

IMPACT OF A BAN ON ANIMAL BY-PRODUCTS AND ANTIBIOTIC GROWTH PROMOTERS –EUROPEAN EXPERIENCE

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Over the last ten years the UK poultry feed industry has been subjected to a series of shifts in legislation and consumer demands that has completely changed the nature of the diets being used in the production of broilers and turkeys. Feed formulas that would have been recognisable to US producers containing animal proteins and fats, ten years ago, have now turned into ‘Veggie’ diets, using basically cereal, soyameal and vegetable fats. At the same time European politicians and legislators have gradually reduced the products available for use as antibiotic growth promoters to the point that from the end of 2005 there will be none of these additives left. Other legislation has also reduced the range of anti-coccidial products, treatment antibiotics, removed all anti-histomonas drugs and made it harder for new products to become approved.

These changes have come about following a series of scares in the food industry that have caused a shift in the mentality of the consumer. The consumer, – the housewife, has reacted to these food scares by making changes in their buying patterns.

The supermarkets who have huge purchasing power in Europe over the poultry producers have reacted to become the housewife’s champion, pushing through their own demands, over and above legislation, that the food going onto their shelves is ‘minimum risk’. The UK poultry producers, being weak sellers, have had no choice but to adopt all these measures, absorb any extra costs and find the best way to survive. Failure to comply has resulted in loosing market share to other European countries, or Thailand and Brazil.

Food Scares – history.

The first major foods scare hitting the poultry industry goes back to 1988 when a UK government minister made the statement: “...**sadly a high proportion of the laying flock is contaminated with salmonella...**” At this time *S. enteritidis* was rampant in the UK, especially in commercial layers. This statement, while true, was badly presented. The public reaction was a rapid reduction in egg consumption – 50% in the first week, and close to 30% as an ongoing loss in market share. The affect on the producers was devastating. The legislators then piled on the misery by increasing the statutory testing regime on flocks, followed by slaughter of positive birds.

A few years later in 1996 BSE (Bovine Spongiform Encephalopathy) hit the headlines. What had been an increasing problem that had not been controlled by normal measures suddenly became ‘Hot News’. The media took the story and turned it into a political issue. Initially politicians and their scientists claimed that the public were not at risk, but soon evidence of transmission emerged and vCJD (variant Creutz-Feldt Jacob Disease) identified in humans. Consumption of beef plummeted, legislators rushed through changes in identification of affected cattle and handling in the abattoirs. Once a potential culprit was identified – the feed, a ban on the use of all mammalian proteins in any animal feed was introduced. There has never been evidence of transfer to poultry, but they have been subjected to the same ban.

At this stage, the supermarkets began to realise a role in ‘protection’ of their customers. Science was now a dirty word and scientists not to be believed. Although Tallow had been shown to not carry any risk, they demanded that poultry producers should stop using

it. This was quickly followed by a thought process that feeding 'like to like' was not good news, so the next demand was for a halt in the use of poultry meal and poultry fats in any poultry diets.

The safety of food had become big news and the media pursued stories to sell newspapers. Over the next few years a number of food-related issues continued to hit the headlines and dent the consumer's perception of the agricultural industry. Examples of these from across Europe have been:

- E coli in beef - UK
- Dioxins in fats – Belgium
- Sewage in feed – France
- Hormone in molasses – Holland
- Herbicides in wheat – Germany
- Chloramphenicol in fishmeal – Germany
- Cadmium in minerals – Holland (ex USA)
- Veterinary residues in imported meat – China, Brazil, Thailand
- Foot and Mouth – UK
- Dioxins in Salmon – UK
- Residues in meat of banned additives – UK
- GM Crops – imported Maize and Soya products from USA.
- Avian Influenza – is currently scaring people away from poultry consumption.

The effect of these issues has been for further legislation on the feed industry. Fishmeal was banned from ruminant diets in 2000, due to suspected cross-contamination with mammalian proteins. Feed mills manufacturing ruminant and poultry diets had to remove fishmeal from all diets, until cross over could be ruled out. Some countries extended this to a total ban and some supermarkets or fast food chains requested the removal of fishmeal on environmental concerns of loss of resources. Recycled cooking oils can no longer be used in animal feeds. Clay binders have been banned.

At the same time as these pressures were building on the ingredients used in animal feeds, another pressure group was building based on the concerns of cross resistance developing in bacteria. Strains of organisms resistant to antibiotics, were beginning to be detected in human medicine. These 'super-bugs' were beginning to cause concerns in hospitals where doctors were not able to control some diseases in their patients.

