Differential gene expression elucidating Campylobacter jejuni perseverance mechanisms after storage at ultra-low temperature

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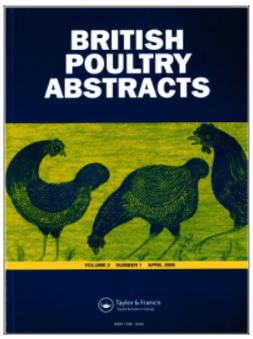

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2024 SPRING MEETING OF THE WPSA UK BRANCH

2024 Abstracts

Communications and invited talks presented at the WPSA UK Branch Spring Meeting held on the 10th and 11th April 2024. These summaries have been reviewed and edited for clarity and style by the WPSA UK Programme Committee but have not been fully peer-reviewed.

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B. Tugnoli, A. Piva, F. Khattak and E. Grilli. A microencapsulated blend of botanicals and organic acids can improve growth performance and gut health of broilers.

H. Scott-Cook, S.C. Mansbridge, A.M. Mackenzie and V. Pirgozliev. Replacing soybean meal with alternative protein sources in Redbro broiler diets.

J.G.M. Houdijk, L. Marchal, A. Bello, K. Gibbs and Y. Dersjant-Li. Complete replacement of soya products with alternative ingredients for fast growing broilers.

J. Taylor, Y. Mercier, T.J. Applegate, R. Selvaraj, O.A. Olukosi, W.K. Kim, M.E. Ball and I. Kyriazakis. Methionine or threonine supplementation of low protein diets affects digestibility of other amino acids during a mixed Eimeria infection.

A. Alkhtib, E. J. Burton, D. V. Scholey, R. Hackett and N. Davies. Effect of rapeseed/field bean blend and corn fermented protein as replacement for soyabean in broiler diets on growth, meat yield, and welfare.

M. Saxena, P. Wilson, L. Vervelde, K. Sutton and I. C. Dunn. Detection of in vitro gene expression from enteroendocrine cells in chicken gut organoids.

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C. Hughes, N. Corcionivoschi, A. Richmond and S. Huws. Pilot Study: In vitro assessment of novel protein digestibility compared to soyabean meal for broiler chickens.

A. Desbruslais, L. Corbett, W. Wakeman, K.E. Anderson and K.L. Cupo. Efficacy of an oregano essential oil-based additive on the helminth burden and productivity of free-range laying hens.

A. Badina, A. Alkhtib, E. Burton, J. Boyd and M.R. Bedford. Impact of exogeneous enzyme supplementation on growth, digestibility, and litter moisture of broilers fed rye-based grower diet.

V. Sandilands, F. Khattak, and J.G.M. Houdijk. Does feeding sprouted barley to laying hens affect feed intake, egg production and egg quality?

A.I. Maxey, D.V. Scholey, A. Wealleans and E.J. Burton. Antioxidant feed stabilisers improve performance in meat poultry.

H. Scott-Cook, S.C. Mansbridge, A.M. Mackenzie and V. Pirgozliev. Broiler farmers' perceptions of slow growing broiler production in Great Britain.

Grasping technical innovation; the route to a new golden era for welfare, industry and science

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The innovative steps in new cheap available technology that can be used in agriculture and the methodology, algorithms and communications to use that technology have taken unimaginable steps forward in the last 20 years. Looking forward we are on the edge of a machine learning/AI revolution which is likely to accelerate scientific progress and make the last 20 years look a crawl.

We at the Lakes became interested in practical on farm science over 15 years ago when we had been telling one of our customers that trees were good for laying birds, they asked us to prove it. Working with Farm Animal Initiative (FAI) 5 years later, thousands of data points from 450 laying farms and a published paper (Bright and Joret, 2007) proved the fact. That work since went on to be included in RSPCA Assured standards meaning that 30 million laying birds have better welfare, farmers make more money and upwards of 2.5 million trees have been planted on UK laying farms.

The valuable lesson to me was that with the right partners solid science can be achieved at farm level that has the potential to massively change bird welfare and farm profitability.

We since went on to instigate numerous other projects including biodiversity benefits of tree planting on laying farms, commercial scale dark brooding of layer chicks, ammonia reduction from trees and smothering as a major cause of mortality in laying birds to name but a few.

Smothering is the biggest single cause of mortality in free range laying birds, FAI and ourselves published the first work globally on this subject in 2012. The biggest single cause of mortality on free range farms and even now you can count the number of papers on the subject on one hand.

This is one of my major drivers, to get science working to improve animal welfare at farm level. Many very focused, highly intellectual poultry scientists out there, producing a lot of pure science that whilst intellectually and scientifically important often has very little direct impact on farms.

What became clear in these early research projects was the lack of solid, data from any of the farms we worked with. Invariably setting up projects with a few farms collecting data from scratch at the start of the research project. Most of

the records were patchy or of poor quality, even on basic data points such as mortality, production, feed use, water use. As a company we looked globally at all the data collection systems we could find and not one was interested in collecting real time data from farms of the quality we wanted. So, we arranged working closely with FAI to develop our own. We now like to think we have the world's leading laying bird data collection system. Rock solid data from hundreds of flocks on over 200 data points real time.

This technology has the potential to massively improve welfare, performance, science and farmer/ poultry interaction. Understand what makes the human keeper work and you understand the weaknesses and problems before they happen. We have been climbing the better designed equipment, better genetics, better nutrition ladder for decades and the steps in improved welfare and performance get smaller and smaller.

The first year we rolled out data systems on our farms, without any significant research we improved mortality by nearly 20% and production by a dozen eggs. Imagine what we can do if we really try. That is where Lakes are at the moment. Looking at AI/ ML to interrogate our data. Recording thousands of hours of CCTV and audio to understand our birds better. Looking at staff to work out what turns a good stockperson into a great stockperson. Linking scientists, with vets, with farmers, with nutritionists, with those data holders out there that do not yet realise the worth of what they have. CCTV can track movement but also disease, behavioral issues, welfare issues. Before you even think of adding thermal imaging where the potential goes stratospheric. Audio analysis can already distinguish and diagnose several diseases, lots of behavioral problems, machine problems, building problems. Seamlessly transfer pullets from rearing farms to laying farms. One of the riskiest moves for bird welfare currently becomes a minor issue if the farms are linked by a solid data stream on all key management tasks.

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Effects of reduced photoperiod or optional access to dark shelters during the first week of life on the health, welfare and performance of broiler chickens

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Application

Information on the impact of photoperiods and dark shelters (as a potential novel environmental enrichment) on the production and welfare of young commercially-housed boiler chicks will help inform industry practice, and direct further research and policy.

Introduction

Broiler chicken farmers typically employ continuous or near-constant (23hrs) photoperiods during the first week of production to aid chicks in accessing sufficient feed and water. Little evidence exists to validate this practice, however significant research conducted on older birds describes the negative effects of long photoperiods. This study evaluated the effects of decreasing photoperiods or providing optional access to dark shelters for the first 7 days of rearing on health, welfare and performance.

Material & methods

This study was approved by the QUB Faculty Research Ethics Committee (MHLS 21–86). Treatments were applied from days 0 to 7 and included: (1) industry standard photoperiod (control, **C**), (2) increased darkness (**ID**), and (3) industry standard photoperiod plus optional to access dark shelters (**DS**). The industry standard photoperiod involved 1 h of darkness per 24 h on days 0–3, with an additional hour added per day thereafter (e.g. 4 h darkness by day 6). In the ID treatment two blocks of darkness were provided during the first 7 days. The first block was 2h on day 0 with 20 min added per day thereafter (e.g. 4 h by day 6), and the second block maintained at 2 h. The DS treatment had a total of 8 dark shelters per house, each occupying 3.6 m^2 in floor space. The study was performed on three farms, each with three houses, and one house on each farm was assigned to a treatment. Flock sizes ranged from 21,500 to 26,600 Ross 308 birds per house. Data was collected from three production cycles on two farms, and two cycles on one farm. Treatments were rotated between houses in each cycle. Performance and abattoir data were recorded on all three farms, with crop fill, gait score and behavioural data recorded on two farms. Performance data included bodyweight (BW, sampling at least 1% of birds) and cumulative mortality at 7, 14, 21, 28 days, 35 day corrected BW, total mortality, and FCR corrected to 2 kg bodyweight. Data recorded at the abattoir included the % of birds with hock burn, pododermatitis and carcass downgrades (recorded from all birds for hock burn and carcass downgrades, and from 1.7% of birds for pododermatitis). Crop fill was scored from 0 (empty) to 4 (feed and water present) in 200 birds per house on days 0 and 1. Gait score was recorded in 60 birds per house on days 28 and 35 on a scale of 0 (no impairment) to 5 (unable to stand). Novel object tests (NO) were performed on days 7 and 14, with the number of birds within 50 cm of the novel object at 3 minutes recorded. Undisturbed bird behaviour was recorded over 25 min periods in six areas per house on days 3, 6 and 21. This was used to determine general bird behaviour through instantaneous scans at 7 and 14 minutes, and to record incidences of play behaviour over continuous 2 minute periods at these times. All data was analysed using

SPSS version 26. Treatment effects on performance, abattoir, novel object test and suitable undisturbed behaviour data were analysed using liner mixed models. Kruskal Wallis tests were used to assess treatment effects on crop fill and gait score data, and on behaviour data unsuitable for parametric statistics.

