Influence of Diet on Breast Meat Yield

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Introduction

Breast meat, in the majority of countries, is the most valuable part of the turkey carcass. While breast meat only contributes 26-28% of the weight of the bird, it probably represents 60-70% of the income from the carcass in most European countries. It would therefore be of economic importance to maximise the growth of breast meat in terms of the weight of breast meat per bird, and the percentage that it takes up in the carcass, i.e. the yield (% of total bird weight).

It is widely accepted following work by animal scientists such as Sir John Hammond in the last century that body tissues do not grow and develop in complete synchrony. This can be appreciated when you consider the change in body shape of animals and birds as they increase in size and age. Body tissue growth occurs in a fixed pattern as mature size is approached, i.e. initially there is a wave of growth of nervous tissue, followed by a wave of skeletal growth, then muscle and the latest developing tissue is fat. This is summarised in the diagram below (Figure 1). Similarly muscles grow and develop at different rates, and the breast is one of the latest developing muscles in the turkey.

Figure 1: Summary of growth rate according to age

The point of time that a bird is killed will therefore affect the final composition of the carcass, in terms of levels of fat, bone and muscle content. The amount of muscle deposited will have a dramatic effect on the economic value of the carcass. The same could be said for the content of the other tissues, i.e. bone and fat. These could be considered to be waste tissues (trim), depending on the type of final processed product. The influence of fat on meat quality will not be covered here.

In order to maximise profits and minimise wastes and costs it is important to maximise breast meat development and minimise proportions of waste tissue e.g. fat and bone. It is useful to understand how a bird develops with age and the point of time of kill can affect the carcass composition. For example killing birds at an earlier age may tend to increase the amount of bone relative to muscle and fat, whilst killing birds at older ages may tend to increase the ratio of fat to muscle.

It is surprising that despite the economic importance of this tissue, relatively few processing plants routinely monitor breast meat yield. Similarly farmers are not usually paid on a breast meat yield basis, and the emphasis during rearing tends to concentrate on feed conversion ratios instead of maximising yields. Relating breast meat weights to body weight at slaughter, and recording previous flock sample weights (growth profiles) can be invaluable in understanding and increasing meat yield.

Growing farms are encouraged to monitor bird progress by regular sample weighing, and comparing weights against Breed goals. In the field there are a wide range of commercial growing units, and typical slaughter weights range from 80-110% of BUT goals in all strains. There are many factors influencing growth and performance, which are summarised in Figure 2.

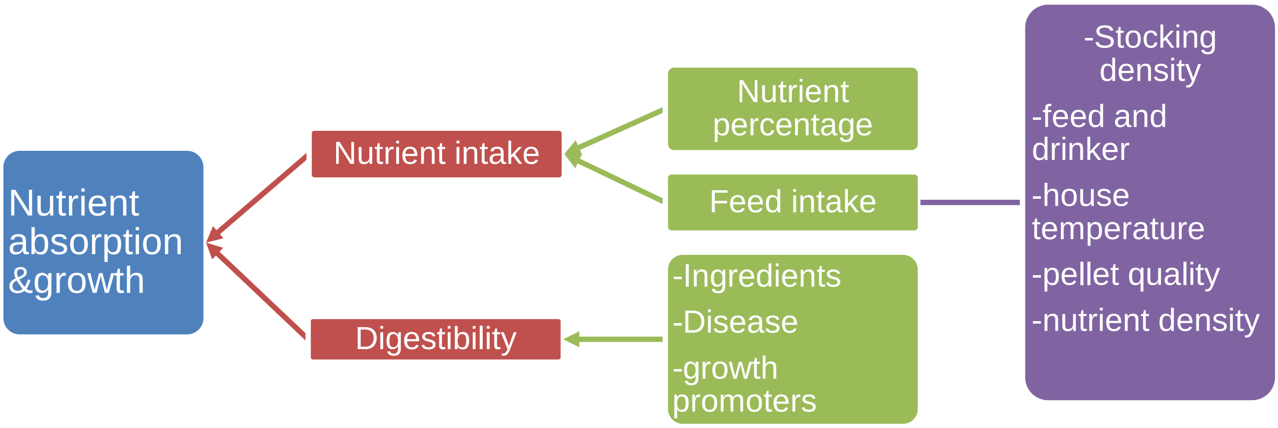

Figure 2: Factors influencing nutrient absorption and growth

Nutrient intake is the product of dietary nutrient percentage and feed intake. There are many environmental factors influencing feed intake, e.g. stocking density and temperature, but these will not be covered in this paper, the focus will be the influence of nutrient percentage on growth and breast meat yield.

