The Influence of Dietary Protein Levels on Growth Curve Parameters of Quail

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Dissertation presented for the degree of MPhil Livestock Industry Management

at the

University of Stellenbosch

Promoter: Prof. SJ Schoeman

June 2004

Declaration

I, the undersigned, hereby declare that the work contained in this dissertation is of my own original work and I have not previously in its entirety or in part submitted it at any university for a degree.

Signed... Kellerman .....

Date..... 21-06-2004 .....

Summary

In South Africa quail do not have the same status as an agricultural produce as do other livestock species. As quail has mostly been judged as a cute little bird seen on shows, very few people have paid attention to the commercial value of this bird specie.

In South Africa quail farming is done on a very limited scale, but competition regarding this very unique market is already challenging. If it is to be a viable project it is of utmost importance to limit the costs to the minimum and, by doing so, increasing the profitability of the project.

In this study the economic aspects of a quail production unit was researched to assess whether any improvements in profitability could be made.

Quails from a production unit outside Stellenbosch were used to describe the growth curves of these birds under three different diet regimes. 300 Birds were used and then divided into groups of a hundred. The first treatment was fed the standard starter (22% protein) then after five weeks a finisher (19% protein). The second treatment was fed a starter ration containing 40% Soya oil cake and 60% of the standard starter (27.2% protein). The same finisher as in treatment one was fed to treatment two after five weeks. Treatment three was fed a newly formulated starter ration (28% protein). The same finisher was fed to treatment three after five weeks as with the first two treatments.

It was found that treatments one and two differed significantly from treatment three, but not from each other. It was expected that treatment three would result in better growth than treatment one, but contrariwise, treatment three did the worst. In accordance with literature it was found that under commercial conditions quail could be fed lower concentrations of protein than prescribed by literature.

Samevatting

As 'n landbouproduk het kwartels in Suid-Afrika nie dieselfde status as ander lewende hawe nie. Omdat kwartels meerendeels gesien is as 'n oulike klein voëltjie op skoue, het weinig mense enige aandag gegee aan die kommersiële waarde van kwartels.

Alhoewel kwartelboerdery in Suid-Afrika huidiglik slegs op 'n baie klein skaal bedryf word, is kompetisie in hierdie nismark reeds kompeterend en uitdagend. Om so 'n boerdery ekonomies vatbaar te maak en hoë profyt marges te handhaaf, is dit van wesenlike belang om insetkostes tot die minimum te beperk.

In hierdie studie is ekonomiese aspekte van 'n kwartel produksie eenheid nagevors om sodoende te kon bepaal op watter aspekte, indien enige, gekonsentreer kan word om wins marges te verhoog. Kwartels van 'n produksie eenheid buite Stellenbosch is gebruik. Hierdie kwartels is op drie verskillende diëte geplaas en afsonderlik ge-evalueer om die groeikurwes op elke dieet te bepaal.

Driehonderd kwartels is in groepe van honderd elk verdeel. Die eerste groep se dieet het bestaan uit die standaard beginners groeimeel wat deur Meadows vervaardig word (22% proteïen), en is na vyf weke afgerond na 'n afrondings dieet (19% proteïen). Die tweede groep se dieet was dieselfde beginners dieet as in groep een wat met 40% Soya oliekoek gemeng is (totale proteïen inhoud van 27.2%). Daar is na vyf weke oorgeslaan na dieselfde afrondings dieet as in groep een. Die derde dieet het bestaan uit 'n nuut geformuleerde beginners dieet (28% proteïen). Weereens is daar na vyf weke oorgeslaan na dieselfde afrondings dieet as in die vorige twee groepe.

Daar is gevind dat die groeikurwes van diëte een en twee beduidend verskil het van dieet drie, maar daar was nie 'n beduidende verskil tussen groepe een en twee nie. Alhoewel daar verwag is dat dieët drie 'n beter groeikurwe sou toon as dieët een, was dit egter nie die geval nie. Dieet drie het egter die swakste groeikurwe getoon. Daar is dus gevind dat kwartels onder kommersiële toestande laer konsentrasies proteïen gevoer kan word as wat algemeen voorgeskryf word.