Results

There was no significant treatment effect on brood quality or early performance in terms of crop fill scores, or 7 day BW and mortality. Performance across the production cycle was also unaffected by treatment, including BW, FCR, mortality and carcass downgrades, as was NO behaviour. Differences in undisturbed behaviour were subtle, however on day 3 DS birds performed less standing inactive behaviour ($F(2, 51.487) = 6.626$, $p = 0.003$) and more feeding behaviour($H(2) = 0.2496$, $p = 0.032$) than birds in other treatments. DS and ID birds performed more apparent play behaviour (wing flapping) than C birds on day 3 ($H(2) = 9.902$, $p = 0.007$). On day 21 C birds tended to show more running ($p = 0.054$), and showed more drinking ($F(2, 77.582)$ 9.200 $p < 0.001$) and less sitting behaviour ($F(2, 76.702) = 7.031$ $p = 0.002$). The gait score at 28 days was significantly better in DS birds relative to C birds ($H(2) = 6.525$, $p = 0.038$), with ID birds not differing significantly from other treatments. Pododermatitis was unaffected by treatment, however DS birds also tended to show a lower hock burn incidence ($p = 0.052$).

Conclusion

This study suggests that very long photoperiods during early life (e.g. up to 23 hours) are not essential to maintain production performance and that increasing darkness during the first days of rearing does not impede chicks from accessing sufficient feed and water. These results present a novel approach to environmental enrichment through the use of dark shelters which appear to have benefits for leg health.

Acknowledgements

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Production efficiency and animal welfare trade-off: breed, faba beans and broiler locomotion

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Application

Broiler locomotion is more sensitive to breed than to faba bean feeding at relatively small impacts of the latter on body weight.

Introduction

Slower growing broilers have better locomotion, observed as lower gait scores, than their faster growing counterparts (Dixon, 2020). As gait scores gradually increase (worsen) when broilers get older, body weight and gait score might be positively correlated. Thus, nutritional strategies that may result in reduced final body weights, such as high levels of faba beans (Olukosi, Walker, & Houdijk, 2019), may reduce (improve) gait score. Here, we tested this trade-off hypothesis by assessing gait scores and body weights of Ross308 and Hubbard JA787 birds fed rations without or with 30% faba beans as a partial soya bean meal (SBM) alternative.

Material and methods

As part of a larger trial (Houdijk, Bentley, Walker, & Dixon, 2022), 384 Ross308 and Hubbard JA787 male broilers, placed as day-old in 32 pens (12 birds per breed) and fed grower-finisher rations without or with 30% faba beans (n = 8 pens; randomised block design) were gait scored weekly, on a 0 to 5 scale of progressively worsening locomotion from a pre-defined ethogram described by Dixon and Yildirim (2020). Diets were wheat-SBM based, with faba beans exchanged against SBM on a digestible lysine basis, formulated to meet average Ross308 and Hubbard JA787 requirements, using pure amino acids as required and small wheat and oil variations to maintain same energy levels. Birds were fed *ad libitum* a common starter crumb (d0-14), grower pellet (d14-28) and finisher pellet (d28 to end: d35 for Ross308 and d42 for Hubbard JA787). Weekly mean bird weights and gait score were analysed via a 2 × 2 factorial ANOVA for breed, faba bean level and their interaction. SRUC's ethical review approved this study (POU AE 14–2021).

Results

Table 1 shows there was no significant interaction between breed and faba bean feeding on body weights and gait score. However, JA787 birds were consistently lighter and had lower gait scores than Ross308 birds ($P < 0.001$). Whilst faba bean feeding reduced body weight on average by ~2.5% over all observation points, with probabilities ranging from $P = 0.011$ to $P = 0.132$, only during week three this tended to reduce (improve) gait score ($P = 0.074$), with some tentative suggestion that this effect was more pronounced with Ross308 than for JA787 birds ($P = 0.105$). Correlation between mean body weight and gait score were 0.74 and 0.64 for final week observations for Ross308 and JA787, respectively ($P < 0.01$).

Table 1. Weekly body weights and gait scores of Ross308 and Hubbard JA787 broilers fed no (CON) or 30% faba beans (FB)

		Ross308		JA787			P-values		
	Wk	CON	FB	CON	FB	s.e.d.	Breed	Feed	Breed × Feed
Body weight	1	197		155		2.6	<.001	-	-
weight (g)	2	509		366		9.9	<.001	-	-
	3	1109	1079	748	716	16.9	<.001	0.011	0.931
	4	1797	1767	1180	1151	25.4	<.001	0.102	0.948
	5	2756	2694	1804	1760	34.3	<.001	0.030	0.722
	6	-	-	2425	2366	34.7	-	0.132	-
Gait	1	0.14		0.04		0.02	<.001	-	-
score	2	0.83		0.11		0.06	<.001	-	-
	3	1.54	1.39	0.14	0.13	0.06	<.001	0.074	0.105
	4	2.06	1.97	0.27	0.21	0.08	<.001	0.218	0.820
	5	2.62	2.52	0.56	0.63	0.16	<.001	0.852	0.323
	6	-	-	1.20	1.07	0.13	-	0.375	-

Conclusion

The positive correlation between body weight and gait score observed in both breeds supports our hypothesis. However, deducted from these correlations, body weight accounted for an average of 48% of gait score, indicating that locomotion is sensitive to other factors. This could partly explain the absence of a clear reduction in gait score in the presence of a stronger effect on body weight arising from the use of 30% faba beans. The effect size of the latter was also relatively small, suggesting greater nutritional manipulation of body weight may be required to further pursuit the trade-off between production efficiency and animal welfare.

Acknowledgments

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Effects of reduced stocking density on broiler chicken behaviour in standard commercial housing

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Application

Improved broiler welfare at reduced stocking densities on commercial farms strengthens the case for industry change.

Introduction

Reduced broiler chicken stocking density has been associated with improved leg health, including bone strength and reduced severity and incidence of foot pad dermatitis and hock burn lesions (e.g. Mocz et al., 2022; van der Eijk et al., 2023). Higher stocking densities are associated with chronic stress (Qaid et al., 2023). In experimental conditions reduced stocking densities are associated with increased comfort, foraging, frolicking and running behaviours (Evans et al., 2023; Vas et al., 2023). Many retailers have signed up to the Better Chicken Commitment, which requires a maximum stocking density of 30 kg/m^2. It is vital to understand the impact of reduced stocking density on behaviour and welfare under commercial conditions.

Material and methods

Researchers visited six houses on a single UK farm over two production cycles; birds were housed at stocking densities of 38 kg/m^2 (standard, SSD) and 30 kg/m^2 (reduced, RSD) during production cycles one and two, respectively. Visits were carried out at 35 days of age and included welfare assessments based on the Welfare Quality protocol (foot pad, hock, gait and cleanliness scoring; tests of fearfulness; and observations of comfort, playing and maintenance behaviours). Researchers carried out behavioural scans at four locations throughout each house, plus ten touch tests, 100 birds were scored for cleanliness, foot pad dermatitis and hock burns, and a further 100 birds were gait scored (each case equally sampled at each of five locations throughout the laying house). Cameras fitted by FLOX recorded continuous video. Videos were available for four SSD flocks. Videos were also available for RSD flocks: these included five flocks visited in person, and three flocks from a third production cycle (not visited in person). Data were collected from flocks before (29–32 days) and after (31–33 days) thinning; the

same behaviours were recorded as during farm visits. Data were analysed in Stata 17.0 using multi-level logistic regression (observation of behaviour), Poisson (touch tests) and ordinal logistic regression (gait, cleanliness, foot pad and hock scores) models (accounting for repeated measures from flocks and houses).

Results

During farm visits preening was 3.9x more likely ($p = 0.003$) and more birds were touched during touch tests ($p < 0.001$) in RSD compared with SSD. Odds of having high cleanliness, foot pad dermatitis and hock scores were 0.12x, 0.24x and 0.61x lower, respectively, at RSD compared with SSD ($p = 0.002$, $p < 0.001$ and $p = 0.001$, respectively). From video data, flapping was 1.67x more likely at SSD ($p = 0.048$). Flapping, frolicking, and locomotion were 0,48x, 0.26x and 0.27x less likely, respectively, after thinning ($p < 0.001$, $p = 0.006$, $p < 0.001$). Preening was 0.24x less likely after thinning at RSD, and 0.30x less likely before thining at SSD ($p < 0.001$). Before thinning, resting behaviour was 6.32x more likely at RSD compared with SSD. Resting before and after thinning were compared: resting was 2.43x and 19.1x more likely after thinning at RSD and SSD, respectively ($p = 0.004$).

Conclusion

At reduced stocking densities under commercial conditions broiler chickens had better welfare and performed more comfort and resting behaviours, compared with standard stocking densities. At reduced stocking densities fewer birds were touched during a touch test; we would normally assume this meant birds were more fearful, however, in this case it is possible that birds simply had more space to move away from a fear-inducing stimulus. Increases in preening and resting after thinning at standard stocking density may suggest rebound behaviour, indicating performance of these behaviours at less than optimal rates before thinning.

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Developing appropriate environmental enrichment strategies for broiler breeders

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Application

Broiler breeder preferences could be used to identify and develop biologically relevant environmental enrichments.

Introduction

Research into the benefits of environmental enrichment for broiler chickens has led to the development of various strategies and a widening commercial uptake (Jacobs et al., 2023). There is a recognised need for this to be extended to the parent stock, however a lack of research into biologically appropriate enrichment for broiler breeders has slowed progress in this area. Therefore, we presented broiler breeders with different forms of perch and dust bath to begin exploring their preferences.

Material and methods

This project was approved by the Faculty of Medicine, Health and Life Sciences REC (MHLS 22_52). On a commercial broiler breeder farm in Northern Ireland, between March-December 2022, two matched houses (98 m x 14 m) were stocked with 7950 Ross 308 parent-stock broiler chickens. In both houses, twelve (six on each side) 3-m-long perches were installed, with an equal number of three forms of perch; 1) a platform perch (16 cm width of plastic gridding), 2) a metal bar (45 mm diameter) and 3) a rubber-coated metal bar (49 mm diameter). Video cameras recorded six perches (two of each type) in each house for 24 hours once a week in four-week blocks during early, peak and late lay. The number of broilers on each perch were noted on the hour, from 10 00 h to 09 00 h inclusive. Analysis (SPSS v29) was performed using a mixed model with perch type and time period as fixed effects, and house as a random effect. During the same time periods, three dustbathing substrates were provided in six areas (1.2 m x 60 cm; two areas per substrate) once a week: 1) oat hulls, 2) sawdust and 3) 50:50 mix. All dustbathing areas were video recorded for one hour once a week. Scan sampling were used to record the number of birds present in the dustbathing areas and their behaviour (classified as foraging, dustbathing or other). Results were analysed using a two-way ANOVA to determine the effects of substrate and week on the number of birds and their behaviour.

