	0.0256	0.550	0.000
		Total:	100.1481	2153.185	0.000

Analysis

[VOLUME]:	100.0000	METH :	0.5249
OIL EE :	6.4658	M+C :	0.8575
PROTEIN :	21.0608	MEP :	13.3150
FIBRE :	3.3257	C18:2 :	2.7004
ASH :	5.6012	VIT A :	14.9778
CALCIUM :	0.9017	VIT D3 :	3.9941
PHOS :	0.7327	VIT E :	100.4326
AVPHOS :	0.4493	SELEN :	0.1499
SALT :	0.3403	BIOTIN :	0.1747
SODIUM :	0.1538	POTASS :	0.8383
CHLORIDE:	0.1549	C18:3 :	0.5125
TLYSINE :	1.2147	DEB :	224.1809
AVLYSINE:	1.0530	C18:0 :	0.1507

Formula [1063] Name: FM02 Fishmeal Updated: 21-APR-94

Sell: 0.000 Margin: 0.000 %Cost: 0.00 Batch size [Kg]: 2150.000
Cost: 0.000 Tonnes: 0.000 %Mar: 0.00 Group: 1047 Type:

Raw Material		%	Kg	Tonnes
43 Wheat 11% @ 76kg/hl	*	69.7674	1500.000	0.000
423 Soya 48 Hipro	*	12.3256	265.000	0.000
474 Meat & Bone 50/10	*	2.3256	50.000	0.000
481 Coloso Chilean fish meal	*	10.0000	215.000	0.000
703 Limestone	*	0.3256	7.000	0.000
706 Salt	*	0.0349	0.750	0.000
710 Sodium Bicarbonate	*	0.5349	11.500	0.000
712 DL-Methionine	*	0.0814	1.750	0.000
802 Soya Bean Oil	*	1.6279	35.000	0.000
812 Farmfat 55	*	2.5581	55.000	0.000
1636 Poultry Breeder P137	*	0.2500	5.375	0.000
1905 Vit E 50	*	0.0151	0.325	0.000
1924 Choline Chloride 50%	*	0.0400	0.860	0.000
1942 Elancoban Premix	*	0.0500	1.075	0.000
1983 Retardox	*	0.0256	0.550	0.000
Total:		99.9621	2149.185	0.000

Analysis

[VOLUME]:	100.0000	METH :	0.5225
OIL EE :	5.2162	M+C :	0.8353
PROTEIN :	21.6083	MEP :	13.3105
FIBRE :	2.7845	C18:2 :	1.6964
ASH :	5.4391	VIT A :	15.0057
CALCIUM :	0.9020	VIT D3 :	4.0015
PHOS :	0.6867	VIT E :	100.6195
AVPHOS :	0.4633	SELEN :	0.1501
SALT :	0.3392	BIOTIN :	0.1751
SODIUM :	0.2946	POTASS :	0.6358
CHLORIDE:	0.1493	C18:3 :	0.3539
TLYSINE :	1.2169	DER :	226.4815
AVLYSINE:	1.0490	C18:0 :	0.1427

Formula [1064] Name: FM03 Fish oil Updated: 21-APR-94

Sell: 0.000 Margin: 0.000 %Cost: 0.00 Batch size [Kg]: 2150.000
Cost: 0.000 Tonnes: 0.000 %Mar: 0.00 Group: 1047 Type:

Raw Material		%	Kg	Tonnes
43 Wheat 11% @ 76kg/hl	*	62.3256	1340.000	0.000
423 Soya 48 Hipro	*	26.9767	580.000	0.000
474 Meat & Bone 50/10	*	2.3256	50.000	0.000
703 Limestone	*	0.2558	5.500	0.000
706 Salt	*	0.2209	4.750	0.000
709 Triphos	*	1.0930	23.500	0.000
710 Sodium Bicarbonate	*	0.0465	1.000	0.000
712 DL-Methionine	*	0.2093	4.500	0.000
713 Lysine HCl	*	0.1512	3.250	0.000
802 Soya Bean Oil	*	1.6279	35.000	0.000
812 Farmfat 55	*	2.3256	50.000	0.000
833 Menhaden oil	*	2.0000	43.000	0.000
1636 Poultry Breeder P137	*	0.2500	5.375	0.000
1905 Vit E 50	*	0.0151	0.325	0.000
1924 Choline Chloride 50%	*	0.0400	0.860	0.000
1942 Elancoban Premix	*	0.0500	1.075	0.000
1983 Retardox	*	0.0256	0.550	0.000
Total:		99.9388	2148.685	0.000

Analysis

[VOLUME]:	100.0000	METH :	0.5278
OIL EE :	6.4090	M+C :	0.8634
PROTEIN :	21.0112	MEP :	13.3151
FIBRE :	3.0586	C18:2 :	1.7089
ASH :	5.5187	VIT A :	15.0092
CALCIUM :	0.9028	VIT D3 :	4.0024
PHOS :	0.7297	VIT E :	100.6429
AVPHOS :	0.4496	SELEN :	0.1501
SALT :	0.3423	BIOTIN :	0.1751
SODIUM :	0.1547	POTASS :	0.8269
CHLORIDE:	0.1549	C18:3 :	0.3476
TLYSINE :	1.2135	DER :	225.1711
AVLYSINE:	1.0512	C18:0 :	0.1603

Formula [1065] Name: FMF Control Updated: 21-APR-94

Sell: 0.000 Margin: 0.000 %Cst: 0.00 Batch Size [Kg]: 2200.000
Cost: 0.000 Tonnes: 0.000 %Mar: 0.00 Group: 1047 Type:

	Raw Material		%	Kg	Tonnes
43	Wheat 11% @ 76kg/hl	*	66.1364	1455.000	0.000
423	Soya 48 Hipro	*	17.9545	395.000	0.000
432	Farm Nut Soy - Dry Extru	*	5.1136	112.500	0.000
474	Meat & Bone 50/10	*	2.2727	50.000	0.000
703	Limestone	*	0.4545	10.000	0.000
706	Salt	*	0.2159	4.750	0.000
709	Triphos	*	1.3636	30.000	0.000
710	Sodium Bicarbonate	*	0.1500	3.300	0.000
712	DL-Methionine	*	0.2159	4.750	0.000
713	Lysine HCl	*	0.1659	3.650	0.000
802	Soya Bean Oil	*	2.2727	50.000	0.000
812	Farmfat 55	*	3.4091	75.000	0.000
1636	Poultry Breeder P137	*	0.2500	5.500	0.000
1905	Vit E 50	*	0.0150	0.330	0.000
1924	Choline Chloride 50%	*	0.0400	0.880	0.000
1983	Retardox	*	0.0250	0.550	0.000
	Total:		100.0550	2201.210	0.000

Analysis

[VOLUME]:	100.0000	METH :	0.5051
OIL EE :	6.4918	M+C :	0.8089
PROTEIN :	19.0864	MEP :	13.3266
FIBRE :	3.2474	C18:2 :	2.5754
ASH :	5.8744	VIT A :	14.9918
CALCIUM :	1.0525	VIT D3 :	3.9978
PHOS :	0.7673	VIT E :	99.9450
AVPHOS :	0.5003	SELEN :	0.1499
SALT :	0.3349	BIOTIN :	0.1749
SODIUM :	0.1827	POTASS :	0.7512
CHLORIDE:	0.1502	C18:3 :	0.4897
TLYSINE :	1.0942	DEB :	214.6542
AVLYSINE:	0.9347	C18:0 :	0.1383