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Introduction

Although quail is already an established product in many countries, the South-African consumer market is not as familiar with this specific product. There are quite a number of aspects of quail farming that make them very suitable to farm with. As quail is such a small bird, weighing less than other commercial poultry, they need less food and space, and a farmer can start a quail production unit with relative low inset costs. Quail is also very adaptable to the intensive farming systems to which chickens are exposed. They are well resistant to sickness and inoculation is not as important with quail as with chickens. The two diseases that occur most commonly in quail populations are Ulcerative Enteriditis and quail bronchitis. Mortality due to cannibalism and anxious and dominating behaviour can be a problem in quail populations as well.

The reasons why quail is such a lucrative animal to farm with are its ability to grow fast, early sexual maturity, high egg production (approximately 300 eggs per year), short generation interval and a short incubation period. According to some researchers, quail are more successful than the chicken in conversion of feed to eggs, because they produce almost twice as much egg per kilogram body weight (Baumgartner, 1994). If you compare that to a milk cow of 600 kilograms that produces 4000 kilograms of milk, then the nutrients produce by quail are eight times better (Baumgartner, 1994).

However, it is of no value to produce a product if you have no consumer market. The biggest competition in South Africa for quail meat and eggs is chicken products. Why must the consumer buy quail when it is much cheaper (and easier to prepare) to buy chicken?

Quail adapt better than chickens in a hot climate because they have a bigger surface to volume ratio than chickens (MacLeod & Dabutha, 1997). In colder regions it is thus important to install adequate heating systems to ensure the survival and performance of the quail.

Quail is of importance to farmers, as well as for animal scientists. Reproductive characteristics are one of the aspects of quantitive genetics that is the least understood. It is therefore a popular research subject because quail have such a short generation interval (start to lay at six to seven weeks of age), and results concerning the affects of long-term selection can be done in a reasonable time frame (Yang et al., 1998).

Quail by-products

As with the chicken there are a number of by-products with quails. Examples of these are:

- Patè of quail livers
- Stock can be cooked from the bones
- The entrails can be used as pet food
- Quail manure can be used for enriching soil
- Feathers can be used to make greeting cards and momento's

Therefore quail is a product with very little wastage.

The quail used for this specific project are situated at Carmay King Quail – on the Blaauwklippen road just outside Stellenbosch. Carmay King Quail was established ten years ago when the business was bought from David Jarvis. He did a lot of research to breed bigger quails, and he crossed several different quail species with each other. When the current owner took over, she continued to select for body weight by simply using the biggest quail in the progeny for her next breeding stock. During the past ten years she had great success doing this. When she bought the quail, they weighed approximately 185 gram – slahgutered weight. Today an average slaughtered weight of 300 gram over a thousand birds is achieved. The size of this quail is unique and nowhere in South Africa is there a quail production unit with produce of the same quality - see figure 1 for a comparison between normal commercial quail and Carmay King Quail quail.

