FINAL REPORT FOR THE PROTEIN RESEARCH FOUNDATION

THE EFFECT OF LIGHTING ON THE EFFICIENCY OF UTILISATION OF DIETARY PROTEIN BY COBB AND ROSS BROILER STRAINS USED IN SOUTH AFRICA

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EXECUTIVE SUMMARY

This report takes the form of a number of scientific papers that have been written on the research that has been conducted for the PRF over a period of about six years. The overall objective of these trials was to determine the extent to which the efficiency of utilisation of dietary protein is influenced by the amount of light given to broilers during growth. The research emanated from that conducted here with broiler breeders, which suggested that this strain of chicken favours shorter daylengths than those used in commercial operations around the world. Previously published research on this topic has not been well designed so the results are somewhat equivocal. Because our research facilities are ideal for lighting research it was logical to design and conduct trials with broilers to determine whether daylength altered their growth rate or feed efficiency.

The results are extremely interesting as we discovered that, whereas growth rate was not altered with the use of short days feed efficiency, health and bone strength were all improved with the use of daylengths considerably shorter than those used conventionally in commercial broiler operations. The utilisation of dietary protein is thus improved, thereby justifying the expenditure of funds from the Protein Research Foundation for such research.

The report includes papers on the following:

1. Broilers perform better on short than on step-up photoperiods.

Welfare codes for meat chickens currently stipulate a minimum photoperiod of 8 h, and are likely to specify a minimum uninterrupted dark period of 8 h in the future. This paper reports a study of the response of two genotypes of broiler females to a lighting regimen that complies with these requirements: an initial 8-h photoperiod followed by a 16-h photoperiod from 21 to 42 d. Constant 8- and 16-h photoperiods were provided as controls.

The two breeds responded similarly to all lighting treatments. Constant 8-h and photostimulated birds had significantly heavier body weights, and strong tendencies towards larger feed intakes and superior feed conversion, than the 16-h controls. Lighting treatment had no significant effect on mortality or the incidence of leg problems. Ross birds had a significantly slower growth to 21 d, higher feed intake after 21 d, and inferior feed conversion efficiency throughout than Cobb birds. Ross birds had significantly lower mortality and fewer leg disorders than Cobb, due possibly to their slower initial growth.

2. Male broiler performance and nocturnal feeding under constant 8-h or 16-h photoperiods, and various increasing lighting regimens.

This paper describes the responses of two genotypes of male broilers to constant 8- and 16-h photoperiods, and to an abrupt transfer from 8 to 16 h at 10, 15 or 20 d. Body weights and feed intakes were generally not significantly different at 35 d, though growth and feed conversion efficiency after 21 d were inferior for constant 16-h birds. When pooled with previously reported data for females, growth and feed conversion efficiency to depletion were significantly superior for constant 8-h and birds transferred from 8 to 16 h. Mortality was similar for all lighting groups. Constant 8-h birds ate about half their feed during the dark period, but 16-h birds consumed less than 10%. Photostimulated birds reduced their nocturnal feeding to between 10 and 15% when

changed to 16 h, but still consumed significantly more than birds held on 16 h. The two breeds responded similarly to all lighting treatments.

3. Photoperiodic responses of broilers: I. Growth, feeding behaviour, breast yield, breast yield, and testicular growth.

A total of 7960 Cobb and Ross broiler males were reared in two trials to 35 d on various photoperiods between 2 and 21 h or under continuous illumination; a total of 444 birds were randomly selected at 35 d and retained for subsequent determination of breast meat yield and testicular weight at 40 or 54 d of age. In both strains, feed intake and growth were positively correlated with photoperiod during the first 21 d, but afterwards feed intake was not significantly affected by photoperiods longer than 6 h and growth was negatively correlated with photoperiod beyond 12 h. Overall to 35 d, there were no significant photoperiodic influences on either feed intake or growth for ≥ 6-h photoperiods, but significant depressions in feed intake and growth for photoperiods shorter than 6 h. Feed conversion efficiency was maximised by 12-h photoperiods, with decreases in efficiency above and below 12 h. Mortality was unaffected by photoperiod < 12 h, but increased proportionately with photoperiod > 12 h. The incidence of Sudden Death Syndrome (SDS) had an inverse relationship with photoperiod ≤ 10 h, but was positively correlated with photoperiod > 10 h. The European Efficiency Factor was curvilinearly related to photoperiod, with the highest efficiency occurring at 12 h. Ross birds had significantly larger feed intakes but poorer feed conversion efficiencies than Cobb; differences in growth, overall mortality and the incidence of SDS between the strains were not significantly different.

By 5 d, birds given ≤ 15 h illumination had learned to eat in the dark, with the amount of feed consumed being inversely proportional to photoperiod; further increases in the amount of nocturnal feeding occurred between 5 and 20 d for ≤ 12-h photoperiods. The mean hourly rate of nocturnal feeding was consistently lower than diurnal feeding, irrespective of photoperiod. Nocturnal feeding patterns were similar for both genotypes.

Breast meat yield at 40 d was unaffected by photoperiod in Cobb birds, but significantly higher in continuously illuminated Ross birds than ≤ 21 h. At 54 d, breast meat yield was significantly higher in both genotypes given 21 h or continuous illumination and, overall, higher than at 40 d.

