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Research note: Does roughage and diluted feed have a health effect on Hubbard M77 broiler breeder cockerels?

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ABSTRACT

Quantitative feed restriction during rearing of broiler breeders is a well-known welfare challenge. This is necessary to secure health and reproductivity in the adult birds, but is associated with hunger and frustration. One alternative to quantitative restriction is to dilute the feed and/or provide roughage. This allows the birds a larger ration of feed, where the aim is a better satiety and thereby less hunger and frustration. Diluted feed and roughage have been tested in breeder pullets in several studies, but only one time with cockerels (Ross 308) and never with M77, the male breeder line for the medium slow growing Hubbard JA787. The aim of this study was to investigate the effects of feed dilution and roughage on selected health indicators in broiler breeder cockerels, 5 to 10 wk of age (WOA). In total, 200 M77 cockerels were housed in 12 pens (6 pens/treatment), 16 to 17 birds per pen. The treatments were standard feed (Control), and feed diluted with (20 %) oat hulls and 150 g of roughage (lucerne alfalfa) daily per pen (D + R). The D + R birds received 20 % more feed per day. Body weight, pecking injuries and footpad dermatitis (FPD) were recorded weekly between 5 and 9 WOA. At 10 WOA all birds were euthanized and subjected to postmortem assessment. The results showed that the D+R birds were slightly heavier than the control group in the last two weeks of the trial ($P = 0.02$). This coincides with a marginally heavier gizzard and longer intestinal tract in the D+R group. The footpad scores were overall low in both groups and all ages, but with slightly more variation in the D+R group. Overall, the results showed few positive nor negative effects of diluted feed and roughage on the selected health parameters in M77 cockerels. Further studies are needed to explore this area more.

Introduction

Due to consumer demands and governmental politics, the production of slower growing broiler hybrids is increasing in Western Europe. The main reason behind this transition from fast to slower growing hybrids is better welfare, also for the broiler breeders. There is a general negative correlation between the growth rate of broiler chickens and the reproduction traits of the breeder stock, referred to as the broiler breeder paradox (Decuypere et al., 2010). Hubbard JA787 is a medium-slow growing hybrid that comprises approximately 30 % of the broiler market in Norway. The Hubbard JA787's parent hen is a dwarf hen, with no need for restricted feeding. The JA787's male breeder line is the fast-growing M77 and must be subjected to a restrict feeding regime during rearing. Feed restriction is a welfare problem, since it may lead to hunger and frustration (De Jong and Guémené, 2011). On the other hand, this feed restriction is important to prevent obesity, lameness, health problems and reduced sexual productivity (Mench, 2002; De Jong and Guémené, 2011).

One measure to reduce the negative effects of restricted feeding is to dilute the feed with insoluble fibre and provide roughage (Tolkamp et al., 2005; Nielsen et al., 2011). These strategies offer the birds a larger quantity of feed to create a feeling of satiety, without increasing the daily caloric intake (Riber and Tahamtani, 2020). Such feed strategies have been tested in several broiler breeder pullet studies but is less explored in cockerels and only in Ross 308 cockerels (Kittelsen et al., 2023), never in M77. Therefore, the aim of this study was to investigate

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the effects of a combination of diluted feed and roughage on selected health parameters during rearing in the Hubbard rooster line M77.

Materials and methods

Ethical approval

This study was conducted at the Norwegian University of Life Sciences' research facility. The study was approved by the Norwegian Food Safety Authority, licence number 30003.

Birds and housing

The cockerels were hatched at a commercial hatchery and reared at a commercial rearing farm for the first 5 weeks of age (WOA). The rearing facility was insulated with mechanical ventilation and wood shavings as litter, with 8000 pullets and 600 cockerels housed in separate compartments within the same barn. Feed, water, ventilation, and lighting were managed according to standardized practices (Hubbard, 2023). Beak trimming is prohibited in Norway, but the cockerels were toe amputated. At 5 WOA, 200 cockerels were transferred to the Animal Husbandry experimental research facility at the Norwegian University of Life Sciences, where they were randomly allocated to 12 elevated pens, 296 × 60 × 71 cm (length x height x depth), with solid floors covered with fresh wood shavings, 16-17 birds per pen, resulting in a density of 8 to 8.5 birds/m^2. The pens were equipped with a nipple drinker lines (4 nipples per cage) and with a 70 cm jute rope (diameter: 20 mm) as an environmental enrichment. Ventilation, humidity, temperature, and lighting followed the Hubbard breeding manual. The light period started at 13 h at 5 weeks of age (from 07:30 to 20:30), gradually decreasing each week until it reached 10 h (from 07:30 to 17:30) at 10 weeks of age. Light intensity was kept at 10 lux. The cockerels were subjected to three days of habituation period before the start of the study. During this period, all birds received the same feed as they had received in the rearing farm (starter, Table 1).