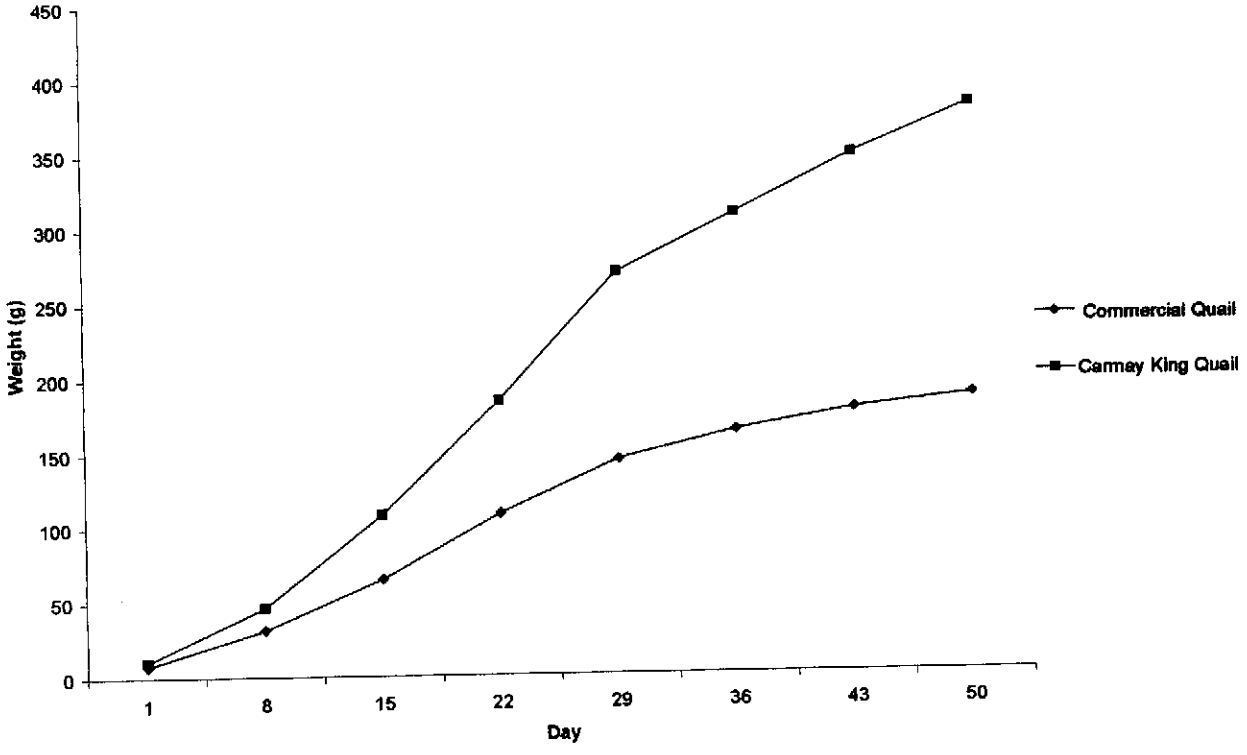

Figure 1: Comparison of average growth curves (live weight in gram over time in days) between commercial quail and Carmay King Quail

Currently the breeding stock is still selected according to body weight. The only other factors that are taken into account are physical abnormalities. Humpbacks are not seen often and have mostly been removed through selection.

Five hens are put with one cock, and the egg collection starts after the birds have been together for a week. Carmay found that the highest hatch percentage is achieved at about eight to nine weeks of age when 50% production or more are reached.

The eggs have to be incubated within a week after it was laid, as the hatch percentage becomes less if it is stored for longer. The eggs are kept in a cool room at 15°C with the sharp point of the egg turned down. The eggs are disinfected before going into the storeroom to minimise the spread of diseases. If the eggs have to be stored for longer than a week, they are turned every morning and evening at an angle of 45° as this improves the hatch percentage. Carmay King Quails use prohatch incubators that can incubate approximately 4 200 quail eggs. They make use of both a hatcher and a setter. The incubation of quail eggs are basically the same as chicken eggs except for the humidity that has to be higher - humidity must be 65% except for the last two weeks when it must be 70%.

The eggs must be turned every three to four days till the 14th day to ensure that the embryo does not stick to the shell – as this can lead to disabilities. On the 14th day the eggs are moved to the hatcher where they hatch. After hatching, the chicks are left in the hatcher for another twelve hours to dry. Early mortalities, between 0 to 14 days, are one of the biggest problems at Carmay King Quail. Great care is therefore taken with the chicks during this period. The day old chicks are put in a circle on bedding (the same as with day old chickens) at a temperature of 36°C. The temperature is kept at 36° until 14 days when the birds are moved to the bigger runs.

Finely milled feed is given to the chicks in flat open feeders. Unfortunately with these feeders a lot of feed are spilled and lost. Fresh clean water is provided ad. lib. to the quail from day one. When the quail are moved they get fed out of new feeders, which reduces the spilling of feed. At the moment the quail at Carmay King Quail are fed a Meadow Feeds starter diet with a protein value of 22% until 5 weeks, and then a Meadow Feeds finisher until slaughter (crumble).

Just enough light is provided for the quail to go about their daily routine – this prohibits cannibalism. The quail are subjected to twenty-four hours of light. Electricity failure is an unwanted occurrence as the quail hurt themselves due to fright during a power failure.

If quail receives fresh and clean food and water every day in a warm and drought free cage, disease can be prevented to a great degree. Another prevention mechanism is to remove the sick quail from the group as soon as possible and to isolate them. Quail are subjected to the same general diseases as chickens, and the same medication can be used for quail as for chickens. Quail are also fed anti-coccidiants in their diets.

Purpose

Farming has long passed the mark of just throwing animals on the field and selling whatever progeny that may arise. To survive economically, a farm must be managed just as well as a business unit, and strategic planning is as essential as in any other business.