APPENDIX 1 CONTINUED

RESULTS OF LABORATORY ANALYSES OF THE TRIAL DIETS

Diet	Oil (%)	CP (%)	Fibre (%)	Nutrient Ash (%)	Ca (%)	P (%)	Na (%)	Mang. (ppm)
FMS1	4.33	20.95	2.80	5.34	0.86	0.68	0.14	74
Expected	4.84	22.19	3.12	5.56	0.90	0.74	0.18	-
FMS2	3.45	20.32	2.08	4.68	0.80	0.59	0.23	72
Expected	3.67	22.39	2.87	5.48	0.90	0.68	0.33	-
FMS3	4.48	20.87	2.70	5.36	0.93	0.65	0.16	81
Expected	4.82	22.19	3.12	5.56	0.90	0.74	0.18	-
FMG1 (mix 1)	5.84	20.77	3.00	5.26	0.89	0.64	0.14	85
Expected	6.67	21.06	3.33	5.60	0.90	0.73	0.15	-
FMG2 (mix 1)	4.88	19.33	2.30	4.94	0.96	0.63	0.23	81
Expected	5.22	21.61	2.78	5.44	0.90	0.69	0.29	-
FMG3 (mix 1)	5.79	19.62	2.55	5.32	0.97	0.65	0.14	87
Expected	6.41	21.01	3.06	5.52	0.90	0.73	0.15	-
FMG1 (mix 2)	6.15	20.56	2.90	5.12	1.03	0.73	0.14	92
Expected	6.67	21.06	3.33	5.60	0.90	0.73	0.15	-
FMG2 (mix 2)	5.17	20.50	2.47	4.54	0.98	0.68	0.23	85
Expected	5.22	21.61	2.78	5.44	0.90	0.69	0.29	-
FMG3 (mix 2)	5.93	20.52	2.67	4.86	0.96	0.68	0.15	87
Expected	6.41	21.01	3.06	5.52	0.90	0.73	0.15	-
FMF	6.11	18.01	2.87	5.26	1.14	0.73	0.17	99
Expected	6.49	19.09	3.25	5.87	1.05	0.77	0.18	-

APPENDIX 2

40 ETNAM STREET
LEOMINSTER
HEREFORDSHIRE
HR6 8AQ
Tel: (0568) 3232
VAT Reg. No. 549 5782 88

FAVLABS

Food and Veterinary Laboratory Services

Salmonella Testing. Submission Form and Report

NAME AND ADDRESS	CHRIS BELYAVIN (TECHNICAL) LTD 2 PINEWOODS CHURCH ASTON NEWPORT SHROPS TF10 9LN
TELEPHONE NUMBER	0952 813418
SITE	LOAH
HOUSE OR FLOCK CODE	10
NUMBER OF BIRDS IN HOUSE	4320
OTHER STOCK ON SITE	BROILERS, REPLACEMENT PULLETS
TYPE OF SAMPLE	CHICK BOX LINERS
NUMBER OF SAMPLES	
DATE SAMPLED	28/4/94

This sample/~~These samples~~ was/~~were~~ tested for Salmonella by the method described in the Poultry Laying Flocks (Registration and Testing) Order 1989, and was/~~were~~ Negative

Signed: M. J. Thomas

Date: 11/5/94

Date when next samples are due:

INVOICE

Salmonella Testing	9	00

Invoice Total	9	00
VAT	1	42
Amount Due	10	42

Discount of £0.90 *may be deducted if account is paid by* ..... Serial number.. S121 .....

Directors: P. W. Laing, B.Sc., M.R.C.V.S., F.R.S.H.; D. F. Collings, M.R.C.V.S.; S. Dunn, A.I.M.L.S.

40 ETNAM STREET
LEOMINSTER
HEREFORDSHIRE
HR6 8AQ
Tel: (0568) 3232
VAT Reg. No. 549 5782 88

FAVLABS

Food and Veterinary Laboratory Services

Salmonella Testing. Submission Form and Report

NAME AND ADDRESS	CHRIS BELYAVIN (TECHNICAL) LTD 2 PINEWOODS CHURCH ASTON NEWPORT SHROPS TF10 9LN
TELEPHONE NUMBER	0952 813418
SITE	LOAH
HOUSE OR FLOCK CODE	10
NUMBER OF BIRDS IN HOUSE	4320
OTHER STOCK ON SITE	BROILERS, REPLACEMENT PULLETS
TYPE OF SAMPLE	DOA
NUMBER OF SAMPLES	
DATE SAMPLED	28/4/94

This sample/~~These samples~~ was/~~were~~ tested for Salmonella by the method described in the Poultry Laying Flocks (Registration and Testing) Order 1989, and was/~~were~~ ....Negative.....

Signed: M. J. Thomas

Date: 11/5/94

Date when next samples are due:

INVOICE

Salmonella Testing	11	00

Invoice Total	11	00
VAT	1	73
Amount Due	12	73

S123

Discount of.....£1-10..... *may be deducted if account is paid by* ..... Serial number.....

Directors: P. W. Laing, B.Sc., M.R.C.V.S., F.R.S.H.; D. F. Collings, M.R.C.V.S.; S. Dunn, A.I.M.L.S.

40 ETNAM STREET
LEOMINSTER
HEREFORDSHIRE
HR6 8AQ
Tel: (0568) 613232 Fax: 616941
VAT Reg. No. 136 4082 81

P.W.LAING

B.Sc, F.R.S.H., M.R.C.V.S.

Blood Test Report and Invoice

NAME AND ADDRESS OF COMPANY C. Belyavin

Fifth Meal trial (18/5/94) TELEPHONE NUMBER ..... DATE: 18/5/94

FLOCK REFERENCE AND AGE T1 16 da broilers

NUMBER OF SAMPLES 12

RESULTS

								COST	
MYCOPLASMA GALLISEPTICUM PLATE TEST		+ VE	– VE	M. SYNOVIAE		+ VE	– VE		
GUMBORO AGP	ANTIBODY	+ VE	– VE	ANTIGEN		+ VE	– VE		
OTHERS TESTS									

Infectious Bronchitis—HAI

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0															
1															
2	X	X													
3	X	X	X												
4	X	X	X	X	X										
5	X	X	X	X											
6															
7															
8															
9															
10															
11															
12															

Variant Infectious Bronchitis—HAI

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
7	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
9	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
10	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
11	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
12	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Newcastle Disease—HAI

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0															
1															
2															
3	X	X		X	X										
4	X	X	X	X	X										
5	X	X	X												
6	X														
7															
8															
9															
10															
11															
12															

Others—HAI

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
7	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
9	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
10	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
11	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
12	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

	28	08
	24	30
INVOICE TOTAL	52	38
VAT	9	17
AMOUNT DUE	61	55

INTERPRETATION: Does not fit in with maternal immunity decay times, but is consistent with all the other batches of birds tested from the same delivery from the hatchery. Follow-on tests will throw more light on the situation.

Peter Laing

Discount of ..... may be deducted if account is paid by ..... Serial number 1348

40 ETNAM STREET
LEOMINSTER
HEREFORDSHIRE
HR6 8AQ
Tel: (0568) 613232 Fax: 616941
VAT Reg. No. 136 4082 81

P.W.LAING

B.Sc, F.R.S.H., M.R.C.V.S.