The Influence of Dietary Nutrient Percentage on Growth and Breast Meat Yield

The most common nutritional factor that is restricting to growth is the level of the first limiting amino acid, which is commonly lysine, methionine, cystine or threonine. However more recently diets are found to be limiting in arginine level, which is not always considered in formulations. There is a lack of a commercially available arginine supplement in the market; however a valuable source is sunflower extract, which is relatively rich in the amino acid.

It is important to provide a nutritionally balanced diet to maximise turkey growth and meat yields. An unbalanced amino acid pattern is inefficient in terms of cost, growth and breast meat yields. In theory birds should be provided with a diet that is non-limiting to growth, in order to maximise breast meat yield.

What is known about the turkey's amino acid requirements for maximal breast meat yield? It has been shown that the amino acid requirements for maximal breast meat development exceed requirements for maximal growth (Lehmann et al., 1996; Lehmann et al., 1997; Sell 1993). At BUT a trial has been run investigating the influence of differing levels of the sulphur amino acids methionine and cystine on growth rates and breast meat yields of BUT8 stags aged between 17 and 20 weeks. Diets were balanced except for methionine and cystine (tsaa) levels. The optimal daily intake of the sulphur amino acids for breast meat was shown to be ~200mg greater than the optimum requirement for maximum growth rate (Bentley, unpublished data). These results suggest that birds achieving good growth rates might not necessarily be achieving maximum breast meat yields. Obviously the economics need to be evaluated, the cost of increased amino acid inclusion against value of meat yielded.

In commercial situations, diets, health challenges and adverse environmental pressures may have negative influences on growth rates. The influence that slow growth periods can have on live weight and subsequent meat yield was investigated recently by BUT.

Fast or slow growth was achieved over three periods: 0-6 weeks, 6-12 weeks and 12-18 weeks, by manipulating the amino acid to energy level in the turkey diets. Fast diets were formulated to BUT recommendations for commercial birds. Amino acid percentage to energy ratio was adjusted in order to encourage slow growth. One thousand six hundred and eighty BUT9 stags were placed at day old at the BUT trial site. Birds were brooded and grown to 18 weeks in 40 x 12.4m^2 pens. Details of the eight treatments used are shown in Table 1; there were five replicate pens per treatment. Details of the lysine to energy ratio of the two extreme treatments are shown in Figure 3.

Table 1: Dietary treatments

F= Fast treatment	S=Slow							
	1	2	3	4	5	6	7	8
0-6 weeks	F	F	F	F	S	S	S	S
6-12 weeks	F	F	S	S	F	F	S	S
12-18 weeks	F	S	F	S	F	S	F	S