Treatments

Each of the 12 pens was assigned one of two treatments: Control or Dilution + Roughage (D+R), both formulated as pellets (2.5 mm) given once per day, scattered on the floor of the pen at 09:00. The amount was based on recommendations from the breeding company. The control diet was formulated according to nutritional specifications of a commercial rearing diet. The D+R diet was diluted with 20 % oat hulls, reducing metabolizable energy (ME) and digestible amino acids content by one fifth, resulting in 20 % more feed allowance per bird and day (Table 1). In addition, the D+R diet received 150 g lucerne alfalfa roughage/pen/day 15 min after the pelleted feed.

Weekly health registrations

All birds were examined at 5, 6, 7, 8 and 9 WOA for the following parameters: weight, footpad dermatitis (FPD), plumage condition, dirtiness and pecking injuries. The footpads were scored on a 5-point scale according to the Welfare Quality Assessment Protocol for Poultry; score 0 represents no evidence of FPD, score 1 and 2 represents small to moderate evidence of FPD, while score 3 and 4 represents evidence of severe FPD (Welfare Quality, 2009). Plumage condition was scored for head, back/wings, breast, and tail in a 3-point scale (0-2); 0 = no feather loss, 1 = feather loss 1-5 cm in diameter, 2 = feather loss > 5 cm in diameter. Dirtiness was defined as prominent dark staining of the back, wing, or tail feathers, covering at least 25 % of the body. Wounds were evaluated on the head, tail, cloaca and back. A wound was defined as a prominent mark due to fresh or old wounds.

Postmortem assessment

At 10 WOA all birds were stunned by blunt trauma to the head and euthanized with cervical dislocation and then subjected to *postmortem* investigations, performed on two consecutive days by two experienced veterinarians. The *postmortem* parameters assessed included: weight, external evaluation (plumage condition, footpads, length of the tibia, wounds, dirtiness) and internal examination (inspection of the femoral heads, visual inspection of the body cavity, weighing of heart, liver, full gizzard, removal of koilin layer, inspection of gizzard mucosa, length of the gut, inspection of gut mucosa). Femoral head necrosis was scored on a dichotomous scale (yes/no) in the case of macroscopic visible lesions in the growth plate, fractures of the neck and head of the femur, brittle cortex or separation of the articular cartilage (Mcnamee and Smyth, 2010).

Statistical analysis

Statistical analyses were performed using the software SAS 9.4 (SAS Institute Inc., Cary, NC) and followed the methods used by Kittelsen et al. 2023. The data on the live weight measured from week 5 to 9 were analysed using the mixed procedure. The model included the diet treatment, week of age and their interaction as fixed factors while the experimental unit pen was included as a random effect. Tukey test (Tukey's HSD test) was used for *posthoc* analyses. The coefficient of variation (CV%) in body weight per pen was used as a proxy for flock uniformity and calculated using the formula below. The higher the CV, the greater the level of dispersion around the pen average, and the lower the flock uniformity:

$$CV\% = \frac{Pen\ standard\ deviation}{Average\ pen\ weight} \times 100$$

The data on footpad dermatitis was analysed using the glimmix procedure with a multinomial (ordered) distribution and cumulative logit link function. The fixed factors were the diet treatment, week of age and their interaction, while pen was included as a random effect. The critical alpha associated with this analysis was Bonferroni corrected to $\alpha = 0.00625$. The prevalence of head wounds and vent pasting were analysed with a glimmix model with binary distribution (Yes/No).

Table 1
Diet composition information for the experimental diets provided for the male broiler parent stock.