Blood Test Report and Invoice

NAME AND ADDRESS OF COMPANY C. Belyavin
fishmeal trial Cre'd 18/5/94 TELEPHONE NUMBER ..... DATE: 18/5/94

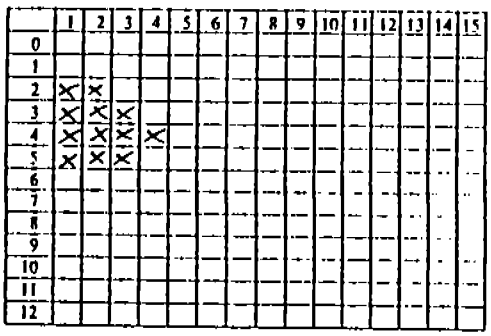
FLOCK REFERENCE AND AGE T2 16 do broilers

NUMBER OF SAMPLES 12

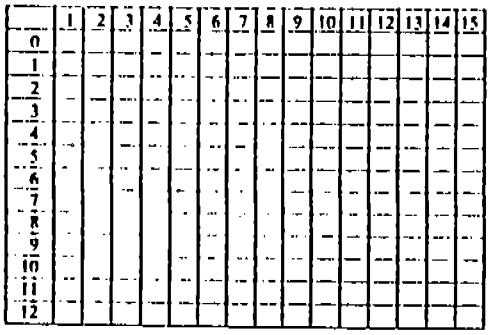
RESULTS

							Cost	
MYCOPLASMA GALLISEPTICUM PLATE TEST		+ VE	– VE	M. SYNOVIAE	+ VE	– VE		
GUMBORO AGP	ANTIBODY	+ VE	– VE	ANTIGEN	+ VE	– VE		
OTHERS TESTS								

Infectious Bronchitis—HAI

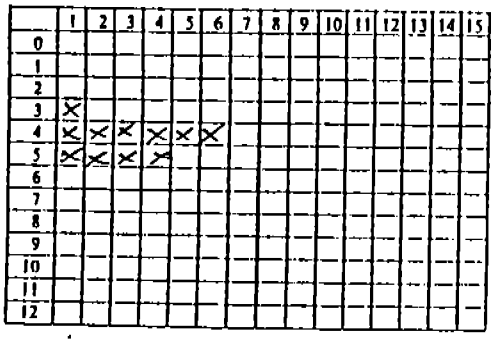


Variant Infectious Bronchitis—HAI

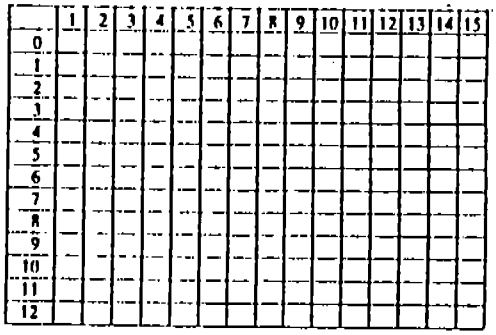


28 08

Newcastle Disease—HAI



Others—HAI



24 30

INVOICE TOTAL	52	38
VAT	9	17
AMOUNT DUE	61	55

INTERPRETATION:

See other report.

Discount of..... may be deducted if account is paid by ..... Serial number 1349

40 ETNAM STREET
LEOMINSTER
HEREFORDSHIRE
HR6 8AQ
Tel: (0568) 613232 Fax: 616941
VAT Reg. No. 136 4082 81

P.W.LAING

B.Sc, F.R.S.H., M.R.C.V.S.

Blood Test Report and Invoice

NAME AND ADDRESS OF COMPANY C. Belgavin
Fish Mead Trad Creed 18/5/94 TELEPHONE NUMBER ..... DATE: 18/5/94

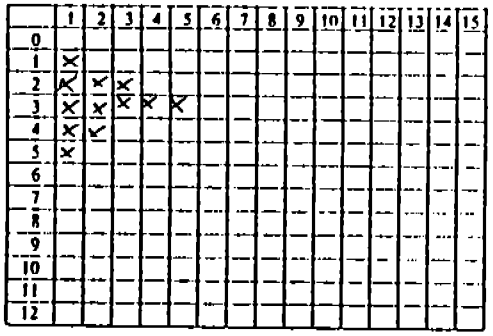
FLOCK REFERENCE AND AGE T3 16 do broilers

NUMBER OF SAMPLES 12

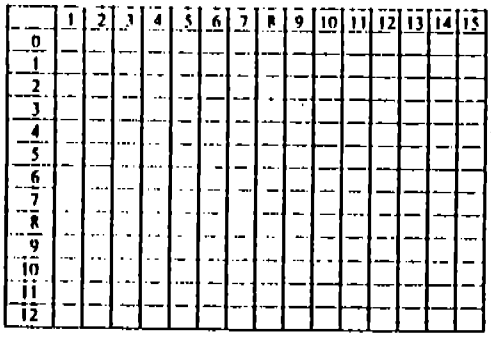
RESULTS

							Cost	
MYCOPLASMA GALLISEPTICUM PLATE TEST		+ VE	– VE	M. SYNOVIAE		+ VE	– VE		
GUMBORO AGP	ANTIBODY	+ VE	– VE	ANTIGEN		+ VE	– VE		
OTHERS TESTS									

Infectious Bronchitis—HAI

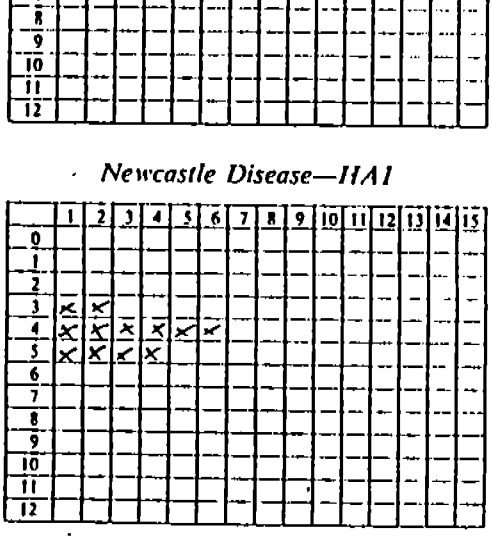


Variant Infectious Bronchitis—HAI

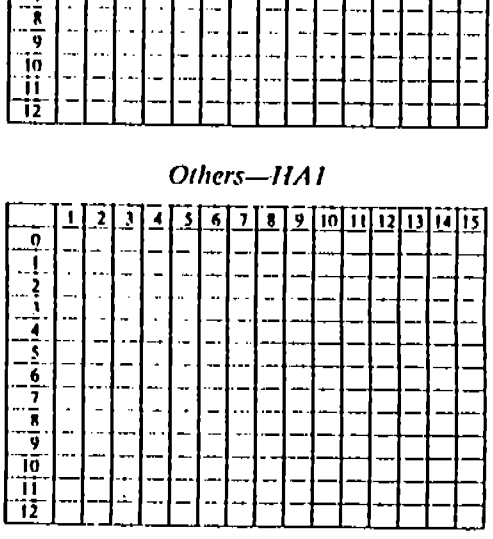


28 08

Newcastle Disease—HAI



Others—HAI



24 30

INVOICE TOTAL	52	38
VAT	9	17
AMOUNT DUE	61	55

INTERPRETATION:

See other report

Discount of ..... may be deducted if account is paid by ..... Serial number 1350

40 ETNAM STREET
LEOMINSTER
HEREFORDSHIRE
HR6 8AQ
Tel: (0568) 613232 Fax: 616941
VAT Reg. No. 136 4082 81

P.W.LAING

B.Sc, F.R.S.H., M.R.C.V.S.