The purpose of this project was to research these aspects and to apply the knowledge to improve the profitability of the business. In a project done previously on this particular production unit it was established that the ROI (Return on Investment) of Carmay King Quails is 13%. This growth in an investment is normally related to a low risk venture. The risk associated with a production unit like this makes it imperative to get a better return; therefore the business needs to improve its profitability.

The study of an animal's growth and development are regularly described as the integration of all the facets of animal science, which includes genetics, nutrition, physiology and meat science (Trenkle & Marple, 1983). The initial purpose of this experiment is to describe the growth curve of these unique quails. Gaining knowledge of the growth curve of a species can be important for the following reasons:

1. The feed conversion efficiency can differ - for example the difference between chickens and quail – which have economic implications
2. The feed conversion efficiency can differ at the different ages – therefore it is important to determine the optimum time to convert to a different ration
3. To determine the most economic age to slaughter the birds (Milby & Henderson, 1937).

Any irregular fluctuations in weight caused by random environmental effects are eliminated when functions are expressed graphically (Knížetová et al, 1991). It is very important to know the optimal slaughter age for animals as slaughtering too early could result in a reduction in carcass quality due to a higher proportion of bones and chemically "immature" meat (Knížetová et al, 1991). Slaughtering at an age after the optimal slaughtering age could result in less profit (the increase in weight do not result in an income high enough to cover extra costs incurred) and a fat carcass, which is an unwanted carcass trait in today's consumer market.

The use of growth curves will make it easier to compare the different treatments with each other - for example, different rations fed (Trenkle & Marple, 1983). Analysing the growth curve can be

useful with future selection if there are any related characteristics that the breeder wants to acquire (Trenkle & Marple, 1983).

The quail are currently fed a starter diet until five weeks of age and then they are fed a finisher diet for the last two weeks before slaughter. The rations of the quail are no less than 70% of the costs for the production unit. Therefore it is important to develop a feeding program that is as cheap as possible without loosing quality. The quails are currently fed a standard chicken diet of a starter diet (22% protein) and a finisher (19% protein). It has been suggested that a quail diet needs to have a higher protein content than a chicken diet. The recommended concentration protein is 250 gram to 280 gram per kilogram total protein in a starter diet (25% to 28%), but it can be as high as 320 gram per kilogram (32%) (Hyankova et al., 1997).

With research done by other researchers it has been found that higher concentrations of protein only made a difference in the first two weeks of growth. Furthermore it has been found that at five weeks there were no differences in carcass composition. The researchers thus found that diets with a lower protein concentration could be fed to quail under commercial circumstances to reduce costs (Hyankova et al., 1997). To be more economic concerning the feed schedule at Carmay King Quails, it can be considered to switch over to the finisher diet at an earlier stage. The growth curve of the quails will be studied to see the difference in different diets fed to the quails.

One of the problems that arose with Carmay King Quails is that they do not lay as good as normal quails. Their hatch percentage is only about 40%. Hatch percentage is an aspect that might be affected by diets. It has, however, been found by different researchers that different diets do not make a difference to the hatch percentage of quails (Marks, 1995).
It has been found that with an increase in the inbreeding coefficient of 1% that the following is likely to happen:

- Fertility will decrease with 0.82%
- Hatchability will decrease with 0.29%
- 150-day egg production decrease with 0.11 eggs, and
- egg mass with 0.03 grams (Baumgartner, 1994)

After ten years of intensive selection no new bloodlines have been used in the breeding program, thus there is a relative high chance for inbreeding. Heritability values for body weight in quails were found to be between 0.18 and 0.38 (Baumgartner, 1994). Carmay King Quails till recently had great success with their selection for body weight. What could have happened is that they,

unknowingly, selected unwanted traits that are correlated with body weight. Table 1 illustrates traits that are positively and negatively correlated with body weight.

Table 1: Positive and negative correlated traits with body weight

Positive	**Negative**
Age with first egg laid	Percentage fertility
Egg mass	Hatch percentage

(Marks, 1996)

Long-term selection has a negative influence on fertility due to the following reasons:

- Bigger percentage ovarian follicles are lost in the body cavity
- Follicular attrition
- Production of defective egg cells
- A combination of the above (Nestor et al., 1996).