Claims were made that the wide spread use of antibiotics in agricultural was out of control and that abuse of these drugs was allowing bacteria in animals to develop resistance and that these bugs were somehow transferring this resistance to bacteria in the same family, which were then affecting humans.

The use of specific antibiotics to improve the performance of animals when fed continuously had been going on since the 1940's. The risk of cross-resistance had been identified in the 1960's and at that time the range of products that could be used was restricted to a group of drugs having no cross over with humans. Sweden was the first country in Europe to completely ban the use of antibiotic growth promoters in 1985. This ban was actually requested by the organisation of Swedish farmers, and was subsequently enforced by the Swedish government. When Sweden joined the EU in 1994 it was granted a derogation, allowing the ban to continue in Sweden whilst other EU countries continued the use of antibiotic growth promoters. Sweden lobbied for an EU wide ban through and during the late 1990s. Following the other feed scares, the pressure built to such an extent that the EU began a programme of re-evaluation of all feed additives and a

campaign of removal of ‘unsafe’ products developed. Many times decisions were made without or with very limited scientific input, the actual vote being won on political rather than scientific grounds. Some companies have refused to reinvest in the registration process, finding that the hurdles set by the EU required large expenditure in re-proving the efficacy and safety of products. Even after that outlay there are no guarantees of approval and no assurances that the approval will last long enough to recover the investment before a new set of regulations might sweep them away.

Products lost to UK industry

Active Ingredient	Activity	Date of Ban
Furazolidone	General antibiotic	1990?
Avoparcin	AGP	1996
Spiramycin	AGP	1999
Tylosin	AGP	1999
Zinc Bacitracin	AGP	1999
Virginiamycin	AGP	1999
Dimetridazole	Anti Histomonas	2000
Avilamycin	AGP	1999/2001/2004 Industry Ba
Bambermycin	AGP	1999/2001/2004 Industry Ba
Nifursol	Anti Histomonas	2003
Avilamycin	AGP	2006 EU Ban
Bambermycin	AGP	2006 EU Ban

Coccidiostats that have disappeared from the market since 2002

Active ingredient	Brand name
Amprolium	Amprol
Amprolium/Ethopabate	Amprol Plus
Clopidol	Coyden
Clopidol/Methylbenzoquate	Lerbek
Nicarbazin	Various
Salinomycin	Generic versions
Monensin	Generic versions

Growing Poultry without Animal By-products

In the space of 2 years the UK poultry industry had to learn to produce diets without any animal by-products. The ingredients which may have been used prior to this time where:

- Meat and Bone Meal
- Blood Meal
- Animal Tallow
- Poultry Meal
- Feather Meal
- Poultry Fat
- Fish/meat protein blends
- Fish Meal – mixed mills/some customers

What feed ingredient is still allowed to be used?

- Soyabean meal – Hipro 49%
- Full Fat soya – toasted, extruded or expanded
- Rapeseed extracted meal (Canola)
- Whole Rapeseed
- Sunflower meal – 30% or 38%
- Pulses – peas and beans
- Pulse/rapeseed blends (cooked)
- Potato protein meal
- Corn Gluten 60%
- DDS
- Biscuit / cooky meal
- Rice Bran
- Vegetable Fats
- Vegetable soap-stocks

What have been the consequences of removing these animal by-products and having to rely on vegetable proteins? Other than the protein and essential amino acid content, animal proteins are good sources of:

- Calcium
- Phosphorus – none phytate
- Trace Minerals –organic form
- Vitamin B12
- Choline
- Glycine
- Saturated fats
- Long chain fatty acids -fish
- Carnitine

However, because they are by-products they, they also have negative attributes, such as variable analysis; availability of some nutrients can be variable, depending on processing; and high microbiological risk.

Removal of these animal proteins happened in stages. Meat and Bone meals was removed from feeds very quickly after the BSE situation blew up in 1996. This initially required rebalancing of the formulas to be able to meet the diet specifications. But, in integrated companies with poultry meal and fishmeal still available, this presented very few difficulties as long as all the nutrients were rebalanced. Following this first change, performance of the birds improved, we saw an increase in growth and less variation in results between farms. This was attributed to the variability and variation in the quality of the meat and bone meals.