Blood Test Report and Invoice

NAME AND ADDRESS OF COMPANY C. Belyavin
AFRC Head Trial
TELEPHONE NUMBER ..... DATE: 30/5/94

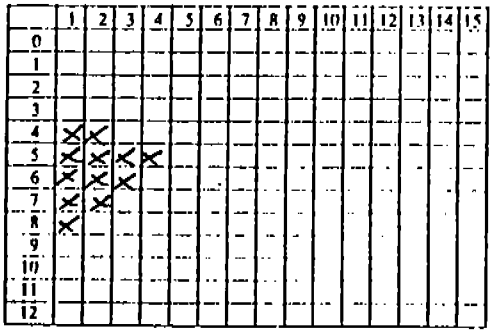
FLOCK REFERENCE AND AGE T1 33 do B

NUMBER OF SAMPLES 12

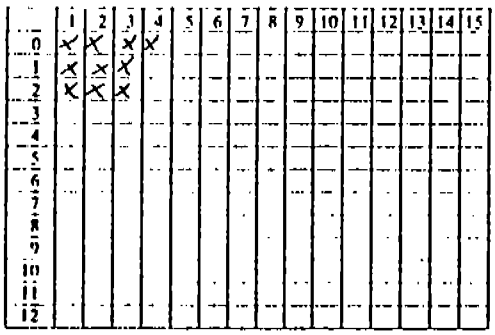
RESULTS

				Cost	
MYCOPLASMA GALLISEPTICUM PLATE TEST	0 + VE	12 - VE	M. SYNOVIAE 0 + VE (weak) 4 - VE	18	45
GUMBORO AGP	ANTIBODY	+ VE - VE	ANTIGEN + VE - VE	10	00
OTHERS TESTS					

Infectious Bronchitis—HAI

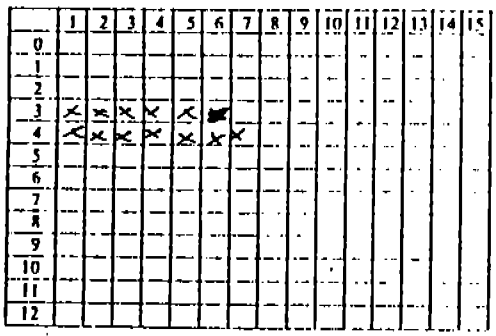


Variant Infectious Bronchitis—HAI 793 B

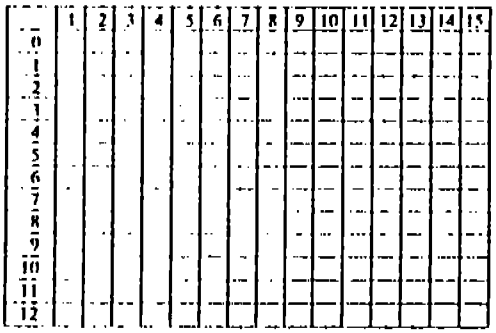


28 08
57 50

Newcastle Disease—HAI



Others—HAI



24 30

INVOICE TOTAL	138	33
VAT	24	21
AMOUNT DUE	162	54

INTERPRETATION:

Discount of..... may be deducted if account is paid by ..... Serial number 1353

40 ETNAM STREET
LEOMINSTER
HEREFORDSHIRE
HR6 8AQ
Tel: (0568) 613232 Fax: 616941
VAT Reg. No. 136 4082 81

P.W.LAING

B.Sc, F.R.S.H., M.R.C.V.S.

Blood Test Report and Invoice

NAME AND ADDRESS OF COMPANY C. Belyavin
Fish Meal Trial ..... TELEPHONE NUMBER ..... DATE: 30/5/94

FLOCK REFERENCE AND AGE T2 33 do

NUMBER OF SAMPLES 12

RESULTS

				Cost	
MYCOPLASMA GALLISEPTICUM PLATE TEST	O +VE 12 −VE	M. SYNOVIAE	O +VE 4 −VE	18	45
GUMBORO AGP	ANTIBODY +VE −VE	ANTIGEN	+VE −VE	10	00
OTHERS TESTS					

Infectious Bronchitis—HA1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0															
1															
2															
3															
4	X	X	X	X											
5	X	X	X	X											
6	X														
7	X	X	X												
8	X														
9															
10															
11															
12															

793 B
Variant Infectious Bronchitis—HA1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	X	X	X	X	X	X									
1	X	X													
2	X	X													
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															

28 08
42 50

Newcastle Disease—HA1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0															
1															
2	X														
3	X	X	X	X	X	X	X								
4	X	X	X	X											
5															
6															
7															
8															
9															
10															
11															
12															

Others—HA1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0															
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															

24 30

INVOICE TOTAL	123	33
VAT	21	58
AMOUNT DUE	144	91

INTERPRETATION:

Discount of..... may be deducted if account is paid by ..... Serial number 1354

40 ETNAM STREET
LEOMINSTER
HEREFORDSHIRE
HR6 8AQ
Tel: (0568) 613232 Fax: 616941
VAT Reg. No. 136 4082 81

P.W.LAING

B.Sc, F.R.S.H., M.R.C.V.S.

Blood Test Report and Invoice

NAME AND ADDRESS OF COMPANY C. Bolyanin

Fish Meal trial TELEPHONE NUMBER DATE: 30/5/94

FLOCK REFERENCE AND AGE T3 33 do

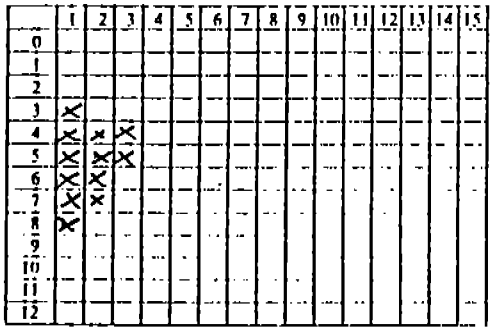
NUMBER OF SAMPLES 12

RESULTS

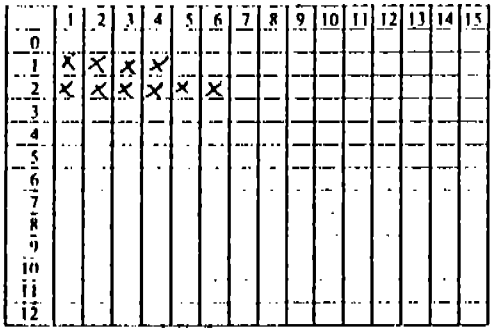
				Cost	
MYCOPLASMA GALLISEPTICUM PLATE TEST 0 + VE 12 - VE			M. SYNOVIAE 0 + VE 4 - VE	18	45
GUMBORO AGP	ANTIBODY + VE - VE		ANTIGEN + VE - VE	10	00
OTHERS TESTS					