Results

There was a significant effect of perch type and time period on perch occupancy ($p < 0.001$ for both). The highest level of perching was recorded on platform perches and during early

lay, with the least observed on metal bars and during late lay (Figure 1). There were no interaction effects. Although dustbathing was observed in the house litter, substrates offered were primarily used for foraging (Figure 2). Substrate had a significant effect on the number of broilers attracted to dustbathing areas overall ($p < 0.05$), with the fewest birds recorded in oat hulls. Only females were observed dustbathing during the study.

Conclusion

Broiler breeders show a strong preference for platform perches over a bar design. In houses where litter is friable, it is unlikely that providing fresh substrates will result in an increase in dustbathing.

Acknowledgments

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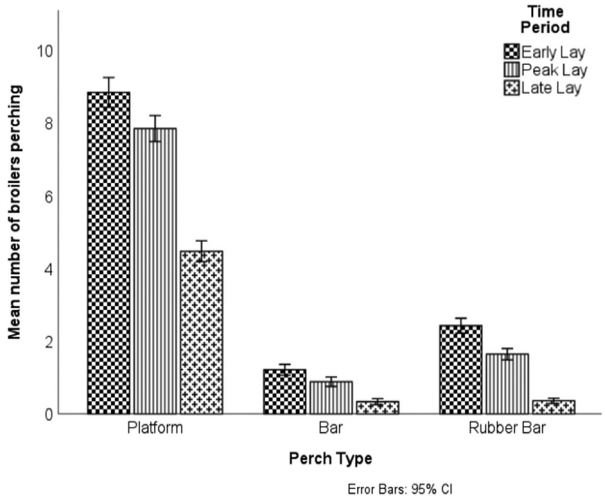

Figure 1. Perch occupancy across different perch types and time periods

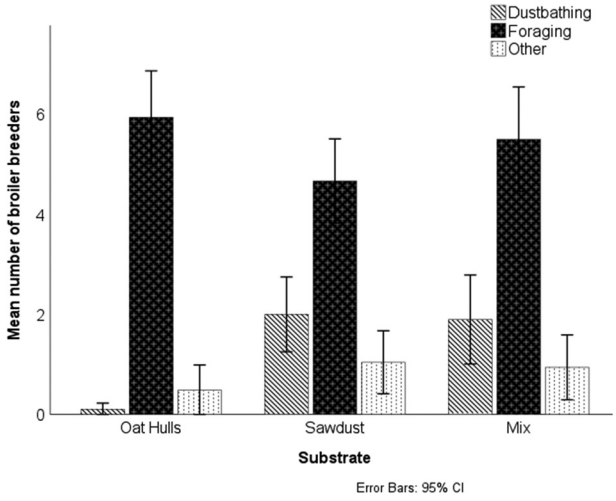

Figure 2. Behaviour observed in different dustbathing substrates

The impact of reducing the levels of Calcium and Phosphorus on broiler performance, Calcium and Phosphorus digestibility and bone parameters

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Application

Reducing the amount of Ca helps on reducing the level of P in the feed, so when combined with addition of phytase, feeds without added inorganic P can be produced, which still give equal or even better performance.

Introduction

The impact of dietary Ca on P digestibility, and consequently the level of the inclusion of inorganic P sources in the feed, plays an important role by hindering the phytase to hydrolyse phytate-P (Sommerfeld *et al.*, 2018). The aim of this trial was to investigate the impact of lowering the inclusion of limestone (and consequently Ca) combined with lowering dietary P on broiler performance, Ca and P digestibility and bone quality.

Material and methods

Eighteen pens with 24 male Ross 308 broilers were fed a feed containing an intrinsically heat stable 6-phytase (OptiPhos® Plus) at 1000 FTU/kg (1.76 g/kg available P (aP)) and were split over 2 treatments. Birds from one treatment were fed a starter feed (day 1–10) containing 0.85% Ca and 0.45% aP, a grower feed (day 10–21) containing 0.70% Ca and 0.36% aP and a finisher feed (day 21–35) containing 0.60% Ca and 0.30% aP. Birds from the second treatment were fed the same feed except with Ca and aP lowered to 0.65% and 0.40%, 0.50% and 0.31% and 0.40% and 0.29% in starter, grower and finisher respectively. As a result, the grower and finisher feed did not contain any added inorganic P. Technical performance was measured for every feeding phase. At day 21, the tibiae from 3 birds per pen were removed and analysed for bone strength. Afterwards, the 3 tibiae were pooled into 1 sample for the determination of ash after fat extraction and drying. At day 35, a mixed faecal sample (pen floor) was taken from 5 birds per pen for the determination of the total tract digestibility of Ca and P. Statistical analysis was performed using T-test. The trial protocol was approved by the University's ethical review group.

Results

The birds outperformed the breed standard (close to 2.7 kg bird weight at 35 days with an FCR of 1.4). Lowering the Ca and P level in the feed did not have a negative effect on performance (Table 1). On the contrary, it increased end weight by 22 g numerically (from 2675 g to 2697 g, $P > 0.05$). However, the bone ash decreased slightly from 47.5% to 46.8%, while bone strength decreased from 548 N to 532 N, but only numerically. On the contrary, lowering the Ca and aP levels in the feed significantly increased the Ca digestibility (51.7% to 66.4%) and P digestibility (77.3% to 83.2%). Based on feed intake and analysed Ca and P levels in the feed, this yielded a significantly lower digestible Ca uptake (0.49 g vs 0.62 g per bird per day) but increased the digestible P intake from 0.53 g to 0.57 g per bird per day.

Conclusion

Lowering the Ca and P levels in the feed with 0.2% and 0.05% in starter, grower and finisher phase, creating grower and finisher diets without added inorganic P, does not have a negative impact on performance and increases Ca and P digestibility. This demonstrated that also a positive effect towards P excretion in the environment.

Reference

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Table 1. Effect on overall performance, bone ash and bone strength (day 21), and Ca and P digestibility (day 35)

	Normal Ca and P	Low Ca and P
Weight (day 21)	1123	1122
End weight (day 35)	2675	2697
FCR (day 1–21)	1.24	1.25
FCR (day 1–35)	1.40	1.41
Bone ash (%)	47.5	46.8
Bone strength (N)	548	532
Ca digestibility (%)	51.7[a]	66.4[b]
P digestiblity (%)	77.3[b]	83.2[a]
Digestible Ca intake (g/broiler/d)	0.62[a]	0.49[b]
Digestible P intake (g/broiler/d)	0.53	0.57

[ab]: means in the same row having different superscripts differ significantly ($P < 0.05$)

Precision feeding insights into nutritional composition, non-starch polysaccharides and apparent metabolisable energy of elite and synthetic lines of wheat in poultry

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Application

Understanding the nutritional composition, non-starch polysaccharide (NSP) content, apparent metabolisable energy (AME) and true metabolisable energy values (TME) of wheat varieties is imperative for strategically optimising crop selection, animal nutrition, improving performance, and cost-effective animal production.

Introduction

Wheat is an essential energy source in UK poultry diets, contributing up to 800 g/kg feed for broilers. Plant breeders focus on improving wheat varieties for global food security, nutrition, environmental challenges, and economics. Yet, they haven't explicitly addressed the requirements of the poultry industry. To explore the potential of designing wheat lines, we tested 40 wheat lines derived from wild ancestors of cultivated wheat, created by using representatives of the ancestral genomes of cultivated wheat, notably the D genome from goatgrass (*Aegilops tauschii*). Here, we tested 24 elite lines and 16 synthetic wheat lines, assessing nutritional composition, NSP profile, and a bioassay measuring dry matter digestibilities (DMD), AME, and TME values.

Material and methods

The compositional quality of 40 wheat lines through near-infrared spectroscopy (37 traits), analytical (7 traits), and NSP (soluble, insoluble, and total NSP) analysis was assessed. Employing a balanced incomplete block design, we conducted a modified precision feeding bioassay (Pasha, Khattak, Khan, & Jabbar, 2008) using four batches of 82 mature male Ross 308 broilers (average body weight ~4 kg) across eight experiments with six replicates each. Due to challenges in obtaining same-age commercial broilers, experiments 1, 3, 5, and 7 had broilers aged 41 to 45 days, while experiments 2, 4, 6, and 8 used birds aged 46 to 49 days. Treatments included glucose and 40 wheat lines. Following a 24-hour fasting period, each bird received either 30 g of test material or 50 ml of glucose solution. Birds were housed in metabolic cages, with excreta quantitatively collected over 48 hours, subsequently freeze-dried, and milled to determine DMD, AME, and TME values. The SRUC's animal welfare ethical review body approved the study. Statistical analysis in R encompassed synthetic vs. elite line comparisons, power calculations, and correlations among digestibility, chemical, and NIR data, considering factors like experiment, bird age, and wheat lines.

Results

Pairwise DMD comparisons among wheat lines showed no significant difference ($P > 0.05$). Robigus, an elite line, had lower values than others, but the difference was not significant (Figure 1). Similarly, for AME (Figure 2) and TME values, Robigus and Soissons (both elite lines) exhibited the lowest ($P > 0.05$) values compared with other lines. In addition, the contrast between synthetic vs. elite lines was significant for DMD values ($P = 0.023$), though not for AME and TME values. Bird age affected digestibility traits, demonstrating better values for older birds ($P < 0.05$). Correlations between digestibility and biochemistry data were low (data not presented here). Chemical and NIR data were poorly correlated ($P > 0.05$), except for crude protein/nitrogen and gross energy, which showed a strong correlation ($P < 0.05$).