Different sources suggested that long-term selection could also lead to an increased mortality rate (Nestor et al., 1996 (b); Moritsu et al., 1997). High mortality, therefore, cannot only be ascribed to miss-management of a production unit, but also as a consequence to long-term selection.

The development of commercial poultry lines has been largely based on selection for traits related to economical importance. That such selection had a secondary effect on behaviour has been well documented (Minvielle et al., 2002). One of the behavioural characteristics documented is fearfulness. Extreme expression of fear is thought to have negative effects on productivity and the welfare of poultry (Minvielle et al., 2002). The quail used in this trial did, however, not show extreme cases of fear (did not run away from handlers), thus this aspect was not taken into account during the trial.

Materials and Methods

The study was started with 300 birds divided into three main groups. The three main groups were then subdivided into four groups each of twenty-five. Quail are very sensitive to cold after hatching, therefore adequate heating had to be provided in the cages that they were put in. They moved freely in their groups of twenty-five as this is how they are raised at Carmay King Quails. This was important, as the circumstances in the trial were kept as similar as possible to that of the production unit for the results to be applicable.

All the quail were ring banded as every individual needed to be identified for the growth curves. A special scale was used to weigh the quail after hatching, because they only weigh about ten to twenty grams when they hatch and it is necessary to have accurate values of the quail during this stadium of their growth curve.

Carmay King Quails supplied the feed for the project. The additional soya was purchased and mixed into the diet in small quantities to ensure that it was thoroughly mixed. The decision to use the soya (oil cake) rested on the facts that it is usually an affordable protein source (R2.60 per kilogram at the time of the study – depending on availability) and can be utilised very effectively by poultry because of a high Lysine value (McDonald et al., 1995). With a protein content of 35% the oil cake will be sufficient supplement for the project's aim. The third ration was mixed at the University of Stellenbosch's chicken unit at Mariendahl.

When the quail hatched they were weighed and placed in their respective groups. The 300 quail that were used were divided into three main groups. These three groups were fed different diets to establish the effect that different protein concentrations have on their growth. The quail were then sub divided into four groups of twenty-five each. Only the protein concentrations were taken into consideration when data were analysed.

The only difference between the treatments of these three groups was the nutrient content of the diets. This was to try and establish a more economic feed schedule for the quail. The quail are currently given a starter diet until five weeks of age, and then a finisher diet until age of slaughter – which is seven weeks. The starter and finisher rations currently fed contain 22% and 19% protein respectively. This is less than what is suggested. However, Hyankova et al (1997) found that under commercial conditions quail could be raised on diets containing lower protein concentrations because protein is more expensive to add to a ration than what the value added to the product will

be. Soya oil cake is, however, a cheap source of protein. The three different treatments were as follows:

1. The standard diet as fed currently (starter containing 22% protein until five weeks and then a finisher containing 19% protein for the remainder of the trial. Both these diets are the standard diets produced by Meadow Feeds in Paarl.
2. A starter diet containing 27.2% protein (40% soya oil cake and 60% of the currently fed starter). The same finisher as in treatment one was fed.
3. A starter diet with a total protein content of 28% that were formulated using Winfeed (see table 2 for the composition of diet). The same finisher as in group one and two was used.

Quail need two times more water in relation to the amount of feed, it was of utmost importance that the quail were provided with clean fresh water daily, because a lack of water could influence the results.

An average feed conversion efficiency of the quail was calculated. The amount of feed that was spilled was measured as this can influence the feed conversion efficiency. During the trial big flat buckets were placed under the feeders to catch the food that was spilled by the quails. The amount of feed wasted influence this calculation. For the first two weeks the quail were fed each day, and the feed weighed back as well. After that method of feeding changed to tube-feeders, thus feed was added (added feed recorded) when needed. These were then weighed at the same time that the quail's body weight was recorded. Spilled feed was weighed when feed consumed was recorded.
The feed conversion efficiency was measured as this has direct implications on the profitability of the production unit. The additional protein in the ration was to establish whether the quails can be slaughtered at an earlier age and if therefore, it is possible to push up production of the unit.