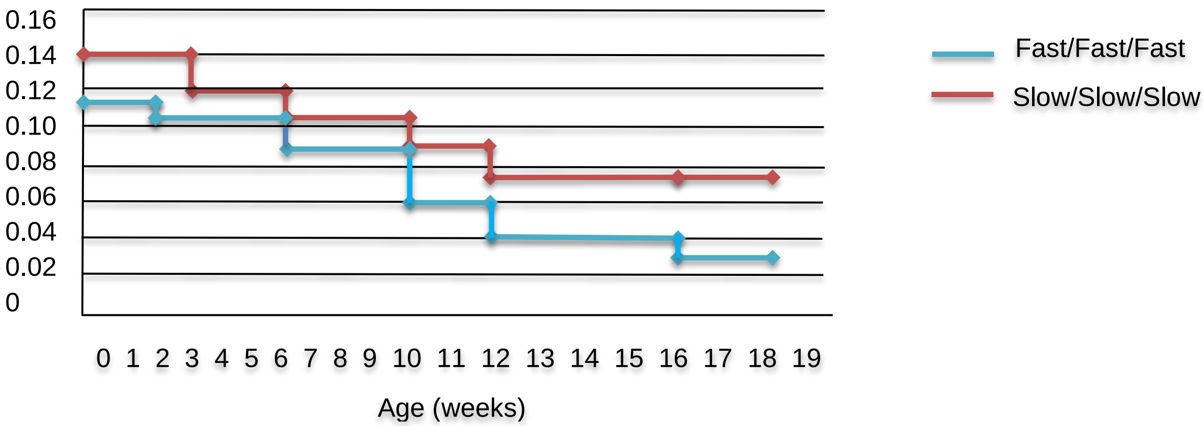

Figure 3: The amino acid profile (digestible lysine, to energy, MJ ratio of the two extreme treatments (Fast, Fast, Fast and Slow, Slow, Slow)

Table 2: Average live weight of the weight treatments

Treatment	Average weight (kg) Age (days)					
	22	43	64	92	113	127
fff	0.63	2.4	5.3	10.6	14.4	16.6
ffs	0.63	2.4	5.4	10.7	13.2	14.5
fsf	0.62	2.4	5.4	10.1	13.8	16.2
fss	0.61	2.4	5.3	9.8	12.1	13.7

sff	0.50	1.9	4.7	9.8	13.7	16.0
sfs	0.51	2.0	4.8	10.1	12.4	13.9
ssf	0.51	2.0	4.8	9.4	13.5	15.9
sss	0.50	1.9	4.6	9.0	11.3	12.7

Table 3: Average live weight as a percentage of performance objectives

Treatment	Average weight (kg) Age (days)					
	22	43	64	92	113	127
fff	84	94	98	106	106	107
ffs	85	95	88	108	99	93
fsf	87	92	98	102	103	104
fss	87	93	98	99	91	88
sff	69	73	86	98	102	103
sfs	70	76	88	101	93	89
ssf	70	76	88	94	101	102
sss	68	75	85	91	85	81

Table 4: Average growth rate (kg/week) of each treatment over the three growing periods

Treatment	Growth period Age (days)		
	0-6 weeks	6-12 weeks	12-18 weeks
fff	0.60	1.16	1.20
ffs	0.60	1.18	0.76
fsf	0.58	1.11	1.22
fss	0.59	1.06	0.77
sff	0.46	1.13	1.24
sfs	0.48	1.16	0.76
ssf	0.48	1.06	1.31
sss	0.48	1.02	0.73

All birds were weighed at 22, 43, 64, 92, 113 and 127 days. Meat and carcass on selected stags (15 birds per treatment) at both 16 and 18 weeks.

The average live weights of the eight treatments are shown below in Table 2. It can be seen that there was a substantial difference in final liveweights between the most extreme treatments; almost 4 kg difference between the sss and fff groups.

The weights as percentages of BUT goal (5th Edition) are shown in Table 3. The fff treatment was 107% of BUT goal whilst the sss treatment was 81% at 18 weeks. Interestingly the four treatments with the highest liveweights and percentages of goal were those that had included fast diets in the last growth period. The growth rates seen in Table 4 are also highest in these treatments.
Table 5 and Table 6 show the average slaughter data. The highest breast meat weights were achieved with birds fed fast diets in the last growing period, for both slaughter ages. These fast fed birds in the last period (fff, sff, fsf, ssf) had average breast weights of 3.63 kg and 4.22 kg at 16 and 18-week slaughter ages. Slow fed birds during this period (sss, fss, ffs, sfs) had breast weights of 3.05 and 3.34 kg at 16 and 18 weeks. The increase in breast weight between 16 and 18 weeks was clearly greater in the fast fed birds. Overall breast meat weights increased for all treatments between 16 and 18 weeks.