Companies that were not using poultry meal at this time experienced a few more problems in balancing diets, but they tended to rely on increased levels of fishmeal and vegetable protein, such as Full-Fat Soya and Canola meal. In 1997, when the poultry meal, animal tallow and poultry fat was forced out by consumer demand, the diets became quite different. Fishmeal remained as the only ‘Animal’ protein source, but due to its cost was only used routinely in starter and grower diets. From 2000, Fishmeal was banned in some countries and in mixed feedmills. Examples of how broiler starter and finisher diets evolved are shown in Tables 1 and 2, respectively. Examples of how turkey starter diets evolved are shown in Tables 3 and 4. These show the increased reliance on

mineral phosphates and synthetic amino acids and the use of vegetable oils to replace the animal fats. Following the removal of fishmeal, there has been a wider use of vegetable protein sources. Full-Fat Soya is used as a source of highly digestible fat, to replace some of the poultry oil and tallow. Another product that is now used widely in poultry diets is a combination (50:50 mix) of Canola seed and pulses, such as Field beans or peas. This is usually processed through an expander or extruder to make the oil fully available, and to destroy some of the anti-nutritive factors in the vegetable products.

In general terms growing poultry on 'veggie' diets has been achievable. There has been a need to balance out micro nutrients and this was a learning curve over the first few months. The following issues have arisen during this period:

1. Cannibalism increased, not as an increase in aggression, but as consumption of any mortality left for more than a few hours. This has been reduced by adjustment of phosphate levels and an increase in trace minerals. Moving to a digestible phosphorus system has resolved some of these issues. By increasing the reliance on vegetable proteins the amount of phytate phosphorus in the diet has increased. Also the use of increased levels of mineral phosphate has highlighted the importance of assigning digestibility values to different types of phosphate. Some of the cases of cannibalism have responded to the addition of chelated trace minerals, indicating that the animal proteins may have been providing these minerals in an organic form.

Phosphorus digestibility in feed ingredients

Wheat	27%
Maize	17%
Barley	30%
Oats	27%
Hipro Soya	22%
Sunflower meal	19%
Canola Meal	28%
Fishmeal	81%
Meat & bone meals	95%
Poultry meal	90%
Midds	27%
Distillers Grains	25%
Rock Phosphate	72%
Mono calcium phosphate	84%
Dicalcium Phosphate	76%

2. Litter was initially harder to manage, with more cases of enteritis. During the changes in ingredient usage there were also changes in the use of AGP's going on so the situation was quite complicated. However, some of these litter issues related to the 'veggie' diets was associated with electrolyte levels and the types of fat being used. By moving away from animal proteins, the balance of Sodium, Potassium and Chloride in the diets altered. Vegetable proteins, especially Soya are high in Potassium, and low in Sodium and Chloride. Simple adjustment of added salt or sodium bicarbonate back to the same levels did not appear to resolve the problems. Water intake on the vegetable diets does tend to be higher than on

diets using animal proteins. There is now a tendency to use lower sodium and chloride levels in the diets.

Electrolyte Levels in Ingredients

	Sodium	Potassium	Chloride
Meat+Bone Meal	0.6	0.55	0.65
Poultry Meal	0.2	0.3	0.25
Fish Meal	1.3	0.7	2.0
Soya Hipro	0.04	2.1	0.05
Canola meal	0.01	1.3	0.07
Sunflower Meal	0.01	1.5	0.15

Electrolyte Balance in Turkey Starter diets

Turkey Starter	Sodium	Potassium	Chloride	MEQ
Animal	0.15	0.95	0.23	258
Vegetable	0.14	1.15	0.18	297

In the move away from animal fats, blends containing high levels of vegetable oil soapstocks have been used, to try and provide a cost effective replacement. These can be quite variable in the levels of Free Fatty Acid (FFA) and Unsaponifiable materials.

Some samples of Palm Fatty Acid have been seen with FFA levels close to 90%. When these are included in blends the FFA level in some blends has been over 40%.

Young birds cannot handle these types of materials and the fat passes through the gut undigested and can also lock up some of the minerals as soaps. To maintain performance, it has been found necessary to use pure vegetable oils in diets for young birds and then to gradually move to the vegetable blends as the birds get older. The type of blends now in use will have a FFA content of no more than 25%.