The quail were weighed on day 1 and 3 of the trial and thereafter weekly till day 63. Then the quail were weighed two more times on a two-weekly interval (day 77 and 91). This resulted in 13 points on the growth curve. All the quail were caught in catching crates and then returned to their cages as they were weighed. It was decided to use only the growth curves of the quail that survived the whole experiment; the total amount of surviving quail equalled 177 quail:

* Treatment 1 – 55 surviving individuals
* Treatment 2 – 60 surviving individuals
* Treatment 3 – 62 surviving individuals

Table 2: Composition of the diet formulated on Winfeed

Maize	37.00%	370.02
Maize Gluten 60	1.44%	14.43
Sunflower 37	15.00%	150.00
Soybean 47	20.00%	200.00
Soybean Full Fat	13.20%	131.95
Fish Meal 65	10.00%	100.00
Oil-Sunflower	2.13%	21.27
Limestone	0.62%	6.21
Monocalcium phosphate	0.31%	3.06
Salt	0.06%	0.55
Vit-min Premix	0.25%	2.50
	100.00%	1000.00

	Units	**Total**	**Available**
AMEn	**(MJ/kg)**	**12.300**	
arginine	(%)	2.068	1.908
ash	(%)	5.044	
avail. Phosphorous	(%)	0.350	
calcium	(%)	0.800	
chloride	(%)	0.171	
crude fibre	(%)	5.187	
crude protein	(%)	30.607	26.000
dry matter	(%)	89.381	
EE		7.962	
fat	(%)	7.596	6.608
histidine	(%)	0.796	0.701
isoleucine	(%)	1.373	1.196
leucine	(%)	2.488	2.212
lysine	(%)	1.712	1.490
methionine	(%)	0.596	0.541
methionine + cystine	(%)	1.043	0.908
phenyl + tyrosine	(%)	2.503	2.211
phenylalanine	(%)	1.458	1.293
sodium	(%)	0.150	
TEAA	(%)	17.945	16.362
threonine	(%)	1.187	1.014
tryptophan	(%)	0.353	0.302
valine	(%)	1.525	1.315
Weight	(%)	1.000	1.000

Because it was very important to identify the quail individually, leg rings were used. Twelve colours were used and the quail were marked in their groups of 25. This served adequatly for individual identification. The weight of the individuals was pre-adjusted for sex, and thus all the data were pooled into one group, but still within treatments. Sexual dimorphism that is typically found in chicken and turkey that males are bigger than females is not found in quail. With quail the females are heavier than the males in most of the growth curve (Anthony et al., 1991). Aggrey et al (2003) however found in an experiment with Japanese quail, that growth rate for the males was higher than the females. They did, however, find that females responded to selection for 4-week body weight faster than the males. In this trial it was clear that the females grew faster than the males. The weight of females was not corrected for the presence or absence of hard-shelled eggs in the oviduct, which can be responsible for a degree of variation (Anthony et al., 1986). The values were pre-adjusted for sex by adding an amount equal to the means of differences between males and females per group. See table 3 for values that were added to male weights for adjusting the values for sex.

Table 3: Preadjusment factors added to males for adjusting weight for sex (gram)

Day	Treatment 1	Treatment 2	Treatment 3
1	0.7	1.04	0.88
3	1.56	1.9	1.49
7	2.23	5.1	3.3
14	2.76	7.49	8.46
21	-1.99	13.25	9.46
28	23.93	32.58	4.82
35	29.33	25.21	12.9
42	27.36	22.21	12.9
49	46.54	42.31	34.3
56	58.74	50.09	47.9
63	69.74	47.4	55.12
77	72.56	57.44	53.3
91	71.96	53.15	57.58

It was decided to use a polynomial function for the growth curve as was the best description of the variance on the data. Initially it was anticipated to do an analysis of variance on the b-values of the equations, but due to unbalanced data (Type I and Type III SS were different), it was found that the GLM-method where the intercept of the functions are used as co-variable, would produce the most accurate results. Statistical analysis of the data were done on (SAS, 2000).

Results

A fair amount of quail was lost during the experiment. With 177 quails left this amounts to 123 quails lost during the experiment. On the first day after hatch, 41 quail were lost over the three treatments. After that the losses were evenly spread. The last time period of the experiment - last month approximately - most of the losses were due to culling. About 10% of the overall loss was due to severe cases of bumble foot. Other reasons for losses were eye infections (so bad that the whole head was swollen), birds becoming lame and there was one incident of a quail with a water belly - presumably ascites. This can be an indication that the growth of this bloodline is near its peak, as ascites is a metabolic disease associated with insufficient oxygen supply relative to the oxygen demand of tissues (De Greef et al., 2001). Some quail died while being weighed. This could have been stress related due to handling of the quail, as it was obvious that they reacted anxiously while they were physically handled.