The greatest breast meat yields (% liveweight) at both slaughter ages were achieved with birds fed the fast programme in the last growing period. Average breast muscle yields in fast fed stags were 23.35% and 24.38% at 16 week and 18 weeks respectively. Slow fed birds in the last period (sss, fss, ffs, sfs) had breast meat yields of 22.50% and 22.40% at 16 and 18 weeks respectively. The breast meat yield however did not increase in all treatments between the two slaughter ages. Two of the treatments fed slow diets in the last growth period (12-18 weeks) decreased in percentage between 16 and 18 weeks. The average difference in breast meat yield between 16 and 18 weeks for these slow fed birds was –0.09%. This is in contrast to the fast fed birds in this last period, which experienced an average increase of 1.03% in breast meat yield, between 16 and 18 weeks.

Statistical analysis on the last growth period (12-18 weeks), showed that there was a significant effect of fast and slow diets on breast meat yields ($P<0.001$) and a significant age x treatment effect on breast meat yield ($P<0.01$). Statistical analysis on the effect of fast and slow diets in the second growth period (6-12 weeks) showed there was a significant effect of diet on breast meat yield ($P<0.05$). There was no significant effect of the diet treatment in the first growth period (0-6 weeks) on breast meat yields

Figure 4 shows the relationship between live weight and breast meat yield. The relationship is linear and shows how the higher the liveweight, the higher the breast meat yield (% liveweight). The graph also suggests that birds at the same liveweight do not necessarily have the same breast meat yield. Birds at 16 weeks of age with the same body weight as those killed at 18 weeks of age, tended to have greater breast meat yields. This suggests that the faster the birds are grown (i.e. achieving a certain liveweight at an earlier age), the greater the breast meat yield.

The abdominal fat content of the birds is shown in Table 5 and 6. The fast fed birds tended to have less fat % than the slow fed birds. The average abdominal fat content of the fast fed birds in the last growth period was 1.03% at 16 weeks and 1.18% at 18 weeks. The average abdominal fat content of the slow fed birds in the last growth period was 1.17% and 1.41%.

Table 5: Slaughter data at 16 weeks

Treatment	Treatment Age (days)							
	fff	ffs	fsf	fss	sff	sfs	ssf	sss
Liveweight (kg)	15.76	14.52	15.53	13.22	15.68	13.72	15.19	12.81
Eviscerated weight (%)	73.47	75.17	73.83	73.63	73.37	73.75	73.54	73.75
Breast meat yield (%)	23.82	23.17	23.15	22.18	23.22	22.31	23.21	22.31
Breast meat (kg)	3.75	3.36	3.60	2.93	3.64	3.06	3.52	2.86
Abdominal fat (%)	1.11	1.17	0.94	1.11	0.99	1.28	1.07	1.09

Table 6: Slaughter data at 18 weeks

Treatment	Treatment							
	fff	ffs	fsf	fss	sff	sfs	ssf	sss
Liveweight (kg)	17.91	15.57	17.06	14.98	17.44	15.06	16.72	13.95
Eviscerated weight (%)	75.43	73.97	75.16	73.69	75.60	74.18	74.76	73.50
Breast meat yield (%)	24.49	22.84	24.22	22.56	24.31	22.73	24.50	21.49
Breast meat (kg)	4.39	3.55	4.13	3.38	4.24	3.42	4.10	3.00
Abdominal fat (%)	1.18	1.43	1.19	1.38	1.19	1.26	1.16	1.57