Growing Poultry without Antibiotic Growth Promoters (AGP)

In the late 1990's, it was becoming clear that the pressure to remove AGPs was gradually increasing. The Scandinavian countries had begun to make the transition to removing these products because of the concerns about increased resistance of bacteria to certain antibiotics. When some of these countries joined the EU in 1994 they began to influence the thought processes of the law makers of the EU in Brussels. The poultry industry, realising what was coming, began to evaluate the effects of removing these additives. In small scale trials the actual changes in performance did not appear to be too detrimental. When one UK company announced that it had run its own trials and would remove all AGPs at the end of 1999 as a marketing strategy, the supermarkets immediately jumped on the band-wagon and demanded that all their chicken product suppliers should follow suit.

So we all plunged in, believing that our trial work showed the results were not going to be too bad. Minor adjustments were made to the diets, but there was no major shift in diet composition and probably no changes to management practices. Most companies would have been on mainly vegetable protein and vegetable oil diets, using some fishmeal in starter and grower diets, but no other animal products. For the first 6 months, performance was generally quite good and then as we got into the winter months the incidence of Necrotic Enteritis (NE) and wet litter gradually began to increase and the

number of rejects at processing began to rise. The use of antibiotics to treat the problems began to increase. Penicillin and similar drugs were being used to treat the NE and broad spectrum products were used against the enteritis problems. Growth of the birds tended to hold up quite well, but feed conversions (FCR) deteriorated significantly, by 10 to 15 points on some of the worse affected farms. Most producers struggled through that first winter supporting performance with antibiotics, expecting that as the warmer weather returned things would get better. They did but only marginally, the incidence of NE decreased, but the problems of the enteritis and wet litter continued.

A new phrase developed to describe the 'condition' – **Dysbacteriosis**, which became the description for what was being seen on the farm. It loosely describes the state where by there is a massive proliferation of bacteria in the gut of the bird. The response is for the bird to try to flush out the gut, resulting in high levels of water consumption. The droppings when seen on the litter tend to be very wet and visually appear as a normal type dropping, but very wet, surrounded by a large ring of water.

Gradually it dawned upon the industry that this was a problem that was not going to be resolved within existing systems. The removal of the AGPs had shifted the landscape: these products had maintained a level of bacterial stability that was not really evident until they had been removed. The poultry industry responded to the challenge and began to evaluate how to produce poultry without these additives.

After 5 years, I would say that the production and performance of poultry in the UK has never been better.

The approaches that have been taken and appear to be beneficial are:

1. Reduce the bacterial load going into the bird
 - a) Feed is now processed to achieve low levels of enterobacteriaceae. Targets are <10cfu/g after pelleting and <10³ cfu/g on-farm
 - b) Maintain the litter in a dry and friable state – the depth of material is generally greater, more gas will be used to drive ventilation to keep the litter dry. It is important not to let bacterial levels build in the litter.
 - c) Match stocking densities to the capabilities of the ventilation system so that the litter is not overloaded.
 - d) Monitor water quality and ensure bacterial levels are kept low, through sanitisation.
2. Promote the development of gut health
 - a) Use of a probiotic to seed the gut with friendly bacteria is used in some companies.
 - b) Stimulate the physical activity of the intestines
 - Coarse grist of feed particles
 - Adding whole wheat as a gizzard stimulant
 - Meal feeding rather than free access
 - c) Enforced rest periods – minimum 4 hours dark
 - d) Increased use of feed ingredients with soluble fibre and reduction of insoluble fibre fractions.
3. Improved digestibility of feeds to reduce the supply of nutrients to lower intestine bacterial populations.
 - a) Use highly digestible fats especially in early diets

- b) Incorporation of exogenous enzymes - xylanase and phytase
 - c) Selecting of ingredients with a higher and faster digestibility of starch.
 - d) Minimisation of wheat in diets by use of alternative cereals – maize, oats, barley.
 - e) Reduce non-protein nitrogen levels by formulating based on digestible amino acids and through the use of higher levels of synthetic amino acids.
 - f) Adjust electrolyte levels to minimise stimulation of water consumption
4. Strategic use of coccidiostats and antibiotics.
- a) Selection of anticoccidial products that have the highest level of activity against clostridia, used in the right sequence at the vulnerable stages.
 - b) Reacting quickly to control enteritis by pre-empting problems: monitor water consumption, this will often increase at the start of a problem. Antibiotics are then given in a short sharp dose to clear the problem up.
 - c) Good husbandry, observe bird behaviour, feed selection/flicking is seen at the start of a problem. Treat the birds when this is seen.
5. Maintain tight biosecurity on farms.
- a) Sites should be single age all-in all-out.
 - b) Down time between flocks needs to be adequate, minimum 5 days.
 - c) Full cleanout, removal of litter, washing and disinfection.
 - d) If taking an undercrop out the hygiene of the catching gang needs to be controlled.
 - e) Movement of personnel from farm to farm increases risk