7938

Infectious Bronchitis—HAI



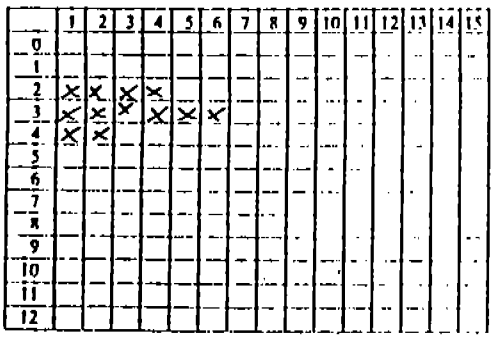
Variant Infectious Bronchitis—HAI



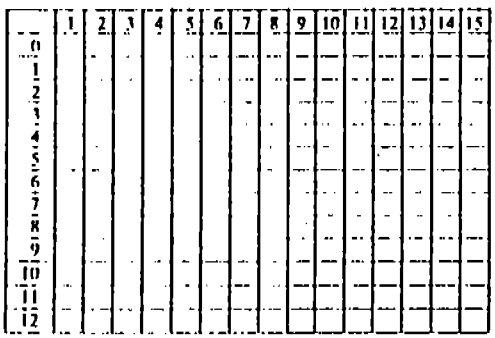
28 08

42 50

Newcastle Disease—HAI



Others—HAI



24 30

INVOICE TOTAL	123	33
VAT	21	58
AMOUNT DUE	144	91

INTERPRETATION:

Discount of..... may be deducted if account is paid by ..... Serial number 1355

40 ETNAM STREET
LEOMINSTER
HEREFORDSHIRE
HR6 8AQ
Tel: (0568) 613232 Fax: 616941
VAT Reg. No. 136 4082 81

P.W.LAING

B.Sc, F.R.S.H., M.R.C.V.S.

Blood Test Report and Invoice

NAME AND ADDRESS OF COMPANY C. Belyavin
(fish Meal trial) TELEPHONE NUMBER DATE 9/6/94

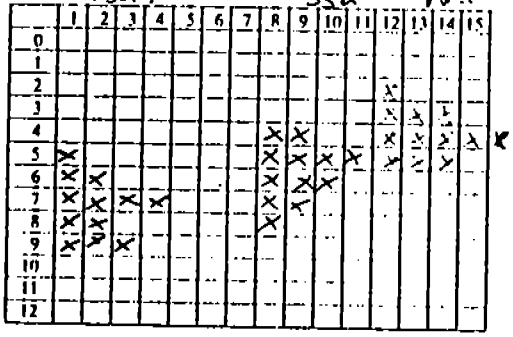
FLOCK REFERENCE AND AGE 43 do - end of trial (T1)

NUMBER OF SAMPLES 12

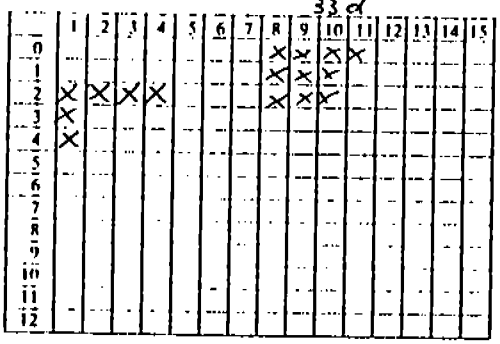
RESULTS weak.

				Cost	
MYCOPLASMA GALLISEPTICUM PLATE TEST	1 + VE 11 - VE	M. SYNOVIAE	0 + VE 12 - VE	£18.	45
GUMBORO AGP	ANTIBODY + VE - VE	ANTIGEN	+ VE - VE	£23	40
OTHERS TESTS	Chick Anaemia ELISA -ve	TRT Elisa	-ve	£39	50

Infectious Bronchitis—HAI (43d, 33d, 16d)



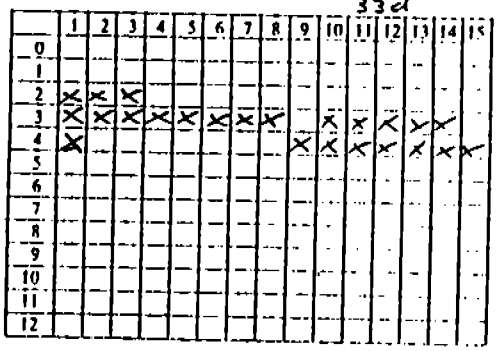
Variant Infectious Bronchitis—HAI (7935, 33d) £38 30



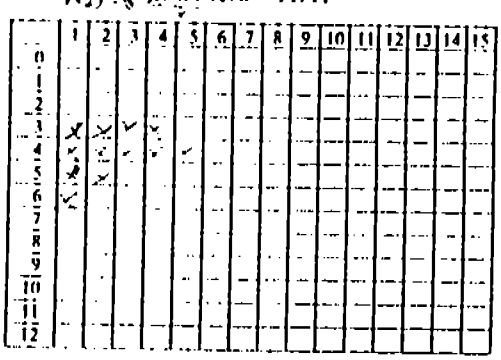
£28 08

£29 30

Newcastle Disease—HAI (33d)



Others—HAI Gumboro £21 60



£24 30

INVOICE TOTAL	£222	93
VAT	£39	01
AMOUNT DUE	£261	94

INTERPRETATION:

Discount of..... may be deducted if account is paid by ..... Serial number 1359

40 ETNAM STREET
LEOMINSTER
HEREFORDSHIRE
HR6 8AQ
Tel: (0568) 613232 Fax: 616941
VAT Reg. No. 136 4082 81

P.W.LAING

B.Sc, F.R.S.H., M.R.C.V.S.

Blood Test Report and Invoice

NAME AND ADDRESS OF COMPANY C. Bolyguin
(fish Meal trial) TELEPHONE NUMBER ..... DATE: 9/6/94

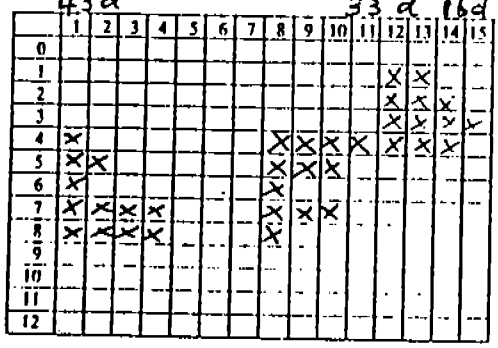
FLOCK REFERENCE AND AGE T2 — 43 do - end of trial

NUMBER OF SAMPLES 12

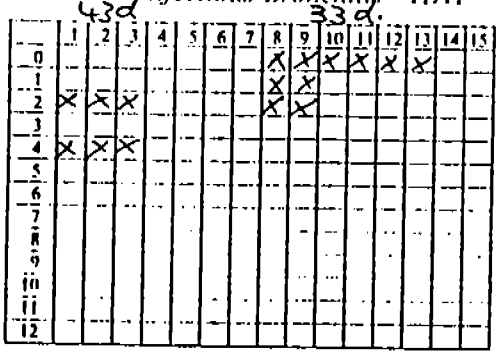
RESULTS

			Cost	
MYCOPLASMA GALLISEPTICUM PLATE TEST 0 + VE 12 - VE		M. SYNOVIAE 0 + VE 12 - VE	18	45
GUMBORO AGP	ANTIBODY + VE - VE	ANTIGEN + VE - VE	23	40
OTHERS TESTS	Chick Anaemia Elisa -ve	TRT Elisa -ve	39	50
			38	30
			28	08
			29	30
		Gumboro	21	60
			24	30
		INVOICE TOTAL	222	93
		VAT	39	01
		AMOUNT DUE	261	94