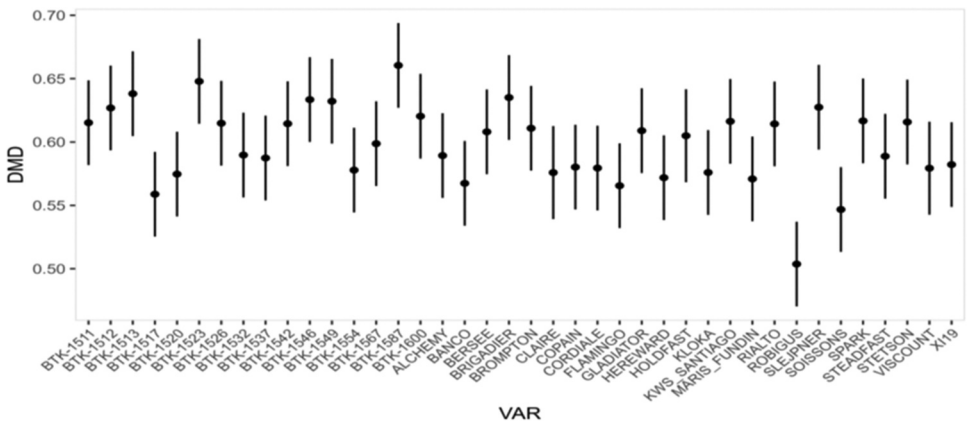

Figure 1. Displaying percent dry matter digestibility (DMD) means and standard errors of 40 wheat lines.

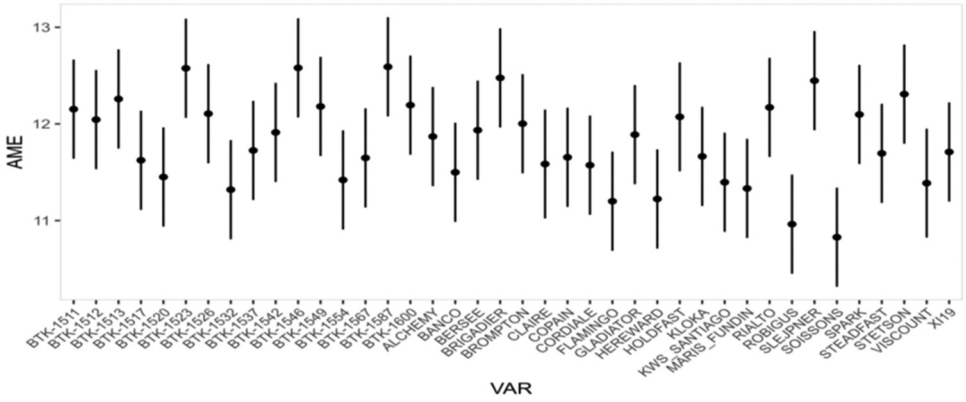

Figure 2. Displaying apparent metabolisable (AME) means and standard errors of 40 wheat lines.

Conclusion

While data suggests low variation in nutritional value for the wheat lines tested, the Robigus and Soissons (elite lines) did exhibit lower DMD than other wheat lines. The Robigus includes novel variations from wild emmer wheat (*Triticum dicoiccides*), giving further impetus to explore new sources of genetic variation to support feed efficiency in the poultry industry. Given their superior digestibility in poultry, synthetic lines warrant further investigation. A complete block design with same-age mature birds may improve statistical power for detecting subtle nutritional differences. Even though chemical analysis outperforms NIR, it cannot substitute the insights gained from animal trials in understanding the wheat line's digestibility complexities.

Acknowledgments

In memoriam of Ian Mackay, a valued collaborator whose expertise in statistical design and initial data interpretation profoundly contributed to the foundation of this study. SRUC is financially supported by the Scottish Government.

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A field study: relationship between poultry litter/manure dry matter and water soluble phosphorus

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Application

The base-line for WSP content of litter/manure from several different production systems has been established.

Introduction

A high correlation (98%) between water soluble P (WSP) content of litter and the amount of P run-off from the soil has been reported (Sharpley & Moyer, 2000) and research is required to determine the amount of WSP in poultry litter/manure to inform future legislative requirement. Foy, Ball, and George (2014) reported that WSP content of broiler litter was inversely related to litter DM but it is necessary to fully elucidate this relationship as mitigation strategies to increase DM may be a means of reducing WSP content and hence reducing the environmental footprint of poultry production. The objectives of this study was to determine to determine the WSP content and the WSP: P ratio of litter/manure from 12 commercially important poultry production systems and to establish the relationship between litter/manure DM and WSP content.

Material and methods

Litter or manure was collected from 20 units from 12 production systems (1. Broiler breeders 0–18 weeks, 2. Broiler breeders 18–60 weeks, 3. Free range broilers 0–28d, 4. Free range broilers 28d-finish, 5. Free range broilers 0d-finish, 6. Broilers under indirect heating systems, 7. Turkeys 0–6 weeks, 8. Turkeys 6 weeks-finish, 9. Pullets, 10. Layers in single-tier free range systems, 11. Layers in multi-tier free range systems, and 12. Layers in housed systems). Samples of litter (n = 5) were collected according to Foy et al. (2014). Samples from laying hen systems were collected throughout the production period (24–74 weeks of age) at 10-week intervals, frozen and mixed to form n = 5 composite samples/unit. Samples were analysed for DM, total P and WSP contents according to Foy et al. (2014). Linear, quadratic and cubic regression analyses were conducted with WSP content regressed against DM and the strongest relationships presented. The WSP:P ratio was calculated for each system.

Results

The WSP content of litter/manure from the 12 production systems are presented in Table 1. WSP content ranged from 1.8 to 4.2g/kg and the ratio of WSP:P ranged from 0.29–0.52.

Table 1. WSP content and the relationship between WSP and DM content for 12 production systems

Production system	WSP content (g/kg)	WSP:P	Relationship between WSP and DM content		
			Equation	R^2	P value
1. Broiler breeder 0–18 weeks	3.5 (SD = 0.41)	0.30	4.98 + (0.03 x DM)	0.21	0.046
2. Broiler breeder 18–60 weeks	3.2 (SD = 0.34)	0.29	−12.59 + (0.50 x DM − 0.0004 x DM^2)	0.21	<0.001
3. Free range broilers 0–28d	2.8 (SD = 0.70)	0.40	−17.15 + (0.64 x DM + −0.005 x DM^2)	0.70	<0.001
4. Free range broilers 28d-finish	2.8 (SD = 0.46)	0.42	2.14 + (0.01 x DM)	0.09	NS
5. Free range broilers 0d-finish	2.8 (SD = 0.36)	0.34	1.97 + (0.014 x DM)	0.12	NS
6. Broilers under indirect heating	2.9 (SD = 0.39)	0.42	24.79 + (−0.67 x DM + 0.005 x DM^2)	0.08	NS
7. Turkeys 0–6 weeks	3.8 (SD = 0.66)	0.49	0.18 + (0.06 x DM)	0.50	<0.001
8. Turkeys 6 weeks-finish	3.1 (SD = 0.66)	0.52	9.36 + (−0.28 x DM + 0.003 x DM^2)	0.55	<0.001
9. Pullets	4.2 (SD = 1.33)	0.35	9.10 + (−0.068 x DM)	0.18	NS
10. Layers – single-tier free range	2.6 (SD = 0.39	0.34	1.25 + (0.029 x DM)	0.47	0.002
11. Layers – multi-tier free range	1.9 (SD = 0.37)	0.43	− 0.52 + (0.07 x DM)	0.25	0.020
12. Layers – housed systems	1.8 (SD = 0.37)	0.45	−3.45 + (0.16 x DM)	0.54	<0.001

SD = standard deviation

The regression equations between WSP and DM content are presented in Table 1; some relationships are positive, some negative and others non-significant.

Conclusion

As WSP content of litter/manure produced in Northern Ireland has only been quantified for broilers (Foy et al., 2014), it is only possible to comment on the changes in WSP content of litter for this system. Broiler litter produced under the hot water heating systems resulted in lower WSP content (3.2 vs 3.8 g/kg) and lower WSP:P content (0.56 vs. 0.29) than conventional broiler litter (cf. Foy et al., 2014). Given the relationship between WSP content and run-off, this means that there is the potential for less P run-off from land spreading litter from broilers under hot water systems. The results of this study have established an important base-line for WSP content of litter/manure from several different production systems which will be useful to inform future legislative requirements. The relationship between WSP and litter/manure is different for different production indicating that there are other factors involved which influence WSP content more strongly than DM alone. Future research should focus on the factors influencing WSP content using the base-line values established in this study as a basis for comparison and improvement.

Acknowledgements

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Effect of an enzyme cocktail in rye-based broiler grower diets on short chain fatty acid production

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Application

Addition of an enzyme cocktail promotes rapid microbial adaptation to short chain fatty acid (SCFA) production in broilers fed rye-based grower diets.

Introduction

In a mature broiler chick, 90% of caecal microbiota is dominated by Firmicutes and Bacteroidetes (Fan, Ju, Bhardwaj, Korver, & Willing, 2023). These phyla become predominant at day 7 reaching 40–45% by the 3rd week of age (Fan et al., 2023). These bacteria preferentially utilize carbohydrates and small molecules to ferment. Added exogenous xylanase helps breakdown fibres into oligosaccharides that are also directly fermented by bacteria to increase their genera and to produce more SCFAs. This study investigated the effect of an enzyme cocktail on the rate of SCFA production in broilers fed a rye-based diet from day 10 of life.