AGP Replacement

There are many products that have come into the market since the removal of the AGPs. There are many types and claims for these products. Some alternatives that are promising as partial replacements of AGPs include; probiotics, prebiotics, organic acids, enzymes, herbs, phenolic aromatic components and many others. However, AGPs appear to have a unique mode of action, and it is probably not possible to replace this with products that by their nature have a different mode of action. The bacterial populations within the gut appear to have been controlled very effectively by the AGPs. Alternative products do not seem to have as consistent effect in controlling the bacterial populations and this probably explains some of the lack of consistency in responses when these alternatives are evaluated under field conditions.

Conclusions.

Due to legislative and consumer demands the nature of the diets being fed to commercial poultry in Europe has changed significantly over the last 10 years.

Animal proteins and fats have been removed from the diets. The use of AGPs will cease completely from 2006, although the majority of broilers and turkeys have been produced without these additives for several years. Through a gradual learning process, diets have been manipulated to minimise the initial problems of increased enteritis. By promoting gut health and adjusting the balance and use of ingredients in diets birds are now being successfully reared without animal proteins and AGPs. However, the use of treatment antibiotics continues in a more strategic and targeted programme to ensure bird welfare does not suffer.

TABLE 1. CHANGES IN BROILER A STARTER DIET COMPOSITION DUE TO INGREDIENT AVAILABILITY

		NO M+B	NO POULTRY	NO FISH
WHEAT		61.72	63.49	65.62
HIPRO SOYAMEAL		23.67	22.00	21.33
FISHMEAL		2.00	4.00	6.00
MEAT & BONE		2.67	-	-
POULTRY MEAL		3.00	3.00	-
TALLOW		1.87	1.70	-
POULTRY FAT		2.07	2.10	-
MONO DICAL		0.73	1.20	1.30
LIMESTONE		0.80	1.10	1.23
SALT		0.20	0.17	0.10
EXTRUPRO		-	-	-
SOYA OIL		-	-	3.07
VITAMIN PREMIX		0.50	0.50	0.50
METHIONINE DL		0.25	0.23	0.23
LYSINE MONO HCL		0.30	0.30	0.33
THREONINE		0.10	0.10	0.13
SODIUM BICARB		0.12	0.10	0.13
Enzyme NSP		0.01	0.01	0.01
<u>CALCULATED ANALYSIS</u>				
PROTEIN	%	23.06	22.42	21.67
OIL 'A'	%	5.93	5.69	4.80
FIBRE	%	2.36	2.29	2.28
ASH	%	5.56	5.79	5.95
D:M:	%	88.18	88.09	88.04
TLYSINE	%	1.44	1.44	1.43
DG LYS	%	1.30	1.30	1.30
METH	%	0.60	0.60	0.61
DG METH	%	0.57	0.57	0.58
CALCIUM	%	1.01	1.00	1.00
T:PHOS	%	0.75	0.75	0.76
DG PHOS	%	0.43	0.43	0.43

**TABLE 2. CHANGES IN BROILER A FINISHER DIET COMPOSITION
DUE TO INGREDIENT AVAILABILITY**

		NO M+B	NO POULTRY	NO FISH
WHEAT		65.84	64.04	63.69
BARLEY		5.00	5.00	5.00
HIPRO SOYAMEAL		15.33	19.00	21.00
MEAT & BONE		5.00	-	-
POULTRY MEAL		3.00	3.00	-
TALLOW		1.13	2.27	-
POULTRY FAT		3.00	3.00	-
MONO DICAL			1.30	1.50
LIMESTONE		0.33	0.93	1.03
FISHMEAL		-	-	1.00
SOYA OIL		-	-	2.33
VEG. FAT BLEND		-	-	3.00
EXTRUPRO		-	-	-
SALT		0.20	0.30	0.27
VITAMIN PREMIX		0.50	0.50	0.50
METHIONINE DL		0.15	0.17	0.15
LYSINE MONO HCL		0.30	0.30	0.30
THREONINE		0.10	0.10	0.13
SODIUM BICARB		0.10	0.08	0.08
Enzyme NSP		0.01	0.01	0.01
<u>CALCULATED ANALYSIS</u>				
PROTEIN	%	19.80	18.83	18.40
OIL 'A'	%	6.18	6.87	6.71
FIBRE	%	2.40	2.39	2.42
ASH	%	4.43	5.19	5.39
D:M:	%	88.08	88.06	88.09
TLYSINE	%	1.16	1.16	1.14
DG LYS	%	1.04	1.04	1.04
METH	%	0.44	0.45	0.43
DG METH	%	0.41	0.42	0.41
CALCIUM	%	0.85	0.86	0.85
T:PHOS	%	0.63	0.68	0.69
DG PHOS	%	0.37	0.37	0.37