Tables 4, 5 and 6 illustrate the values obtained for weight, feed intake and feed efficiency during the trial.

Table 4: Values obtained for weight during the trial

Day	Treatment 1	Treatment 2	Treatment 3
1	14.44	13.89	14.14
3	22.10	22.02	21.08
7	48.11	49.12	42.78
14	112.12	113.18	98.64
21	187.01	196.10	167.20
28	260.06	270.99	246.59
35	314.06	318.35	303.04
42	340.80	346.33	332.04
49	389.88	397.04	384.85
56	424.97	426.46	417.51
63	444.88	437.83	430.42
77	459.53	458.68	445.98
91	455.16	450.33	447.10

Table 5: Feed intake during the trial

Day	Treatment 1	Treatment 2	Treatment 3
3	20.33	14.72	12.15
7	66.17	45.39	48.63
14	152.99	139.71	135.39
21	246.88	228.23	216.92
28	214.16	229.62	258.49
35	246.43	271.97	297.99
42	307.13	266.67	280.21
49	406.67	372.01	416.75
56	438.76	319.53	372.15
63	357.38	308.03	304.30
77	637.63	524.30	556.05
91	736.71	692.87	658.22

Table 6: Feed efficiency values obtained during the trial

Day	Treatment 1	Treatment 2	Treatment 3
3	2.62	1.81	1.74
7	2.56	1.67	2.25
14	2.38	2.19	2.43
21	3.32	2.75	3.16
28	2.95	3.11	3.26
35	4.62	5.72	5.28
42	11.94	9.66	9.96
49	8.21	7.45	7.89
56	13.35	10.96	11.63
63	20.44	34.4	23.80
77	36.20	25.92	35.80
91	Negative feed efficiencies – no more growth		

With the GLM procedure it was established that there was significant differences between treatments 1 and 3 (B2: $P = 0.0063$; B1: $P = 0.0011$) and treatments 2 and 3 (B2: $P < 0.0001$; B1: $P<0.0001$). No significant differences were observed between treatments 1 and 2 (B2:

P = 0.1698; B1: P = 0.4348). The average coefficients (b1 and b2 estimates) of the polynomial functions for growth are illustrated in table 7.

Table 7: Coefficients (b1 and b2 estimates) of the polynomial functions of the growth curves for treatments 1, 2 and 3

Group	B1	B2	Intercept	R^2
1	71.399	-2.0216	-105.27	0.9782
2	75.142	-2.3163	-110.81	0.9766
3	68.001	-1.8155	-103.83	0.9742

As can be seen in Table 7, 97 % of the variance is described with the polynomial functions (R^2 = 0.9782, 0.9766 and 0.9742). B values also varied little. Significant differences were observed between groups 1 and 3 and groups 2 and 3. With the B1 and B2 values of group 1 being 95 % and 87 % respectively of the B1 and B2 values of group 2, and the B1 and B2 values of group 3, 91 % and 78 % respectively of the B1 and B2 values of group 2 it is evident that differences are not substantial – although they differ significantly.

It was established that different levels of protein did result in differences in weight, though not as expected. Treatment 3 – the newly formulated ration – was expected to result in the better growth than treatment 1, but contrariwise, treatment 3 did the worst.

When taking feed efficiency into consideration, it is clear that the feed efficiency between the three treatments is almost the same (SAS, 2000)

When the GLM procedure was run on the feed efficiencies it was found that there were no significant differences between them, with large P-values (group 1/2; P = 0.414: group 1/3; P = 0.4551 and group 2/3; P = 0.9429). A R-square value of 0.905372 was obtained indicating that approximately 90 % of variance is explained by the equation. See Figure 2 for the influence of age on the feed conversion in quail and table 8 for the coefficients for the polynomial functions for feed efficiency.