Material and methods

This study was approved by the University's ethical review group. 88 male Ross 308 broiler chicks were randomly allocated into 8 floor pens (11 per pen) in an environmentally controlled room. Mash starter diets were formulated based on wheat (61.5% inclusion) with added oil, vitamins, minerals, and amino acids, to meet the requirements of the age and strain of the birds. Feed and water were provided ad libitum. On Day 10, birds were weighed and offered one of two grower diets: No Enzymes (NoEnz) or Plus Enzyme

Table 1. Effect of diets on the production of different SCFAs. Measured values are in the units of mg kg^{-1}

Bird age	Diet	Acetic acid	Propanoic acid	Butyric acid	Isovaleric acid
11	NoEnz	2892.7	173.2	1075.0	26.7
	PlusEnz	3100.3	171.3	1248.3	19.5
14	NoEnz	3635.6[b]	241.9	1776.8[b]	31.1
	PlusEnz	5108.3[a]	231.0	2363[a]	21.9
21	NoEnz	5316.2[b]	261.9[b]	2084.8[b]	38.2
	PlusEnz	6467.9[a]	392.9[a]	2835.3[a]	38.7
28	NoEnz	4241.3[b]	286.1[b]	1311[b]	48.5
	PlusEnz	5161.3[a]	381.5[a]	1855.8[a]	39.7
35	NoEnz	2513.1[b]	264.9[b]	908.8[b]	33.2
	PlusEnz	3243.9[a]	328.1[a]	1439.1[a]	23.5
Pooled SEM		289.3	23.5	166.4	5.0
P values	Diet	<.001	<.001	<.001	0.034
	Bird age	<.001	<.001	<.001	<.001
	Diet*bird age	0.252	0.011	0.512	0.837

[ab]:Means within the bird age, there was a significant effect ($P \leq 0.05$)

Cocktail (PlusEnz) where a cocktails of mannanase 0.025 g/kg, xylanase (0.1 g/kg) and phytase (1 g/kg) were added to diets containing 45.47% rye. Two birds per pen were euthanized on day 11,14,21,28, and 35, caecal samples were pooled per pen, and analysed by for SCFA using gas chromatography mass spectrometry. Statistical analysis was performed using SPSS with univariate analysis to identify any age*diet interactions with means separated using unpaired T-tests for each age.

Results

Table 1 shows the effect of diet on caecal concentrations of the four most prominent SCFAs as the bird's age. The interaction between diet and bird age was significant for acetic and butyric acid which was due to the enzyme increasing caecal concentrations of these VFA only after 14 days of age. The interactions were not significant for propanoic and isovaleric acids, but diet and age were. At all ages the enzyme increased propanoic and reduced isovaleric acid (high levels increases shift in pathogenic bacteria and ammonia production) concentrations.

Conclusion

Addition of enzymes had significant, positive effects on fibre fermentation which may have helped in reducing protein putrefaction due to reduction of pH at the lower gut as evidenced by the increased caecal concentrations of acetic, propanoic, butyric and reduction in isovaleric acid concentrations in birds fed rye grower diets.

Acknowledgements

The author gratefully acknowledges the support of David J Belton in the analysis of SCFA and AB Vista for funding the trial.

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Tibia density as a proxy for keel quality using radiographs in the living laying hens

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Application

Bone quality in living laying hens can be assessed easily on the farm and the data can be used for genetic selection.

Introduction

Laying hens can be affected by limb or keel bone damage, which may affect their welfare (Webster, 2004). Finding an easy and reliable phenotype of bone quality that can be measured on the living hen would be beneficial, as current methods require the hens to be culled. After using diets with varying levels of calcium (Ca) and phosphorus (P) to alter bone quality (Schreiweis, Orban, Ledur, & Hester, 2003), tibia and keel phenotypes were measured to detect differences in bone integrity (Wilson, Dunn, & McCormack, 2023).

Material and methods

26 week of age Hy-line brown laying hens (n = 72) in two replicates were fed either a control diet (CON) (3.28% Ca, 0.46% P), a hypocalcaemic diet (HC) (1.9% Ca, 0.48% P), or a hypocalcaemic and hypophosphataemic diet (HCHP) (1.39% Ca, 0.31% P) for 5 weeks. Lateral whole-body radiographs and body weights (BW) were measured at 0, 3 and 5 weeks of the experiment, as well as egg weight (EW) and eggshell breaking strength (EBS). From these radiographs, the radiodensity of the pila carinae of keel bone (KPC) and tibia density (AUC) were measured. After 5 weeks of

Table 1. The results of the measured phenotypes in the different treatment groups

	HC	HCHP	CON	Probabilities	SEM
BW change (g)	1742	1677	1882	≤ 0.001	43
EW (g)	55.88	57.43	59.81	≤ 0.001	0.77
EBS (N)	32.74	32.48	42.28	≤ 0.001	1.22
Tibia density (mm Al)	77,656	77,409	85,794	≤ 0.001	1085
KPC density (mm Al)	30,269	28,436	29,417	0.45	1451
Dissected keel density (mm Al)	0.8	0.77	0.82	0.01	0.01

treatment, the keel bones were dissected and radiographed. Dissected keel radiograph images were used to measure overall density and to score percentage of keel bone affected, deviation, deformity, number of fractures and location of fracture. Each keel factor was given a score between 1 and 4, depending on severity. ANOVA was used with diet as treatment and replicate as blocking factor for all data except keel scoring factors which used Kruskal-Wallis analysis with post-hoc Mann-Whitney U. All analysis was performed using Genstat 22nd edition. This study was approved by the Animal Welfare and Ethical Review Body at The Roslin Institute, UK.

Results

Other measurements included the percentage bone affected ($H(2) = 7.62$, $P < 0.01$) and a difference in deformity ($H(2) = 9.21$, $P \leq 0.001$) between the dietary groups. There was no difference in deviation, number of fractures and location of fractures scores.

Conclusion

The dietary treatment groups were successful in showing a difference in the tibia and keel density, and also affected BW, EW and EBS. HC and HCHP groups had lower tibia quality and had more keel deformities and higher percentage keel bone damage (Table 1). This demonstrates that the quality of both tibia and keel are related and the use of tibia density measurement could be used as a proxy for keel quality. Although the keel may be more prone to damage, attempts to improve the keel may not need to be treated in isolation. This result shows that improving the overall skeletal quality would be beneficial for keel bone quality and reduce damage.

Acknowledgements

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Differential gene expression elucidating Campylobacter jejuni perseverance mechanisms after storage at ultra-low temperature

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Application

Elucidating the resilience mechanisms of *Campylobacter* spp. at different storage conditions could improve meat safety by providing practitioners with the molecular biomarkers to correlate food contamination to infection risk.

Introduction

Campylobacter jejuni (*C. jejuni*) is the most predominant agent of zoonosis in Europe, whose persistence on meat post carcass processing poses an elevated risk to consumers (Khattak & Galgano, 2023). We previously demonstrated that *C. jejuni* can be recovered from the caecal content of infected broilers even after 62 days after storing at −80°C (Khattak et al., 2022). Therefore, aiming to elucidate the genetic mechanisms behind the perseverance of *C. jejuni* at these extreme low temperatures and for such an extended duration, we analysed the metatranscriptome of caecal samples, and pure *C. jejuni* cultures both at room temperature soon after collection and after 62 days of storage at −80°C. The comparison between *in vivo* and *in vivo* derived samples provided important information on the ability of *C. jejuni* of expressing genes whilst growing as part of an extended microbial community, indicating that *quorum sensing*-like mechanisms could be in place leading to an adapted response to environmental conditions.

Material and methods

As part of a parallel study approved by the SRUC's animal welfare ethical review body, four male broiler birds from four replicate floor pens were gavaged with a single strain of *C. jejuni* at day 20 of age. Simultaneously, as part of the

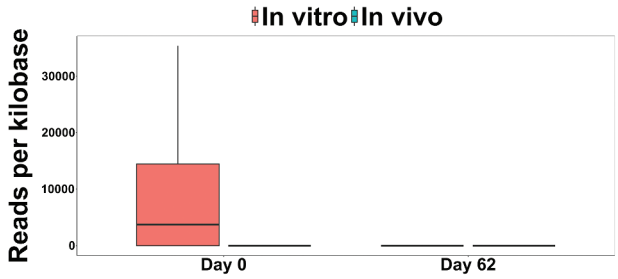

Figure 1. Reads per kilobase of S-ribosylhomocysteine lyase (A7H2H9), expressed in *C. jejuni* at the two different time points and through the two different experimental conditions.

in vivo gavage procedure, four tissue culture flasks (75cm^2) containing Muller Hinton broth and 10 µg/ml of trimethoprim (MH_T) were inoculated with the same *C. jejuni* strain. Thus, on day 35, total RNA was isolated (RNeasy PowerMicrobiome Kit, QIAGEN) from an aliquot of these eight samples (i.e. four caecal content from the *in vivo* study and four liquid cultures). The remaining samples were stored at −80°C for 62 days, after which RNA isolation was repeated. RNA sequencing was carried out (Omega Bioservices) and raw reads were quality-filtered using Kneaddata. Taxonomy was assigned using Metaphlan3, and the functional transcriptome was aligned through translated search using Humann3. Finally, differential gene expression analysis was performed via using deSeq2, either looking at transcriptional differences between the two time points in general or by including the interaction between the time point and the experimental condition (i.e. *in vivo* or *in vivo* derived samples).

Results

When interrogating the dataset to elucidate potential transcriptional differences solely between the two distinct time points only, we observed that a total of 444 genes (0.086%) were upregulated at day 62 compared to day 0, whilst 655 genes were downregulated (0.13%). Amongst these, at *C. jejuni* level, the Cytochrome c family protein (A0A381D0W2) was downregulated at day 62 (Log2 fold change = −22.3, P adj. < 0.001) and was exclusively expressed *in vitro* (3712 ± 731 reads per kilobase, RPK). Additionally, the expression of S-ribosylhomocysteine lyase (A7H2H9) downregulated at day 62 (Log2 fold change = −25.7, P adj. < 0.001), whilst also being only expressed *in vitro* at day 0 (Figure 1 21,402 ± 13,921.6 RPKs)

Conclusion

A substantial number of genes were differentially expressed across the analysed time points and experimental conditions. Interestingly, S-ribosylhomocysteine lyase, which encodes for a protein secreted by *C. jejuni* to communicate metabolic information (e.g. environmental metabolic potential), was exclusively expressed *in vitro* at day 0, likely indicating that *quorum sensing* mechanisms could intervene in the establishment of *C. jejuni* under changing environmental conditions.