TABLE 3. CHANGES IN A TURKEY STARTER DIET COMPOSITION DUE TO INGREDIENT AVAILABILITY

		NO M+B	NO POULTRY	NO FISH
WHEAT		41.96	42.12	40.44
BARLEY		5.00	5.00	5.00
HIPRO SOYAMEAL		37.00	37.00	37.00
FISHMEAL		2.66	3.48	5.24
MEAT & BONE		2.00	-	-
POULTRY MEAL		3.60	3.60	-
TALLOW		1.00	1.00	-
POULTRY FAT		2.38	2.70	-
MONO DICAL		1.94	2.40	2.54
LIMESTONE		1.06	1.30	1.46
SOYA OIL				2.00
EXTRUPRO				5.00
MAIZE GLUTEN 60				1.00
SUNFLOWER				2.00
PEAS				2.00
SALT		0.06	0.06	0.06
VITAMIN PREMIX		0.50	0.50	0.50
METHIONINE DL		0.23	0.23	0.21
LYSINE MONO HCL		0.30	0.30	0.30
THREONINE		0.06	0.06	0.06
SODIUM BICARB		0.17	0.17	0.11
<u>CALCULATED ANALYSIS</u>				
PROTEIN	%	28.38	27.93	28.14
OIL 'A'	%	5.47	5.66	3.76
FIBRE	%	2.55	2.51	3.01
ASH	%	7.36	7.63	8.00
D:M:	%	88.39	88.38	88.26
TLYSINE	%	1.85	1.85	1.85
DG LYS	%	1.68	1.68	1.69
METH	%	0.67	0.67	0.68
DG METH	%	0.63	0.63	0.64
CALCIUM	%	1.36	1.37	1.37
T:PHOS	%	1.05	1.06	1.09
DG PHOS	%	0.65	0.65	0.65

**TABLE 4. CHANGES IN A TURKEY FINISHER DIET COMPOSITION
DUE TO INGREDIENT AVAILABILITY**

		NO M+B	NO POULTRY	NO FISH
WHEAT		61.23	57.67	46.23
BARLEY		5.00	5.00	5.00
HIPRO SOYAMEAL		10.60	15.80	14.00
MEAT & BONE		6.00	-	-
POULTRY MEAL		5.00	5.60	-
TALLOW		8.08	9.28	-
POULTRY FAT		3.00	3.00	-
MONO DICAL		0.03	1.54	2.00
LIMESTONE		0.03	0.70	0.90
FULL FAT SOYA		-	-	7.00
EXTRUPRO		-	-	8.00
MAIZE GLUTEN		-	-	1.84
SOYA OIL		-	-	2.00
VEG. FAT BLEND		-	-	7.00
BISCUIT MEAL		-	-	5.00
SALT		0.14	0.26	0.22
VITAMIN PREMIX		0.50	0.50	0.50
METHIONINE DL		0.13	0.30	0.12
LYSINE MONO HCl		0.06	0.02	0.03
THREONINE		0.02	0.18	-
SODIUM BICARB		0.17	0.14	0.15
Enzyme NSP		0.01	0.01	0.01
<u>CALCULATED ANALYSIS</u>				
PROTEIN	%	18.62	18.27	18.06
OIL 'A'	%	13.30	14.02	13.70
FIBRE	%	2.17	2.08	2.86
ASH	%	4.28	5.15	5.62
D:M:	%	89.00	88.97	89.29
TLYSINE	%	0.92	0.93	0.90
DG LYS	%	0.80	0.80	0.80
METH	%	0.40	0.57	0.40
DG METH	%	0.37	0.54	0.37
CALCIUM	%	0.91	0.91	0.90
T:PHOS	%	0.68	0.74	0.77
DG PHOS	%	0.45	0.45	0.45