Can nutrition improve the welfare of commercial broiler breeders?

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Summary

Feed restriction is practiced during the rearing of broiler breeders to control the propensity for multiple ovulation maximise the production of hatching eggs and has raised concerns for the welfare of the birds. Qualitative modifications have been evaluated and experiments have shown that feeding diets high in fibre (oat hulls) and with high levels of calcium propionate (up to 10%) control body weight to the required extent, abolish abnormal frequencies of hunger related behaviour and lead to conventional rates of lay during the breeding period. However, the welfare benefits of feeding these diets are not clear. There are practical problems affecting their adoption by industry and issues over the public perception of the broiler industry if they were adopted. Genetic selection to decrease the propensity for multiple ovulation is likely to result in the long term sustainability of the broiler industry rather than nutritional manipulation.

Introduction

The body weights of broiler breeders are limited by feed restricted to control ovarian function, improving mortality, feed efficiency, egg production and fertility (Hocking et al., 2002). Whereas limiting nutrient intake in many breeding animals is desirable form the perspective of optimising fitness and fertility, the decrease in body weight as a proportion of potential is as high as 35-50% and has caused concerns about the welfare of these birds (EFSA, 2010). The simple expedient of increasing the feed allocated to broiler breeders is impractical because there is a linear increase in multiple ovulations and a consequent reduction in the production of hatching eggs in females and of fertility in males (Hocking, 2009). Several workers have investigated dietary modification as a means to improve the welfare of broiler breeders and their different approaches can be classified into qualitative and chemical methods or a combination of these two. The results of this research will be summarised below. The welfare of feed restricted broiler breeders and the ethical considerations surrounding the practice has been discussed extensively by Decypere et al. (2010). However the methods used to assess the welfare of broiler breeders will also be outlined as a background to considerations of nutritional modifications that have been evaluated for potential use to improve the welfare of broiler breeders.

How can the welfare of feed restricted broiler breeders be assessed?

The welfare of broiler breeders cannot be measured directly but is inferred from observations of behaviour, physiology and metabolism that reflect their ability to cope with their environment and are proxies for their “mental state” or well-being.

Many papers published from the early 1990s have shown that that restricted boiler breeders are more active than full fed controls and are characterised by raised proportions of time spot pecking at pen furniture and the pen walls (e.g. Hocking et al., 1993, 1999; Savory and Maros, 1993; Savory et al., 1993). In many papers this activity has been interpreted as
stereotypic behaviour and to be indicative of unacceptable stress of poor welfare. As far as I can tell there are only two reports of assessment of behaviour in commercial flocks, both investigating environmental enrichment: one is an unpublished PhD thesis (King, 2001) and the other is by Hocking and Jones (2006). In the latter research stereotypic spot pecking was rarely observed raising questions about the validity of inferences about breed welfare based on small scale experiments: there is a need for research poultry welfare to be conducted in commercial flocks.

The physiological and metabolic profiles of feed restricted broiler breeders generally reflect their limited feed intake and in general are unsurprising (i.e. they represent attempts by the bird to increase intake by searching for feed). The heterophil-lymphocyte ratio of stress (Gross and Siegel, 1983) was consistently raised in our experiments but not in reports by other workers. A comparison of several welfare indicators in broiler breeders restricted over a range of body weights from 25% to ad libitum showed curvilinear responses to many observations suggesting that less severe restriction than conventionally practiced may be beneficial (de Jong et al., 2003; Hocking et al., 1996). The panel of physiological assays used by Hocking et al. (1996) to assess the functionality of essential organs indicated there was no evidence that these were adversely affected by commercial levels of feed allocation and limited results also suggest that feed restriction does not compromise immune function (the ultimate end-point of the ability to cope with stress).

**Qualitative dietary manipulation**

Feeding nutritionally poor diets with low energy, low protein or diets deficient in essential amino acids should permit an increase feed intake and improve satiety. Feeding an unbalanced amino acid diet was effective in controlling body weight at the expense of higher mortality and lower hatchability and rate of lay compared with quantitative restriction (Table 1). Higher rates of mortality and other welfare issues were identified in early research on the control of body weight by feeding unbalanced diets to laying hen pullets (Lee et al., 1971a) and broiler breeders (Lee et al., 1971b; Wambeke and Okerman, 1976; Wilson et al., 1971) suggesting that they should not be used. Feeding a low protein diet is effective in controlling body weight and ovarian function (Table 2) and more recently some authors have examined quantitative feed restriction with diets containing low concentrations of crude protein, low energy and/or high fibre diets.

**Table 1.** Effects on body weight, mortality, rate of lay and hatchability of eggs of broiler breeders fed ad libitum, quantitatively restricted or fed on of low lysine diets during the rearing period from 0-20 weeks of age (from Lee et al., 1971b).

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Weight at 0-60 weeks</th>
<th>Mortality, %$^1$</th>
<th>Rate of lay %</th>
<th>Hatchability %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20 weeks, kg</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ad libitum</td>
<td>3.0</td>
<td>1.8$^a$</td>
<td>47</td>
<td>71</td>
</tr>
<tr>
<td>Restricted</td>
<td>2.1</td>
<td>3.8$^{a,b}$</td>
<td>50</td>
<td>75</td>
</tr>
<tr>
<td>6.3 g lysine/kg</td>
<td>2.6</td>
<td>6.0$^b$</td>
<td>51</td>
<td>72</td>
</tr>
<tr>
<td>5.0 g lysine/kg</td>
<td>2.5</td>
<td>6.0$^b$</td>
<td>48</td>
<td>71</td>
</tr>
<tr>
<td>4.0 g lysine/kg</td>
<td>2.2</td>
<td>14.0$^c$</td>
<td>48</td>
<td>68</td>
</tr>
<tr>
<td>SE</td>
<td>0.02</td>
<td>-</td>
<td>0.9</td>
<td>0.6</td>
</tr>
</tbody>
</table>

$^1$Different superscripts indicate significant differences ($P<0.05$)
Table 2. Body weight, age and number of yellow follicles at the onset of lay in boiler breeders fed on a diet containing 150 or 100 g crude protein/kg from 6 weeks of age (unpublished experiment).