Acknowledgments

SRUC receives support from Scottish Government (RESAS)

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The relationship between gizzard weight and bone integrity in end-of-lay hens

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Application

Gizzard development may be a valuable target to enhance bone strength in laying hens

Introduction

Eggshell formation demands high levels of calcium, mainly during the night when the hen is not consuming feed. Mobilisation of the medullary bone compensates for this difference in calcium supply and demand; however, over time this negatively impacts bone integrity. The gizzard plays a pivotal role in the degradation and solubilisation of dietary calcium (Svihus, 2011, Hervo et al., 2022). This study aimed to investigate the relationship between gizzard weight and bone integrity in end-of-lay hens.

Material and methods

All protocols used in this study were approved by the Animal Ethics Committee of the University of Nottingham. Thirty-six Shaver hens at 85 weeks of age were randomly selected from a free-range house accredited with the RSPCA Assured scheme and the BEIC Lion code of practice. The hens were euthanised by a veterinary surgeon and dissected. Body weight, liver weight and adipose fat pad weight, gizzard weight, which consisted of the proventriculus and gizzard, and gizzard contents weight were measured. Both legs of each hen were removed and de-fleshed to obtain the tibia and femur before being frozen. Callipers were used to measure the width, length, and weight of both tibias and both femurs from each bird before they were subjected to compressive testing using a texture analyser. The maximum load (a measure of breaking strength) and compressive stiffness (a measure of elasticity) were determined using force-displacement

Table 1. Physiological parameters of birds ranked on the basis of bone-breaking strength[1]

Tibia maximum load group (TML)	Bodyweight (g)	Gizzard Weight (g)	Gizzard Weight (%BW)	Tibia Maximum Load (N)	Tibia Stiffness (N/cm)
Low	1694	34.7[a]	2.06[a]	164[a]	1178[a]
Medium	1823	40.7[b]	2.25[ab]	195[b]	1410[a]
High	1814	42.1[b]	2.33[b]	246[c]	1708[b]
SEM	71.12	1.72	0.11	10.32	102.74
P-value	0.145	<0.001	0.045	<0.001	<0.001

[a,b] Means within a column with different superscripts differ significantly by $p < 0.05$.
[1]Data are the means of 12 laying hens / bone strength group

graphs and used as indicators of bone integrity. Birds were retrospectively ranked into groups on the basis of tibia max load (TML) and compared using the GLM procedure of SPSS.

Results

When birds were grouped on the basis of tibia maximum load (TML), relative gizzard weight (expressed as a percentage of body weight) was significantly different ($p < 0.05$) between the high TML and low TML groups (2.06 vs 2.33 respectively) (Table 1). This effect was echoed when grouped for tibia stiffness, with the highest group having the biggest numerical relative gizzard weight, though this is not significant ($p > 0.05$). A larger relative gizzard was associated with greater bone-breaking strength of end-of-lay stage hens. Interestingly, body weight did not have a significant effect on the breaking strength of the bone.

Conclusion

Birds ranked as exhibiting a high TML had a proportionally greater gizzard when adjusted for bodyweight. Further research is needed into the factors affecting relative gizzard weight and gizzard development and how this may be beneficial for skeletal integrity

Acknowledgements

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Effect of diet bulk density on production performance, digestive tract and litter traits in broilers

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Application

Understanding the constraints of feed intake of broilers on bulky feeds.

Introduction

There is growing concern regarding the adaptability of modern broilers to handle increased feed intake and energy content in the diet (Scholey, Marshall, & Cowan, 2020). The digestive tract of broilers has demonstrated the ability to adapt and enlarge when provided with diets containing bulky ingredients (Leeson, Caston, & Summers, 1996). Oat hulls are inert and bulky fibres that improve the development of the digestive tract of broilers when included in broiler diets at moderate levels (Naeem, Burton, Scholey, Alkhtib, & Broadberry, 2023). The current study aimed to explore the effect of altering diet bulk density (BD) with oat hulls on production performance, digestive tract and litter characteristics in broilers.

Material and methods

The trial was ethically approved by the University before starting. Ross 308 male broiler chicks (n = 168) were randomly allocated to 24-floor pens, 12 pens per treatment with 7 chicks each, in an environmentally controlled room. Wheat-soy-based mash diets meeting the nutritional requirements of Ross 308 broilers were fed upto day 35. Diets were isonitrogenous and isocaloric, however, BD was changed with the inclusion of the same material; i.e. oat hulls. Oat hulls in whole and ground form were included in diets resulting in BD of 800 and 650 kg/m^3. Feed and water were provided *ad libitum*. Pen-based production performance and absolute weights of empty digestive organs (proventriculus, gizzard and small intestine) from two cervically dislocated birds were recorded on day 35. Litter nitrogen and moisture were analysed on day 34 following methods of AOAC (1990). The independent samples t-test was used to determine the effect of dietary treatment on the measured response variables at $P < 0.05$ using SPSSv26.

Results

Diet bulk density did not significantly affect feed intake and any other growth performance parameters, digestive tract and litter characteristics. However, the diet with a bulk density of 650 kg/m^3 increased gizzard weight significantly compared with the diet with a bulk density of 800 kg/m^3 (Table 1).

Table 1. Effect of bulk density on production performance, digestive tract and litter traits in meat poultry

Bulk Density (kg/m^3)	BWG (g)	FI (g)	FCR	Proventriculus Wt (g)	Gizzard Wt (g)	SI Wt (g)	Litter N (%)	Litter moisture (%)
800	1982	3198	1.618	7.854	30.12^b	47.80	3.281	29.87
650	2049	3243	1.584	7.880	33.53^a	47.50	3.412	29.81
SEM	41.28	48.34	0.018	0.158	1.034	1.765	0.077	2.335
P-value	0.259	0.571	0.182	0.907	0.029	0.904	0.239	0.984

^{ab}Means within the same column with no common superscript differ significantly ($P < 0.05$).
BWG: body weight gain; FI: feed intake; FCR: feed conversion ratio; Wt: weight; SI: small intestine; N: nitrogen

Conclusion

Altering bulk density from 800 to 650 kg/m^3 with whole oat hulls appears beneficial for gizzard development. However, the challenge lies in determining a characteristic related to the 'bulkiness' of feed which can accurately predict the feed intake of broilers when provided with diets containing substantial bulky materials, due to differences in the types of bulky material or even their particle size.

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Culture meat and advanced plant-based proteins: benchmarking against poultry products

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The global market for meat substitutes was estimated to be valued at $1.9 billion in 2021 (McKinsey, 2021) and, at that time, was projected to reach $4 billion by 2027. While the rapid growth of the sector as not been sustained, consumer interest in alternatives to meat has remained and UK poultry meat consumption appears to be plateauing (DEFRA, 2024). A growing challenge for the poultry sector is the rapid rate at which artificial intelligence tools propagate uptake of fact-like statements into new virtual platforms without an accompanying evidence base. Without easy access to underpinning evidence, consumers are obliged to simply accept the statements provided to guide their decision-making (Chen, Xiao, & Kumar, 2023). Understanding the features of other, emerging proteins sources available to consumers will allow poultry practitioners accurately contextualise poultry meat in terms of current interest to society.

This talk will give an overview of the new and emerging protein products available in terms of their format, texture and intended key attributes. The talk will also consider the markets trying to displace poultry meat and explore some of the key values and mindsets that seem associated with the differing markets. In particular the talk will consider whether consumers are looking for meat protein with limited live animal involvement in production or for protein without any animal products. The nutrient profile and human health impacts of each protein source will also be briefly considered.

The production methods used for each protein source will be described to create a platform for comparing energy and environmental costs of production methods both currently and also projecting forward to a future situation where planned mitigations are implemented. These data will be contrasted to broiler production with brief discussion on the hygiene requirements, resource inputs, logistics, production time and alignment with differing societal values.

Nearly every globally large meat and dairy processor/manufacturer has acquired or developed plant-based meat and dairy substitutes. More than a dozen of these firms have also invested in start-ups or are attempting to commercialise lab-grown meat and fish in-house (IPES-Food, 2022). Therefore the final section of the talk will discuss the possibilities and limitations associated with each protein in order to contextualise how far each concept is from practical viability, with some comparisons to emerging proteins within the animal feed sector.

The primary aim of this talk is to equip the audience with detail and evidence on attributes of cultured meat and plant-based meat substitute proteins as such details are not easy to source.

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Longitudinal profile of the bacterial microbiota in UK broiler chicken litter

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Application

An understanding of the development of the bacterial community in broiler chicken litter during the production cycle under UK commercial conditions is important for animal health and production as well as disinfectant product selection.

Introduction

Broiler chickens in UK production systems are bedded on fresh litter for each cycle, with litter types including wood shavings, straw crumb/pellets and cut straw. These litters have different physical characteristics, which may affect the bacterial community composition. The bacterial microbiota of the litter develops throughout the production cycle as excreta (containing organic matter and micro-organisms) accumulates. The bacterial microbiota of the litter could affect flock health, as well as ammonia production and the efficacy of cleaning and disinfection regimens. The aim of this work was to develop an understanding of the development of the bacterial microbiota in broiler litter on commercial farms under UK production systems.