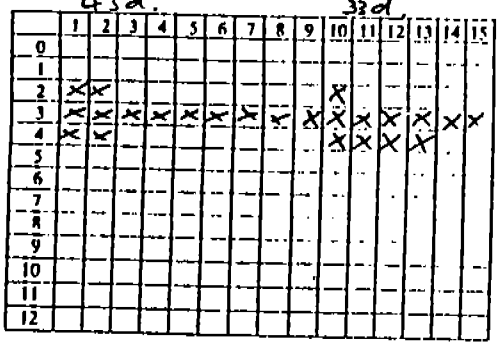
Infectious Bronchitis—HAI 43d 33d 16d



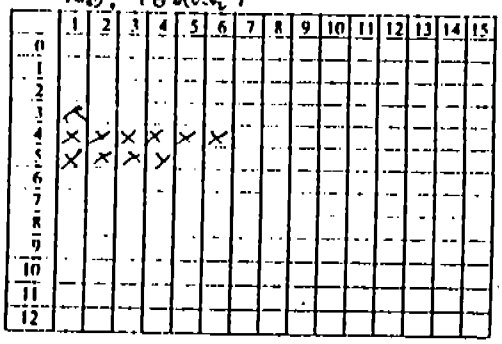
Variant Infectious Bronchitis—HAI 793B 43d 33d



Newcastle Disease—HAI 43d 33d



Others—HAI No. 16 days



INTERPRETATION:

Discount of..... may be deducted if account is paid by ..... Serial number 1360

40 ETNAM STREET
LEOMINSTER
HEREFORDSHIRE
HR6 8AQ
Tel: (0568) 613232 Fax: 616941
VAT Reg. No. 136 4082 81

P.W.LAING

B.Sc, F.R.S.H., M.R.C.V.S.

Blood Test Report and Invoice

NAME AND ADDRESS OF COMPANY C. Belyavin
(fish Meal trial) TELEPHONE NUMBER DATE: 9/6/94

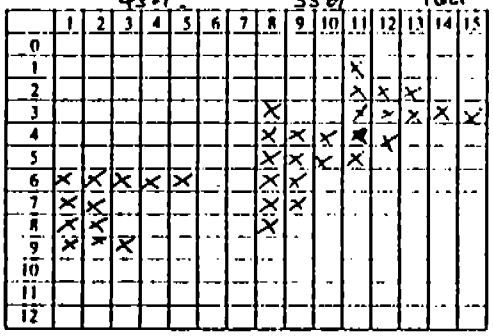
FLOCK REFERENCE AND AGE T3 - 43 dd - end of trial

NUMBER OF SAMPLES 12

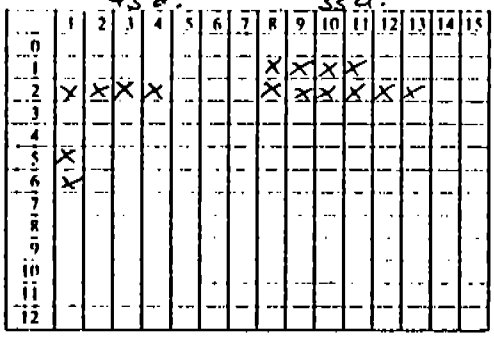
RESULTS

			Cost	
MYCOPLASMA GALLISEPTICUM PLATE TEST 0 + VE 12 - VE		M. SYNOVIAE 0 + VE 12 - VE	18	45
GUMBORO AGP	ANTIBODY + VE - VE	ANTIGEN + VE - VE	23	40
OTHERS TESTS	Chick Anaemia Elisa -ve	TRT Elisa -ve	39	50
			38	30

Infectious Bronchitis—HAI (43d, 33d, 16d)



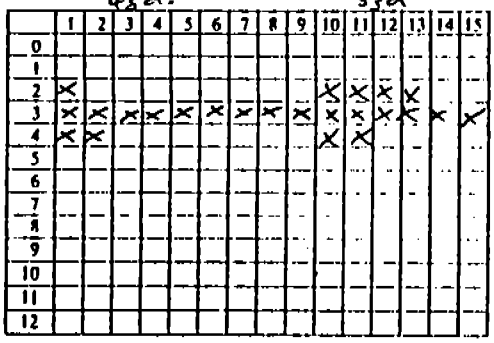
Variant Infectious Bronchitis—HAI 793B (43d, 33d)



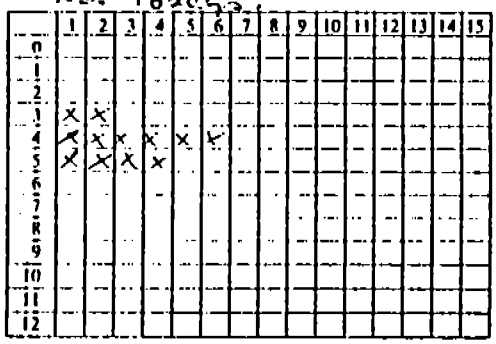
28 08

29 30

Newcastle Disease—HAI (43d, 33d)



Others—HAI N.D. 16 20 22



24 30

Gumboro: 21 60

INVOICE TOTAL	222	93
VAT	39	01
AMOUNT DUE	261	94

INTERPRETATION: Comments for all three trials. T1, T2, T3 :-
There is no evidence of a field challenge (as distinct from a vaccine challenge) for Infectious bronchitis M41 or 793B, or Newcastle disease.
No bloods at any time showed evidence of CAA or TRT

Serial number 1361

Note:- End of trial bloods from all 3 were screened for exposure to Gumboro disease and the tests indicated that all there had not been any field exposure

APPENDIX 2 CONTINUED

RESULTS OF POST MORTEM EXAMINATIONS

KEY

1. + indicates a severe infection or abnormal condition present.

   \- means no lesion present.

   + - means a slight but definite infection or abnormal condition present.

   N means normal.

   Blank left where there was no additional significance to the trial results.

2. Individual weights do not necessarily relate to the individual findings but are listed so that you can assess variations within test groups on particular days.

Wt.	= weight
Trach.	= tracheitis
Air sac	= airsacculitis
Gen. E.coli	= generalised bacterial infection
Pneu.	= pneumonia
Cong. or oedema of lung	= congestion or oedema as distinct from primary pneumonia
Heart flre.	= heart failure, including all types of the broiler-dropsy syndrome
Hyper k & HK (gizzard)	= hyperkeratinisation
Slt.	= slight
Svre.	= severe