4. Photoperiodic responses of broilers: II. Ocular development.

In the trial reported in 3. above, Cobb and Ross broilers were exposed to various photoperiods between 2 and 21 h or to continuous illumination. Broilers on ≤ 12-h photoperiods learn to eat in the dark, and so eyes were enucleated, post mortem, and weighed from a sample of birds at 40 and 54 d to ascertain the extent to which the light-dark cycle, and indirectly darkness-feeding, might affect ocular development. Eye weight had previously been shown to be highly correlated with eye dimensions.

In both genotypes, there was an inverse linear relationship between absolute eye weight and photoperiod up to 21 h, but continuously illuminated birds consistently had large eyes. When expressed relative to body weight, eye weight for ≤ 21-h birds was inversely related to the logarithm of photoperiod.

The slope of the regression of relative eye weight on ≤ 21-h photoperiod log values was significantly shallower at 54 d than at 40 d for both genotypes, but constant-light birds continued to have large eyes. Cobb birds invariably had larger absolute and relative eye weights than Ross.

5. Photoperiodic responses of broilers: III. Tibial breaking strength and ash content.

In the trial reported in 3. above, 7960 Cobb and Ross broiler males were reared on various photoperiods or continuous illumination in two trials to 35 or 40 d. Tibial breaking strength was measured in both, and tibial ash content determined in the first of the two trials.

Tibial breaking strength was significantly affected by photoperiod, body weight, testicular weight, and genotype. Although peak bone strength occurred at about 7 h for Ross and at 12 h for Cobb, with reductions in strength for both shorter and longer photoperiods than these peaks, the removal of body weight effects showed that tibial breaking strength was negatively correlated with photoperiod per se. However, after removal of photoperiodic influences, breaking strength was positively correlated with both body weight and testicular weight.
Ross birds had higher tibial breaking strengths than Cobb, irrespective of whether the comparisons were made at the same photoperiod, the same body weight, or the same ash content.

Ash content increased according to the logarithm of photoperiod, but was unrelated to body weight. Tibial breaking strength increased with ash content. Ash contents were similar for Ross and Cobb birds.

Despite the significant differences in breaking strength and ash content, there were no broken bones or signs of leg abnormality in any of the 300 birds sampled. Tibial breaking strength data may therefore be of limited value in assessing the benefits of photoperiod to welfare in modern broilers.

6. Welfare-compliant lighting regimens for broilers.

This study investigated the responses of broilers to lighting regimens that would be compliant with the new EU welfare regulations for the protection of chickens kept for meat production (from 7 d of age, regimens must allow a bird to follow a 24-h rhythm, contain ≥ 6 h darkness per 24 h cycle of which ≥ 4 h must be uninterrupted) and be alternatives to 23L:1D conventional and 1L:2D short-cycle intermittent programmes. Two hundred and twenty Cobb '500' and 220 Ross '308' male broilers were housed in separate pens in each of 8 light-proof rooms. Two rooms were allocated to each of the following four regimens: 23L:1D (23L), 18L:6D (18L), 8(1L:2D) (SC), and 6(1L:2D):1L:5D (MSC). At 35 d, a random sample of birds was taken from each of the pens, and breast meat (on the bone) yield measured and tibial breaking strength determined. There were no significant interactions between lighting treatment and genotype for any of the performance variables. In the first 21 d, 18L had significantly lower feed consumption and smaller BW gain than MSC birds, and SC and MSC birds converted feed more efficiently than 23L. At 35 d, there were no significant differences in cumulative feed consumption, BW, feed conversion efficiency, European Efficiency Factor, breast meat yield or tibial breaking strength between the four lighting treatments. Mortality for 23L was significantly higher than MSC, which was, in turn, significantly higher than 18L or SC. These findings show that modifying broiler lighting regimens, be they conventional or short-cycle, to comply with new EU welfare legislation is unlikely to have any adverse effect on feed intake and growth. However, a reduction in photoperiod from 23 h to 18 h may well improve liveability, but with a possibility that breast meat yield will be reduced.

7. Broiler performance and bone strength is minimally affected by either a simulated dusk or night-interruption photoperiod.

Two genotypes of male broilers were given 12 h of daily illumination; as a conventional photoperiod, with the final hour at reduced illuminance to simulate dusk, or with 1 h of the light given during the middle of the night. The lighting modifications had no significant effect on any performance variable or on tibial breaking strength. Feed intake was unaffected by the lighting treatments during either the 1-h dusk period or the night, but was inexplicably stimulated in both experimental groups during the main photoperiod. There appears to be nothing gained from providing a 'dusk' or night-interruption to broiler males exposed to 12-h photoperiods.

It can be concluded from these results that the conventional lighting treatments used in commercial broiler operations, of between 16 and 23 h light per day, are both wasteful of electricity and result in a lower feed conversion efficiency, weaker legs because of a lower tibial breaking strength, and a greater propensity to

suffer from metabolic disorders such as Sudden Death Syndrome leading to a higher mortality. When 12 h uninterrupted light is given to broilers each day from day old they continue to eat in the dark, but utilise food more efficiently than when given longer daylengths than this, so growth rate is not compromised by the shorter daylengths. The only disadvantage of using short daylengths is that breast meat yield is reduced, and this issue is addressed in another project conducted at this university and funded by the PRF, namely, 'A comparison of the response to dietary protein by the Cobb and Ross broiler strains used in South Africa'.

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