	Age (wk)	ME (kcal/kg)	Protein (g/kg)	Crude fiber (%)	Soluble NSP[1] (%)	Nonsoluble NSP[1] (%)	Daily amount of feed g/bird/day[2]
Starter	5	2820	165	5.18	2.92	14.4	49
Grower							
- Control[3]	6 – 10	2680	135	6.2	2.98	18.09	50 - 60
- Diluted[4]	6 - 10	2150	110	11.6	2.74	30.71	60 - 72
- Alfafa[5]	6 - 10	860	168	27.1	Total NSP 55 %		ca. 8 - 9

[1] Non-Starch Polysaccharide.
[2] The daily amount increased according to the weight of the birds. This shows the increase from the first week to the last week.
[3] Standard commercial breeder feed.
[4] An additional 20 % ration diluted with oat hulls.
[5] 150g ration per pen per day.

The analysis of the postmortem data was similar to that of the live health assessments, with the exception that week of age was not included in the model. The models for the assessment of the weight or length of the body parts assessed were corrected for the body weight of the birds by including this variable in the model as a covariate. Finally, the prevalence of pathologies (i.e., vent pasting, alterations of the intestinal mucosa, head wounds, femoral head necrosis) were analysed with a binomial distribution glimmix with treatment as a fixed factor and pen as a random effect.

Results and discussion

The aim of this study was to investigate the effects of a combination of diluted feed and roughage on selected health parameters during rearing in the Hubbard rooster line M77. Overall, the results showed no severe health outcomes and few differences between the groups. The behavioural result from the same study is published in a separate publication (Tahamtani et al., 2025).

Live cockerel weight

The study aimed to investigate if it is possible to increase the amount of feed without increasing the weight of the birds, since increased weight may have detrimental effects on health and production later in life. There were no effects of treatment ($F_{1,10} = 0.74$; $P = 0.41$) or age ($F_{3,30} = 0.32$; $P = 0.81$) on the uniformity of the flocks, but the results showed an effect of the interaction between diet treatment and age on the live weight of the cockerels ($F_{3,747} = 4.0$; $P = 0.008$). Both groups of birds had an equal growth curve on week 5-8 ($P > 0.05$) but differed on week 9 ($P = 0.02$), where the D+R birds were slightly heavier than the control group, Fig. 1. In contrast, in an identical trial with Ross 308 cockerels there was an overall tendency for heavier D+R birds during the entire trial and not just at week 9 (Kittelsen et al., 2023). At week 9 the gizzard weight differed between the groups, but only with 5 g (Table 2). This will therefore not explain the body weight differences between the groups. Lucerne alfalfa does not provide high nutritional value (Pres and Fritz, 1963), nevertheless the nutritional contribution of lucerne alfalfa to the daily nutrient uptake was approximately 5 % per daily portion in terms of metabolizable energy. As such, lucerne alfalfa contributed to a slight increase in daily nutrient intake. In addition, there may be residues in the oat hulls that can have contribute to the nutritional value. This, in combination with the lucerne alfalfa, may explain the increased weight in the D+R birds.

Table 2
Comparison of weight and length (LS means ± SE) of body parts measured in the postmortem assessment of male broiler parent stock, across diet treatments.

Organ	Control[1]			Dilution + Roughage[2]			
	LS means	SE	% body weight	LS means	SE	% body weight	P value
Liver (g)	25.95	0.43	1.64	26.11	0.43	1.6	0.8
Gizzard[3] (g)	80.8[a]	1.27	5.1	85.19[b]	1.25	5.2	0.02
Heart (g)	6.32	0.16	0.4	6.2	0.16	0.38	0.55
Intestines[4] (cm)	177.9	2.23	na[5]	184.34	2.22	na[5]	0.07
Tibia (cm)	40.72	0.22	na[5]	40.46	0.22	na[5]	0.45

[1] Standard commercial breeder feed.
[2] An additional 20 % ration diluted with oat hulls and 150g ration per pen per day.
[3] Gizzard with content.
[4] The full length of the intestines from the start of the duodenum to the end of the colon, not including the cloaca.
[5] Not applicable.
ab Different letters represent a significant difference between LS means.

Footpad dermatitis

Feed composition and formulation may affect gut health, water intake and thereby gut content (Hocking, 2006; Ducatelle et al., 2023). This may in turn affect litter quality and thereby footpad health. Therefore, the study monitored the footpads once a week. There was an effect of the interaction between the diet treatment and week of age on the scores of FPD ($F_{3,748} = 4.49$; $P = 0.003$) with more variation with age in the D+R group than in the control group ($P > 0.006$). However, the overall scores were low in both groups with no moderate or severe lesions observed, indicating overall good footpad health. These results are in line with previous research in both pullets and cockerels, which has found that birds fed diluted diets do not differ severely from control birds in terms of footpad dermatitis (Tahamtani et al., 2020; Kittelsen et al., 2023), indicating that diluted feed does not pose a threat to the bird's footpad health. No feather loss or dirtiness were observed in either of the groups.