Trial No.	Date	Age	Number exmnd	Wt.	Trach.	Air sac	Gen. E.coli	Pneu.	Cong. or oedema of lung	Heart flre.	Bursa	Bone marrow	Gizzard	Comments
Unknown	26/5	28	10	792	+ -	+	+						4 normal	
				802	+ -	+	+						1 hyper k	
				812	+ -	+	+						2 hyper k + ulceration	
				832	+ -	+	+							
				889	+ -	+	+							
				923	+ -	+	-							
				983	+ -	+	-							
				1143	+ acute	+	-		+				2 normal	
				1265	+ acute	+	-		+				1 discrete	
				1410	+ acute	+	-		+				healing ulcer	
T1	28/5		6	1197			-	-	+	+	large	N	Slt. hyper k	Gizzards
				955			+	+ -	-	-	N	N	Svre HK & haem.	all
				940		+	+	+	-	-	N	N	HK ridges	small &
				735			-	-	+	+	large	N	N	atonic
				876			+	+	-	-	small	N	N	
				685			+	-	+	-	N	N	N	
T2	28/5		5	690	-	-	+	+	+	-	small	+ -	N	Nasal
				842	+ -	-	-	-	+	+	large	N	Severe hyper k	conges-
				1074	+	-	+ -	+	+	+	N	N	N	tion
				1103	+ -	+	+ -	-	+ -	+	N	N	N	
				1408	+ -	-	+	+	+	-	small	N	Slt. hyper k	
T3	28/5		6	812	+ -		+	-	+	-	N	N	Slt. hyper k	
				992	-		+	+	-	-	small	N	N	
				1089	-		+	+	+	-	small	+ -	N	
				1089	+ -		+	-	+	-	small	N	N	
				1274	+ -		+	-	+	-	large	N	N	
				1285	+ -		+	-	+	-	N	N	N	

Trial No.	Date	Age	Number exmnd.	Wt.	Trach.	Air sac	Gen. E.coli	Pneu.	Cong. or oedema of lung	Heart flre.	Bursa	Bone marrow	Gizzard	Comments
T1	29/5		1	818	-		+	+	-	-	small	N	N	
T2	29/5		10	945			-	-	+	+	N	N	Mod. hyper k	Mainly good birds
				1012			-	-	+	+	large	N	N	
				1094			+	-	+	-	N	N	N	
				1117			+	-	+	+	N	N	N	
				1118			-	-	+	+	large	N	slt. hyper k	
				1172			-	-	+	+	N	N	1 ulcer + HK	
				1235			+	+	+	-	N	N	N	
				1398			+	-	+	-	N	N	Mod. hyper k	
				1418			-	-	+	+	N	N	N	
				1808			+	-	+	-	N	N	1 ulcer + HK	
T3	29/5		3	976	-		+	+	+	-	small	N	N	Very small gizzards
				1380	-		-	-	+	+	N	N	N	
				900	-		-	-	+	+	small	N	N	

Trial No.	Date	Age	Number exmnd.	Wt.	Trach.	Air sac	Gen. E.coli	Pneu.	Cong. or oedema of lung	Heart flre.	Bursa	Bone marrow	Gizzard	Comments
T1	30/5		Nil											
T2	30/5		13	832	+ -		-	-	-	+	N	+ -	N	
				873	+ -		+	+	+	-	N	N	Mod. hyper k	
				979	-		-	+ -	+ -	+	N	N	N	
				1132	+		+ -	+	+	+	small	N	Mod hyper k	
				1142	+ -		+	+	+	+	N	N	N	
				1224	+ -		+	-	-	-	N	N	N	
				1256	-		+ -	-	-	-	small	N	N	
				1297	-		+	-	+	-	N	N	Slt. hyper k	
				1309	+ -		-	+	+	+	N	N	Mod. HK + ulcers	
				1309	-		+	-	+	+	necrosis	N	Small ulcers	
				1333	-		+	+	+	-	N	N	Mod. hyper k	
				1594	-		-	-	+	+	N	N	Slt. hyper k	
T3	30/5		1	1062	+ -		+	-	-	-	N	+ -	Slt. hyper k	

Trial No.	Date	Age	Number exmnd.	Wt.	Trach.	Air sac	Gen. E.coli	Pneu.	Cong. or oedema of lung	Heart flre.	Bursa	Bone marrow	Gizzard	Comments
T1	09/6		5	2230 796 2175 2020 2080	+ - + + -		- - - - -	- - + - -	- + + + -	- + - - -	N small N N N	N N N N N	N N N Slt. hyper k N	
T2	09/6		3	844 1690 2420	+ + -		+ + -	+ + -	- + +	- - -	small N N	N N N	Severe hyper k N N	
T3	09/6		2	1080 913	- +		- +	- +	+ -	+ -	small small	N N	Slt. hyper k N	

APPENDIX 2

Influence of Diet on the Eating Quality of Cold Roast Chicken Breast

Objective

To investigate the influence of diet on the sensory characteristics of cold roast chicken breast.

Materials & Methods

Thirty six frozen breast samples were received from Chris Belyavin (Technical) Limited. The samples comprised 12 samples from each of 3 treatments (Groups 1 to 3) and within each group there were six male and 6 female chicken breasts.

Breast samples were thawed overnight prior to cooking, wrapped in aluminium foil and then roasted in electric computer controlled ovens set at 180 °C, until the internal temperature of the chicken breast reached 85°C.

Samples were allowed to cool at room temperature and were then placed in a refrigerator ovemight. One centimetre slices were cut, at right angles to the muscle fibre direction, from each chicken breast and then served at room temperature to a panel of 10 assessors experienced in the sensory assessment of chicken. Assessments were made under red light to mask any appearance differences that might have influenced the results.

Assessors were instructed to taste the samples in the order given and record their opinions on a computer generated form as shown in appendix 1. Assessors were not given any indication of the nature of the treatments under test.

At each session panellists assessed three samples, comprising one sample from each group within a single sex.

Results

Analysis of variance models were used to analyse the data. The results for male chickens are shown in Table 1 and show that all samples were in the categories moderately tender to very tender. However, the meat was significantly more tender from groups 1 and 3 than from group 2.

There were no significant differences between the groups for juiciness, flavour intensity or abnormal flavour intensity. Values for abnormal flavour intensity were generally low, falling within the categories weak to moderately weak abnormal flavour intensity.

In terms of overall liking there was no significant differences between the chickens.

The results for female chickens are shown in Table 2. There were no significant differences for any of the categories used and values in general were lower than those for the male chickens.

The data for male and female chickens were combined and re analysed using diet, sex and assessor as factors and the results are shown in Table 3.

Meat from groups 1 and 3 was significantly more tender than that from group 2. There were no significant differences in terms of juiciness, flavour, abnormal flavour or overall liking between the groups.

There were differences between the sexes for each of the sensory categories. Meat from male chickens was more tender and juicy with increased flavour intensity and reduced abnormal flavour intensity and was preferred over the meat from female chickens.

Assessors have the option to make and record unsolicited comments concerning any other characteristics that they have perceived. In this trial there were comments concerning fish/fish oil/ cod liver oil. For group 1 there were 3 comments, group 2, 2 comments and group 3, 11 comments. These comments were only given by a small subset of the panel (5 assessors) and were not given by these panellists at every session.

Conclusion

In this experiment, the effects due to treatment group were limited to the texture effects in male chickens with groups 1 and 3 being significantly more tender than group 2. This trend was also shown with female chickens although the results were not statistically significant.

When the results for males and females were compared, it was found that meat from male chickens was rated higher than that from female chickens. Although there was not a direct comparison between the sexes within panel, the linking factor of the same assessors being present at all panels suggests that this would be the result if they had been compared within panel.

The number of unsolicited comments made by the panel concerning fishy type notes was small when placed in the context of the total number of comments that could have been made. For example if ten assessors tasting 36 chicken each made a comment there would be a total of 360 comments. In this trial the total number of comments concerning fishy notes was limited to 16. Therefore although some assessors picked up the fishy notes the majority did not comment.