Material and methods

This study conformed with institutional ethical requirements at Queen's University Belfast. Litter samples were taken from six broiler houses on commercial broiler farms in Northern Ireland (one house per farm). Houses were stocked with between 22,000 and 28,000 day-old Ross chicks and were partially depopulated ('thinned') during week five and cleared during week six. Each house was followed for two consecutive production cycles. Three farms used wood shavings as litter, two used straw crumb and one used cut straw. Sampling points were in the EARLY (day 5–10), MID (day 25–30) and LATE (post-thin, day 32–42) parts of the cycle. DNA was extracted from litter using a Qiagen PowerSoil Pro kit. The v3-v4 region of the 16s rRNA gene was amplified and sequenced using Illumina Miseq. Sequences were processed using Dada2 and taxonomy assigned using SILVA. Phyloseq was used in R to produce beta diversity indices and plots after count data had been transformed using a variance stabilising transformation. DESeq2 was used to identify sequence variants (representing species or strains) with differences in abundance between Shavings and Straw Crumb at each time point.

Results

The ordination plot of overall similarity of bacterial community composition in samples (Figure 1) shows a clear separation between samples from EARLY (5–10 days) and the two later time points. At the EARLY time point, samples from each litter type appear to cluster together, although this pattern becomes less clear in the later time points when all samples are more closely grouped. At genus level the largest changes between EARLY and MID were the mean proportions of *Staphylococcus* spp. (increased from 0.052 to 0.309) and *Lactobacillus* spp. (decreased from 0.357 to 0.142). The number of sequence variants that differed in abundance between Shavings and Straw Crumb was 17 at the EARLY time point, 12 at MID and four at LATE.

Conclusion

These results demonstrate changes in the bacterial community composition of broiler litter during the production cycle on UK commercial farms. Differences between litter types were also detectable, particularly in the early part of the cycle.

Acknowledgements

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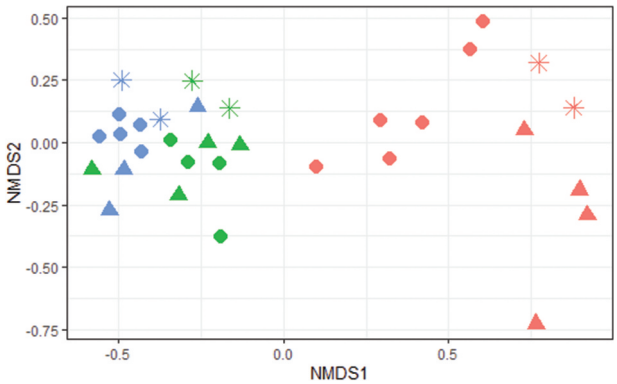

Figure 1. NDMS ordination plot of Bray-Curtis distances between transformed count data showing overall bacterial community composition. Samples with a more similar community composition are closer together. The colour of points relates to the time of collection (red = EARLY; green = MID; blue = LATE) and shape to litter type (star = Cut straw; circle = Shavings; triangle = Straw crumb).

A microencapsulated blend of botanicals and organic acids can improve growth performance and gut health of broilers

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Application

Poultry producers can use AviPlus®P in feed to enhance broilers growth performance and improve gut health.

Introduction

Botanicals and organic acids (OA) are widely used in poultry nutrition based on their numerous biological functions. Our previous work showed that a specific blend of botanicals and OA can improve intestinal health *in vitro* (Toschi, Rossi, Tugnoli, Piva, & Grilli, 2020). In this study, the same blend, microencapsulated in a lipid matrix (commercially known as AviPlus®P), was fed to broilers to evaluate the effects on growth performance and gut health *in vivo*.

Material and methods

A total of 480 day-old male chicks (Ross 308) were vaccinated for coccidiosis (Paracox®), divided into floor pens (12 birds/pen) and assigned to 2 dietary groups (20 reps): control group (CON), were fed a basal diet and treated group (TRT), were fed a basal diet + a microencapsulated blend of botanicals and organic acids (AviPlus®P) at 300 g/MT of feed. The wheat/soya bean meal basal diets were not-medicated and were formulated to meet Ross 308 nutrient requirements. The experimental diets were fed as mash during the starter phase (d0-14), and as pellets during the grower (d14-28) and finisher (d28-42) phases. Feed and water were supplied *ad libitum*. The study lasted 42 days, with gut lesions determined on day 21 (1 bird/pen, 20 birds/group). Average daily feed intakes (ADFI) and average body weights (BW) were recorded per pen at day 0, 14, 28 and 42 and average daily weight gain (ADG) and mortality-adjusted feed conversion ratio (FCR) were calculated. Data were analysed with T test using GraphPad Prism 10 and differences were considered significant at $P < 0.05$. The study was approved by the SRUC's animal welfare ethical review body.

Results

Results for growth performance are displayed in Table 1. The BW of birds in TRT group was +2.3% and +3% higher ($P < 0.05$) at d28 and d42, respectively, compared to CON. The ADFI was reduced ($P < 0.05$) during the starter (−8.0%) and grower (−6.3%) phases in birds fed TRT diets compared with the CON. This improvement in BW and reduction in ADFI was reflected in a significantly lower FCR value during the overall period (d 0–42) in birds fed TRT diets compared with the CON group (−0.06). Moreover, the TRT diets reduced the incidence of lesions associated with coccidia throughout the intestinal tract, from duodenum to caeca (Table 2).

Conclusion

To conclude, the microencapsulated blend of botanicals and organic acids used in this study has the potential to enhance growth performance of broilers vaccinated for coccidiosis, improving gut health.

Reference

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Table 1. Growth performance throughout the study

		CON	TRT	SE	P-value
	d14 BW (g)	381	363	8	0.19
Starter:	ADFI (g/day)	38.8	35.8*	0.4	<0.001
day 0–14	ADG (g/day)	24.2	23.0	0.6	0.21
	FCR	1.63	1.56	0.04	0.14
	d28 BW (kg)	1.690	1.730*	0.010	0.04
Grower:	ADFI (g/day)	135.1	126.9*	1.3	0.001
day 14–28	ADG (g/day)	86.2	90.6*	1.1	0.009
	FCR	1.57	1.39*	0.02	<0.001
Finisher:	ADFI (g/day)	214.2	220.4*	1.7	0.02
day 28–42	ADG (g/day)	132.5	136.7	1.8	0.12
	FCR	1.62	1.61	0.03	0.42
	Mortality (%)	3.3	4.1	1.3	0.66
Overall:	d42 BW (kg)	3.570	3.680*	0.020	0.007
day 0–42	ADFI (g/day)	126.2	124.1	0.7	0.06
	ADG (g/day)	79.4	80.5	0.7	0.22
	FCR	1.59	1.53*	0.01	0.005

Table 2. Gut lesions at d 21

	CON	TRT
Duodenum	2/20 birds *E. acervulina* 4/20 birds *E. maxima*; 1/20 birds necrotic enteritis	1/20 birds *E. acervulina* 2/20 birds *E. maxima*;
Jejunum		
Caeca	1/20 birds *E. tenella*	0/20 birds *E. tenella*
Notes	1/20 birds Yolk sac infection	none

ADFI = average daily feed intake, ADG = average daily gain, FCR = feed conversion ratio, SE = Standard error

* within a row asterisks indicate significant differences (P<0.05)

Replacing soybean meal with alternative protein sources in Redbro broiler diets

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Application

Dietary SBM can be replaced with alternative protein sources in Hubbard Redbro feed.

Introduction

Broiler production currently relies on soybean meal (SBM) as the main dietary protein source. Slow growing broilers reared to 82 days of age have previously shown good adaptation to diets that partially replace SBM with alternative protein ingredients (Berger et al., 2021). However, this has not been tested for Redbro broilers in an indoor system. Hence, this study assessed the effects of alternative dietary protein inclusion compared to SBM on growth performance, apparent metabolisable energy (AME) and total tract dry matter digestibility (DMD) of Redbro broilers from 0–42 days of age.

Material and methods

This study was approved by Harper Adams University Research Ethics Committee prior to starting. A total of 525 day-old as-hatched Hubbard Redbro broilers were placed in 35 pens (15 birds per pen) following a randomised block design. Birds were fed a wheat-SBM control (Diet 1) containing 30.5%, 30.4%, 23.5% and 21% soya in the starter, grower, finisher 1 and finisher 2 phases respectively, or a diet that replaced up to 50% of soya with lupins (Diet 2), up to 62% of soya with beans and peas (Diet 3), or up to 48% of soya with sunflower (Diet 4). Diet 5 replaced 100% of the SBM with a mixture of lupins, beans, peas, and sunflower. Diets were formulated to meet Hubbard Redbro requirements and fed *ad libitum* as mash during starter (d0 to 10; ME 12.3 MJ/kg, CP 22.4%), grower (d10 to 24; ME 12.5 MJ/kg, CP 20.1%), finisher 1 (d24 to 36; ME 12.8 MJ/kg, CP 18.1%), and finisher 2 (d36 to 42; ME 13.0 MJ/kg, CP 17.1%) phases. Acid insoluble ash was added at 20 g/kg to the finisher 2 diets as an indigestible marker. Bird bodyweights (BW), feed intake (FI), weight gain (WG), mortality corrected feed conversion ratio (FCR) and the European Production Efficiency Factor (EPEF) were determined. Excreta was collected during the final 3 days of the finisher 2 period and was dried and milled before analysis. Data were analysed by one-way ANOVA followed by Duncan's test. Differences were reported as significant where $P < 0.05$.

Results

Results are shown in Table 1. The average final BW of broilers at 42d was lower than performance objectives (1912 g vs 2174 g), potentially due to mash diets used. Birds fed diets 1 and 4 had lower final BW ($P < 0.001$) and WG ($P < 0.001$), however diets 1 and 2 tended to provide better feed efficiency ($P = 0.075$). Diets 1 and 3 had higher AME than other diets ($P < 0.001$). Similarly, DMD was higher in diets 1, 3 and 4 than diet 5 ($P = 0.001$). No differences ($P > 0.05$) were observed between EPEF values.

Conclusion

Alternative proteins can replace soyabean in all phases of diets formulated to meet Hubbard Redbro specification

Acknowledgements

Thank you to Hubbard for supplying the birds and to the John Oldacre Foundation for funding this study.