<table>
<thead>
<tr>
<th>Crude protein, g/kg</th>
<th>n</th>
<th>Weight, kg</th>
<th>Age at first egg, d</th>
<th>Yellow follicles</th>
</tr>
</thead>
<tbody>
<tr>
<td>150</td>
<td>7</td>
<td>4.5</td>
<td>154</td>
<td>12.6</td>
</tr>
<tr>
<td>100</td>
<td>8</td>
<td>3.6</td>
<td>173</td>
<td>8.4</td>
</tr>
<tr>
<td>SD</td>
<td>-</td>
<td>0.5</td>
<td>18</td>
<td>2.6</td>
</tr>
</tbody>
</table>

Different dietary dilution approaches were examined by Savory et al. (1996) including a range of incorporation of oat hulls, softwood sawdust, monensin sodium, calcium propionate and unsupplemented wheat diets. Their conclusions are worth repeating here as subsequent research has largely failed to disprove them.

1. Different methods of qualitative food restriction can be used to control growth rate within desired limits.
2. Problems with these methods include reduced uniformity in weight gain, increased excreta production and/or increased cost.
3. Although they appear to suppress abnormal oral behaviours, they do not alter the increased general activity which is correlated with suppression of growth rate, and which may more accurately reflect associated hunger.
4. Suppression of abnormal oral behaviours may only rarely correspond with reduction in blood indices of stress, and so cannot be taken to indicate improved welfare.
5. Some of these methods can add to physiological stress.
6. There was insufficient evidence of improved welfare, based on both behavioural and physiological criteria to justify, advocating the suitability of any of these methods for commercial use.

A recent illustration of the conclusions was presented by Nielsen et al. (2011) who fed diets with high (89%) or low (71%) levels of insoluble fibre at twice the level of crude fibre as the control diet (80%) to broiler breeders. Birds fed on the control diet ate significantly faster and showed a higher compensatory feed intake than those fed on the high fibre diets. They also showed higher rates of pecking at non-feed items; birds fed on the 89% diet foraged throughout the day whereas those fed on the 71% diet displayed behavioural signs indicative of discomfort, and the high water usage on this diet created problems with litter quality. These authors concluded that a high ratio of ISF may improve the well-being of birds fed on high fibre diets.

In a large scale experiment, de Jong et al. (2005) examined the welfare of broiler breeders fed on low density diets during the rearing period. These authors showed that whereas a diet of 8.4 MJ/kg “may reduce hunger and frustration in the first half of the rearing period”, more extreme diet modifications would be required “for substantial improvement of broiler breeder welfare during rearing”. However, practical difficulties also arise in feeding low nutrient density diets: as noted above, there is more environmental waste and larger volumes of feed to transport. Furthermore, unusual and high fibre feeds are often not available or are expensive, feed storage is a problem if different feed ingredient silos are needed, and manufacturing costs may be increased, although high fibre rations can be successfully processed with suitable technology (Hocking, 2006). Whereas Morrissey (2012), Tolkamp et
al. (2005) and Enting et al. (2007) showed that such diets did not adversely affect subsequent production of hatching eggs compared with the control diet, feeding restricted quantities of low protein diets from an early age adversely affected rates of lay in another experiment (Hocking et al., 2001) suggesting that feeding diets containing adequate concentrations of crude protein during the first 6 weeks after hatching are essential to maximise the subsequent production of hatching eggs.

Appetite suppressants

Sandilands and co-workers examined calcium propionate supplementation of high fibre diluted diets based on oat hulls (Sandilands et al., 2005; Sandilands et al., 2006). A high fibre diet (400 g oat hulls/kg) with up to 10% of calcium propionate fed ad libitum controlled body weight to the required extent and virtually abolished abnormal rates of pecking at non-food objects suggesting improvements in welfare. However the mode of action of calcium propionate on feed intake is not known: it may be unpalatable or affect the physiology of the birds in an adverse manner. Extensive detailed attempts to demonstrate a preference for an oat hulls and calcium propionate diet have proved to be problematic and have generally failed to show an effect except for a preference for the control diet in one experiment (Buckley et al., 2011a; Buckley et al., 2012; Buckley et al., 2011b). Furthermore there are practical considerations regarding the feeding of a chemical and a potential appetite suppressant: handling and manufacture of the diets may be problematic and it is doubtful if an industry that is sensitive to its public image would wish to be associated with the practice (Hocking and Bernard, 1993).

Conclusions

There is now a substantial body of literature demonstrating that a diet high in fibre (typically from oat hulls) combined with high levels if calcium propionate fed and fed ad libitum can lead to satisfactory control of body weight and conventional rates of lay during the breeding period. These diets may improve welfare as indicated by virtually abolishing abnormal levels of pecking at non-food objects. However, research has failed to determine the physiological basis of these changes and unequivocally demonstrate the welfare benefits of their use. It is also unclear that manufacturing and feeding such diets is either practical or acceptable to industry or the public. It is the view of the author that a reduction in the genetic propensity for multiple ovulation is the only sustainable way to improve the welfare of broiler breeders during rearing (Hocking, 2009).

References