Wounds

Pecking on conspecifics may be a sign of frustration (De Jong and Guémené, 2011). Therefore, pecking injuries manifested as skin wounds were included as a health parameter. Only minor head wounds were seen and only at 9 WOA. At this age, the D+R group was more likely to

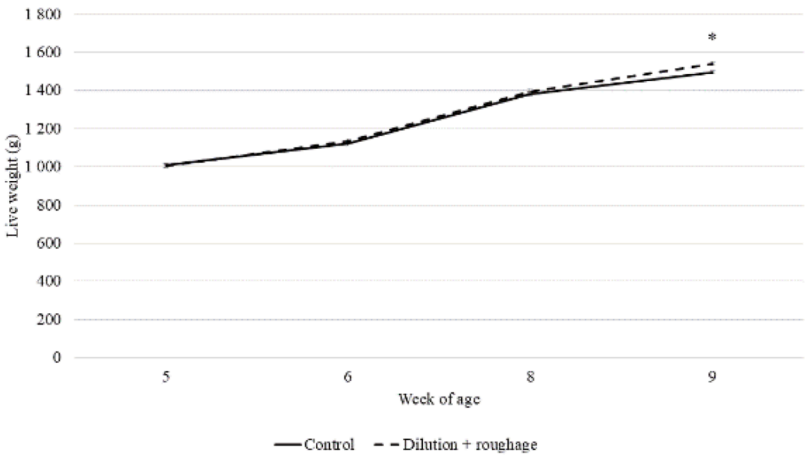

Fig. 1. Live weight (LS means ± SE) per week for male broiler breeders, both control[1] and treatment[2].
[1]Standard commercial breeder feed. [2]An additional 20 % ration diluted with oat hulls and 150g ration per pen per day.

have head wounds compared to the control group ($F_{1,180} = 4.52$; $P = 0.03$, odds ratio: 4.4). The hypothesis behind the D+R treatment was that this will increase satiety and hence reduce frustration and aggression. Therefore, it was surprising that this group had more wounds at 9 WOA, which contrasted with a similar study with Ross 308 cockerels were no effect of treatment was found (Kittelsen et al., 2023). Further and more long-term studies are needed to explore the pecking injuries and the cause of these in the cockerels.

Postmortem examination

The D+R birds weighed significantly more than the Control birds *postmortem* (LS means ± SE: 1637.3 g ± 16.7 and 1583.6 g ± 16.8 respectively; $F_{1,10} = 5{,}13$; $P = 0.04$). This is in line with the results from the live bird weights, where D+R birds were heavier at week 9. The same result was also reported in an identical study of Ross 308 cockerels (Kittelsen et al., 2023). Since the trial ended at 10 WOA, we do not know if this development would continue. Further studies are needed to explore the weight development during the entire rearing period, since control of the weight of the cockerels is crucial in the breeder period. The observed weight difference may be attributed to longer intestines ($F_{1,10} = 4.12$; $P = 0.07$) in the D+R birds compared to control birds, see Table 2. In contrast to this, no dietary effect on intestinal length was found in Ross 308 cockerels (Kittelsen et al. 2023).

We found no effect of diet on the weight of the liver ($F_{1,10} = 0.07$; $P = 0.8$), the heart ($F_{1,10} = 0.38$; $P = 0.55$), or on the length of the tibia ($F1,10 = 0.62$; $P = 0.45$). There was also no effect of the diet treatment on the incidence of FPD assessed postmortem ($F_{1,194} = 1.57$; $P = 0.21$). Also, diet did not affect vent pasting ($F_{1,194} = 2.27$; $P = 0.13$), the intestinal mucosa ($F_{1,194} = 0.06$; $P = 0.81$) or femoral head necrosis ($F_{1,194} = 0.00$; $P = 0.99$).

Towards the end of the study period, the D+R birds were heavier than the Control group. In addition, minor head wounds were more common at the same age in D+R birds. Besides this, the study found insignificant differences between the Control and D+R birds. This indicates that 20 % feed dilution combined with roughage few positive nor negative effects on the selected health parameters investigated in this study.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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