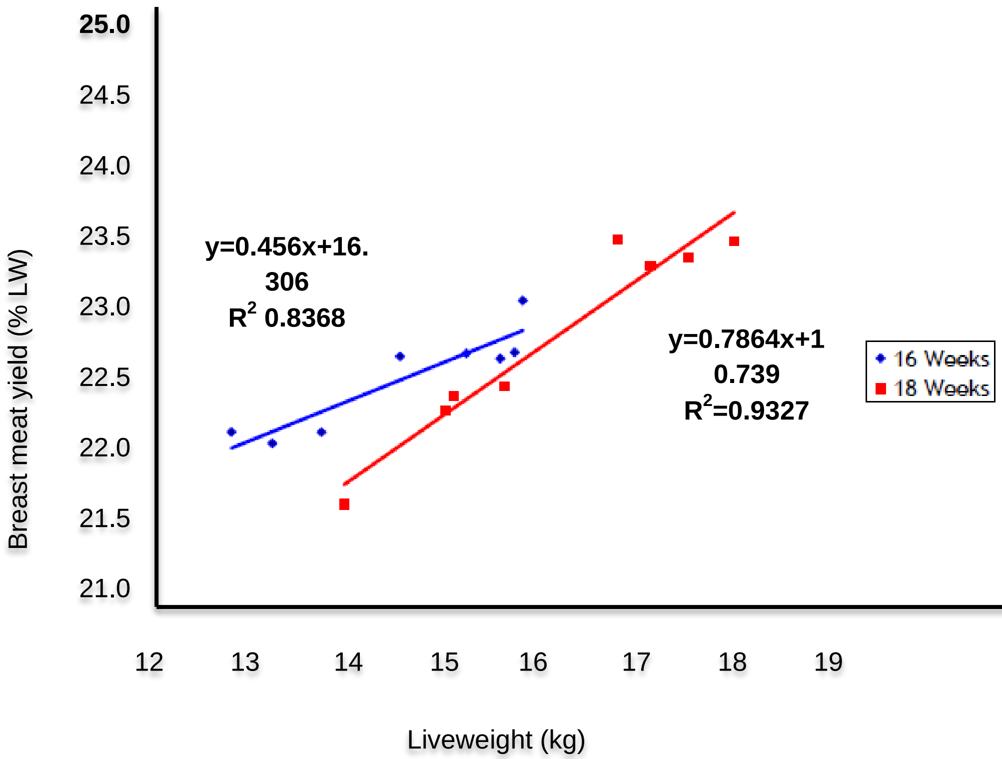

Figure 4: Relationship between live weight and breast meat yield

Summary

We understand that the nutritional requirements for maximal breast meat are different to the nutritional requirements for growth. This trial has investigated the effect of manipulating amino acid to energy levels i.e. high or low protein diets, on growth rates and breast meat growth. The results showed that fast growth (fff) maximised breast meat yields compared to slow growth (sss).

The most influential period of growth on breast meat deposition, out of the three periods studied, i.e. 0-6 weeks, 6-12 weeks and 12-18 weeks, was found to be the latest. Fast growth in this period gave significantly superior breast weights (kg) and yields (% liveweight) compared to slow fed birds at 16 and 18 weeks. A reduction in growth rate during this time had a negative effect on the breast meat amount (kg) and yield (% liveweight) compared to fast fed birds. Also the slow fed birds experienced an average loss in breast meat yield between 16 and 18 weeks, fast fed birds gained breast meat yield during this period.

These results suggest that under these trial conditions previous nutrition, i.e. 0-12 weeks, had minimal impact on final breast meat yields. It should not be assumed that the growth achieved during 0-12 weeks is insignificant however. The greatest amount of breast meat was achieved on the fff birds compared to all other treatments. Also the birds studied were reared in small pens in controlled environmental conditions. When growing flocks in houses under normal commercial situations there will be more complex interactions at play, which could prevent birds from expressing their maximum potential growth and breast meat yield. Good growth rates at early ages may be a requirement for proper development, and poor growth rates during this time may not be recoverable in commercial growing conditions. The safest route would be to feed the birds to achieve good growth rates throughout their life.

As expected there was a good correlation between liveweight and breast meat yield. The results however did highlight the fact that birds do not necessarily have the same breast meat yields at the same liveweights. The trial showed that the faster the birds are grown, throughout all growth periods, the greater the amount of breast deposited in the carcass. Younger birds at the same liveweight tended to have greater breast meat yields than older, slower grown birds. This supports the recommendation to obtain fast growth throughout all growth periods.

The amount of abdominal fat deposited also tended to be greater in slow fed birds compared to fast fed birds, which is a waste of nutritional resources. It suggests that in slow fed birds, nutrients not utilised in breast meat are channelled into other tissues such as fat. Alternatively the turkeys may be over consuming energy to try and achieve higher protein intakes. The excess energy consumed is then deposited as fat.

It would be advised that breast meat amounts and yields are routinely monitored and used, with sample weight data, to improve economic performance of the birds. An increased understanding should help to maximise profits. Feeding good quality and high protein diets, can help to maximise breast meat yields, assuming environmental conditions are non-limiting to growth.

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