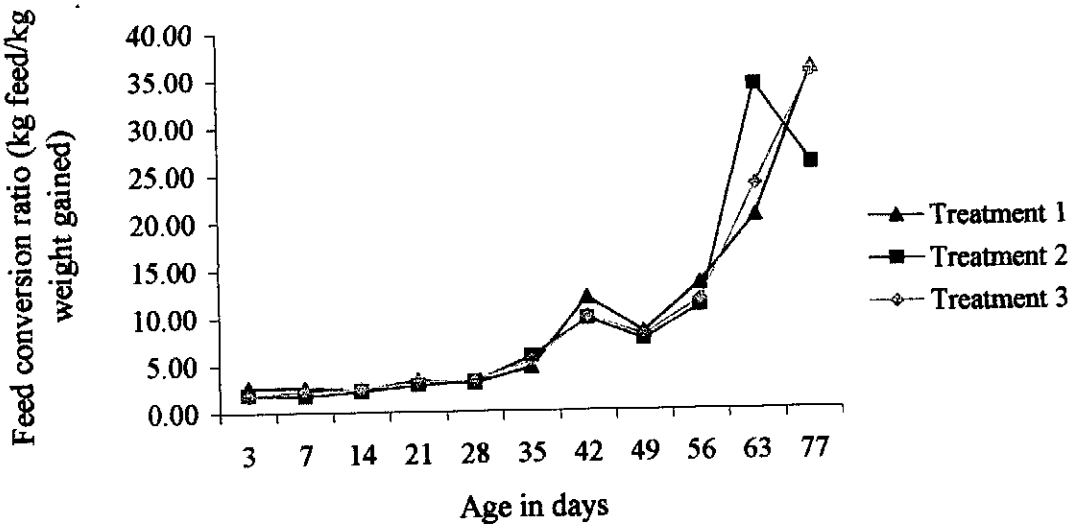

Figure 2: The influence of age (in days) on the feed conversion ratio in quail

Table 8: Coefficients (Estimate b1 and b2-values) for the polynomial functions of feed efficiency for treatments 1, 2 and 3

Group	B1	B2	Intercept	R^2
1	-4.7808	0.5305	12.037	0.916
2	-3.6263	0.4498	8.4522	0.8184
3	-4.8966	0.5448	11.882	0.9238

As shown in table 8, R^2 values indicate that the variance in treatments 1, 2 and 3 are explained by 92 %, 82 % and 92 % respectively.

As there were no significant differences between the treatments, it is not surprising to note that the B-values correlate well.

Discussion

The use of a growth curve allowed a comparative analysis of the effects of the different rations fed to the different groups. It was decided to use a polynomial function as this describes the variance on the growth curve best. The results of this study show that the increase of protein content in the diet does not result in increased growth. There were significant differences between groups 1 and 3 and groups 2 and 3. There were no differences between groups 1 and 2. This corresponds with the findings of Hyánková et al (1997) that a diet with lower protein content can be fed under commercial situations. The extra protein, did not enhance the growth of the quail, and therefore alter the slaughter age of the birds. This coincides with research done by Hyánková et al (1997) that the positive effect of high crude protein declines from 14 days of age. They also found that after four weeks there were no more significant differences between the groups.

Also quite remarkable in this population of quail is the strong indication of long-term selection. The quail consume more feed than normal quail, but they do reach higher weights. They have good feed conversion up to day 35 with group 1 averaging at 3.08 g feed/ g weight gained, group 2 at 2.88 g feed/ g weight gained and group 3 at 3.02 g feed/ g weight gained. Another consequence of long-term selection is an increased mortality rate (Nestor et al., 1996(b); Moritsu et al., 1997). It is very clear that Carmay King Quail suffer great post-hatch losses (13.67% of the chicks were lost over the three treatments within the first day after hatch), in contrast to the good care that is taken with the newly hatched chicks.

The problem of low hatch percentage and poor fertility still remains. It can thus be concluded that selection against fertility did take place. Seeing that a low hatching percentage influences the profitability of the production unit, it is a challenge for this quail population to attain a higher hatch percentage. This will prove to be a great challenge because the structure of the breeding unit makes it impossible for individual selection for traits that need to be recorded through the life span of the barn raised quail. Another problem could be the variation among the genetic material. According to Marks (1996) loss of genetic variation is a consequence of long-term selection, which limits the ability to select for improved fertility. The easiest option would be to include a new line in the selection, but as the genetic stock of this production unit is so unique, it is likely that the inclusion of a new bloodline in the selection will do more harm than good.

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