In general the chicken breast meat was of good eating quality with low values for abnormal flavour intensity and high values for tenderness

Treatments

Group 1	Control
Group 2	10% fish meal
Group 3	2% fish oil

Table 1. Influence of Diet on the Eating Quality of Cold Roast Chicken Breast

Values are the means derived from analysis of variance using diet and assessor as factors and panel as a 'block' for 6 replications.

Male chickens

	Diet					
Attribute	Group 1	Group 2	Group 3	vr	sed	signf
Texture	7.13[b]	6.70[a]	6.98[b]	9.10	0.103	***
Juiciness	4.48	4.33	4.32	0.47	0.190	ns
Flavour intensity	4.18	3.68	4.02	2.47	0.229	ns
Abnormal flavour intensity	2.68	2.97	2.72	0.88	0.233	ns
Overall liking	4.77	4.52	4.87	1.43	0.214	ns

vr = variance ratio

sed = standard error of differences of means

signf = significance value, where * = p>0.05, ** p>0.01, *** p>0.001

Means with the same superscript do not differ significantly

Table 2. Influence of Diet on the Eating Quality of Cold Roast Chicken Breast

Values are the means derived from analysis of variance using diet and assessor as factors and panel as a 'block' for 6 replications.

Female chickens

Attribute	Group 1	Group 2	Group 3	vr	sed	signf
Texture	6.81	6.64	6.75	0.99	0.120	ns
Juiciness	3.89	4.03	3.85	0.50	0.196	ns
Flavour intensity	3.60	3.71	3.54	0.43	0.182	ns
Abnormal flavour intensity	2.74	3.00	3.07	1.08	0.238	ns
Overall liking	4.09	4.22	4.07	0.30	0.210	ns

vr = variance ratio

sed = standard error of differences of means

signf = significance value, where * = p>0.05, ** p>0.01, *** p>0.001

Table 3. Influence of Diet on the Eating Quality of Cold Roast Chicken Breast

All chickens

Values are the means derived from analysis of variance using diet, sex and assessor as factors for 12 replications.

Diet

Attribute	Group 1	Group 2	Group 3	vr	sed	signf
Texture	6.94[b]	6.66[a]	6.84[b]	6.55	0.080	**
Juiciness	4.19	4.17	4.06	0.40	0.145	ns
Flavour intensity	3.82	3.71	3.78	0.33	0.137	ns
Abnormal flavour intensity	2.69	2.83	2.79	0.48	0.154	ns
Overall liking	4.38	4.38	4.47	0.25	0.150	ns

Sex

Attribute	Male	Female	vr	sed	signf
Texture	6.89	6.74	5.11	0.066	*
Juiciness	4.32	3.96	8.85	0.118	**
Flavour intensity	3.91	3.63	6.46	0.112	*
Abnormal flavour intensity	2.60	2.94	7.25	0.126	**
Overall liking	4.69	4.13	20.91	0.123	***

vr = variance ratio

sed = standard error of differences of means

signf = significance value, where * = p>0.05, ** p>0.01, *** p>0.001

Means with the same superscript do not differ significantly

Appendix 1

Category rating scales used in the assessment of cold roast chicken breast

Values subsequently awarded.

Rating	Texture	Juiciness	Chicken flavour intensity
1	extremely tough	extremely dry	extremely weak
2	very tough	very dry	very weak
3	moderately tough	moderately dry	moderately weak
4	slightly tough	slightly dry	slightly weak
5	slightly tender	slightly juicy	slightly strong
6	moderately tender	moderately juicy	moderately strong
7	very tender	very juicy	very strong
8	extremely tender	extremely juicy	extremely strong

	Abnormal flavour intensity	Overall Liking (Hedonic)
1	extremely weak	dislike extremely
2	very weak	dislike very much
3	moderately weak	dislike moderately
4	slightly weak	dislike slightly
5	slightly strong	like slightly
6	moderately strong	like moderately
7	very strong	like very much
8	extremely strong	like extremely

APPENDIX 3

UNIVERSITY OF BRISTOL

Division of Food Animal Science
Langford
Bristol BS18 7DY UK
Direct line: (44) (0117 928) 9212
DFAS Office: (44) (0117 928) 9227
Fax: (44) (0117 928) 9324 or 9505

FACSIMILE MESSAGE

TO: DR IAN PIKE
INTERNATIONAL FISHMEAL AND OIL
MANUFACTURERS ASSOCIATION

FROM: DR M ENSER

DATE: 29.11.95

FAX NO: 01727 842866

NO OF PAGES: 2

Dear Ian,

In reply to your fax of 28 November 1995 concerning the lipid analysis of the cooked chicken I am supplying the following data:

1. The chicken breasts were cooked in foil with the skin on. The skin was removed before taking samples for the taste panel but the residue of the breast muscle was left in the foil with the cooking drip and frozen. It was this muscle residue, which had absorbed the drip on cooling, that we were asked to analyse for fat content and fatty acid composition, although we were not aware of its history until we observed unusually high fat contents which were apparently the result of uptake of lipid from the drip. Hence the lipid analysed included the endogenous muscle lipid and lipid rendered from the skin and subcutaneous adipose tissue during cooking. The addition of these extraneous fats to the muscle will dilute the fatty acids of the phospholipids if the data is expressed on a % of total fatty acid basis. However, it will not have such an effect using the data expressed as mg/100g muscle since in this case the effect will be additive if the same fatty acids are present in lipid from all sources or there will be no effect if the fatty acid in question is only present in muscle phospholipid.

2. The fat content of the tissue was determined using the procedure of Folch, J., Lees, M. and Stanley, G.H.S. (1957). Journal of Biological Chemistry 226, 497-509. A simple method for the isolation and purification of lipid from animal tissues. This is the gold standard for quantifying lipids (see Enser, M. (1988) Food Science and Technology Today 2, 200-203). Sample size for extraction was 10g.

3. Fatty acid composition was determined on samples of minced muscle, 1g, saponified in 6ml of 5M potassium hydroxide in water : methanol (1:1, v/v) containing 1mg/ml hydroquinone as antioxidant. After dilution with distilled water the non-saponifiables were extracted with three washes of petroleum spirit BP 40° - 60°C. The hydrolysate was then acidified to pH 1.0 and the fatty acids extracted into petroleum spirit with three washes.

The extracts were neutralized with sodium hydrogen carbonate, dried with anhydrous sodium sulphate and the fatty acids converted to methyl esters using a solution of diazomethane in ether. The methyl esters were analysed by gas-liquid chromatography on a 50m x 0.25mm CP Sil 88 FAME column, using a split injection optimized to give a linear response from C12 to C24 fatty acids using a Carlo Erba 5160 mega GC with an A200S autosampler.

Samples of lipid from the Folch extraction were also hydrolysed, except that the alkali concentration was reduced to 2M, and gave the same fatty acid composition as direct hydrolysis of the tissue. Fatty acids were quantified using heneicosanoic acid methyl ester, added before hydrolysis, as the internal standard.

4. I will compare the results for the three treatments, combining the male and female groups to give four samples per treatment, by analysis of variance. However, there will be a short delay since the assistant who does this work and has details of the computer file holding the raw data is not available at the moment. I will send them as soon as possible.

I hope this answers all your queries except 4 but please let me know if you need more data.

Best wishes,

Mike

M.B. ENSER