Reference

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Table 1. The effect of diets containing various proteins on Hubbard Redbro performance, AME, DMD and EPEF

Diet	d42 BW (g)	FI (g/b/d)	WG (g/b/d)	FCRm 0–42	AME (MJ/kg DM)	DMD	EPEF
1	1835^{a}	77.5^{a}	40.8^{a}	1.903	14.60^{c}	0.726^{c}	229
2	1926^{b}	82.4^{b}	43.4^{b}	1.899	13.96^{ab}	0.686^{ab}	241
3	2020^{c}	91.1^{c}	45.3^{b}	2.014	14.80^{c}	0.721^{c}	239
4	1813^{a}	80.8^{ab}	41.2^{a}	1.960	13.46^{a}	0.704^{bc}	221
5	1964^{bc}	88.2^{c}	44.2^{b}	1.999	14.06^{b}	0.670^{a}	234
SEM	28.7	1.55	0.70	0.034	0.182	0.0094	5.99
P value	<.001	<.001	<.001	0.075	<.001	0.001	0.164

[a]BW, body weight; FI, feed intake; WG, weight gain; FCRm, mortality corrected feed conversion ratio; AME, apparent metabolisable energy; DMD, total tract dry matter digestibility; EFEF, European Production Efficiency Factor. Means within a column with the same letter are not significantly different ($P > 0.05$)

Complete replacement of soya products with alternative ingredients for fast growing broilers

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Application

Alternative feedstuffs combined with a strategic mixture of feed additives may completely replace soya in broiler rations.

Introduction

Upper inclusion limits are often observed for specific alternative feed ingredients (e.g. Houdijk & Walker, 2020), constraining their soya bean meal (SBM) replacement potential. Such alternative feedstuffs may be combined at lower inclusion levels each to remain below those limits, together with a strategic mixture of feed additives to improve nutritional value. Here, we tested this hypothesis by assessing growth performance in fast growing birds in soya-free rations with different additives.

Material and methods

Pens with 30 Ross 308 day-old male broilers were allocated to four feeding treatments (n = 12 pens; randomised block design; SRUC ethical approval POU AE 28–2022). The control ration (CON) was based on wheat, corn and SBM with some rapeseed meal and sunflower meal, and soya oil. CON additives were phytase (1000 FTU/kg) and xylanase (1200 U/kg). The soya free basal ration (ALT0) contained more rapeseed meal and sunflower meal, and pea flour, faba bean, lupin, maize gluten meal and potato protein, and rapeseed oil replaced soya oil. Synthetic amino acids were used to balance for the first 7 limiting ones. The ALT0 feed additives were phytase at 2000, 1500 and 1000 FTU/kg for the starter (0–10d), grower (10–21d) and finisher (21–35d) phase, respectively, probiotic (150,000 CFU/g), supplement XB providing xylanase at 1200 U/kg and ß-glucanase at 152 U/kg, and protease at 4000 U/kg. For two additional treatments, the XB dose was doubled, and protease was either reduced to 2000 U/kg (ALT1) or kept at 4000 U/kg (ALT2). Diets were offered *ad libitum* as crumbs/pellets as per commercial practice and formulated to meet Ross 308 requirements. Mean bird body weights, feed intake and mortality corrected feed conversion ratio (FCR) were determined at each feeding phase end. Carbon footprint (CFP) per kg body weight gain was calculated using WUR Feedprint data, with land use change for SBM. Data were analysed via one-way ANOVA with means separated via Tukey HSD test ($P < 0.05$) and three orthogonal contrasts (ALT, XB and PROT) to assess effects of ALT *per se* (CON vs ALT combined), elevated XB levels within ALT (ALT0 vs ALT1+ ALT2), and protease level in elevated XB ALT (ALT1 vs ALT2), respectively.

Results

The ALT contrast indicated that on average, ALT outperformed CON during the starter phase, with a ~ 2.5% uplift in body weight and feed intake (Table 1). During the grower and finisher phase, these effects on body weight reduced and reversed, respectively, with FCR increased but carbon footprint significantly reduced on ALT rations. Final body weight was similar for CON and ALT2, the latter at a greater FCR. The elevated XB level increased body weight and reduced FCR during the starter phase, whilst reducing protease levels reduced final body weight, increased overall FCR and CFP.

Conclusion

This data supports the view that less digestible alternative feed ingredients with extra synthetic amino acids and a strategically designed mixture of phytase, xylanase, ß-glucanase, protease and probiotics can completely replace soya products in commercial relevant rations. Although the similar final bird weight achieved on the best enzyme mixture (ALT2) was achieved with a ~ 2% increased FCR, it was associated with a 57% reduction in land use change based CFP at a ~ 10% above breed target performance.

Table 1. Body weight, feed intake, feed conversion ratio and carbon footprint (CFP) for Ross308 broilers fed soya-free rations[a]

		Feeding treatment					P-values for contrasts		
	Feed phase	CON	ALT0	ALT1	ALT2	s.e.d.	ALT	XB	Prot
Final body weight, g	Starter	297[a]	303[b]	307[b]	305[b]	2	<.001	0.039	0.409
	Grower	1078[a]	1088[a]	1090[a]	1098[a]	8	0.032	0.372	0.299
	Finisher	2688[a]	2643[ab]	2609[b]	2678[a]	24	0.028	0.966	0.007
Feed intake, g	Starter	289[a]	297[b]	295[ab]	297[ab]	3	0.004	0.615	0.675
	Grower	1027[a]	1065[b]	1061[b]	1067[b]	12	<.001	0.901	0.617
	Finisher	2399[a]	2403[a]	2383[a]	2391[a]	31	0.810	0.572	0.808
Feed conversion ratio	Starter	1.131[a]	1.133[a]	1.106[b]	1.119[ab]	0.007	0.068	0.003	0.106
	Grower	1.317[b]	1.359[a]	1.364[a]	1.351[a]	0.006	<.001	0.768	0.045
	Finisher	1.500[d]	1.583[b]	1.614[a]	1.541[c]	0.008	<.001	0.406	<.001
	Overall	1.408[c]	1.466[a]	1.478[a]	1.438[b]	0.005	<.001	0.044	<.001
CFP, kg CO_2 eq/kg weight gain	Overall	2114[a]	924[b]	931[b]	906[c]	4	<.001	0.155	<.001

[a]Means with different superscript differ at $P < 0.05$.

Acknowledgments

We thank Danisco, IFF for financial support, and Allermuir staff and students for bird maintenance and technical support.

Reference

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Methionine or threonine supplementation of low protein diets affects digestibility of other amino acids during a mixed *Eimeria* infection

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Application

Low protein diets supplemented with Met or Thr may be used to improve amino acid (AA) digestibility during *Eimeria* infection.

Introduction

Understanding how nutrition affects birds during the peak and recovery (these are not defined) of infections is important for veterinary medicine and animal production. The outcomes of *Eimeria* infection (e.g. feed intake or oocyst excretion) have been shown to be sensitive to dietary crude protein (CP) content (Taylor, Sakkas, & Kyriazakis, 2022). Part of this study sought to investigate whether reduced CP diets supplemented with Met or Thr would improve amino acid digestibility during the peak and recovery of a mixed *Eimeria* infection.

Material and methods

768 one-day old male Cobb 500 chicks were allocated to one of four experimental diets from d9-28; a high protein diet (19% CP), a low protein (LP) diet (16% CP), the LP diet supplemented with Met (16% + Met), or the LP diet supplemented with Thr (16% + Thr). Met and Thr were supplemented at 50% above breeder recommendations. Diets were formulated to have constant CP to Lysine ratios and AA to Lysine ratios, with the exception of the supplemented diets. On d14 of age, birds were orally inoculated with either a dose of 1 ml of distilled H_2O, or a solution containing 12,500 sporulated oocysts of *Eimeria* maxima, 12,500 sporulated oocysts of *E. tenella*, and 62,500 sporulated oocysts of *E. acervulina* suspended in 1 ml of distilled H_2O. There were eight pen replicates per treatment. On day 7 and 14 post-infection, three birds from each pen with a body weight close to the pen average were culled and digesta were collected from the lower 2/3 of the ileum to determine ileal digestibility of amino acids. Statistical analysis was performed using the nlme package in R and significance was determined at $P < 0.05$. Ethical approval was obtained from the AWERB of AFBI.

Results

There was no interaction between diet and infection. At d7pi, infection significantly reduced the digestibility of all AA ($P < 0.01$) with the exception of Tyr ($P > 0.05$). Supplementing the 16% CP diet with Met or Thr increased the digestibility of Lys, Met, Thr, Arg, Val, Iso, and Gly in comparison to the 19% CP diet ($P < 0.05$). There was no difference in AA digestibility between the birds given the 19% CP and 16% CP diets, except for Arg which was greater in birds given the 16% CP diet ($P < 0.001$) and Gly and Ala which was greater in the birds given the 19% CP diet ($P < 0.001$). In the infected birds, Lys, Met, Thr, Try and Val digestibility ranged from 0.895–0.924, 0.928–0.964, 0.800–0.885, 0.849–0.881 and 0.821–0.960, respectively. At d14pi, digestibility of Asp, Gly and Pro was greater in infected birds than uninfected birds ($P < 0.05$). Supplementing the 16% diet with Met or Thr increased the digestibility of Lys, Met, Thr, Arg, Val, Iso, Cys, Gly, Tyr and Phe ($P < 0.05$). Met digestibility was greater in birds given the 16% CP diet compared to the birds given the 19% CP diet. There was an interaction between diet and infection on Val and Tyr digestibility ($P < 0.05$); there were significant differences in Val digestibility between the uninfected birds whereas there were no significant differences between the infected birds, whereas the reverse was the case for Tyr. In the infected birds, Lys, Met, Thr, Try and Val digestibility ranged from 0.921–0.939, 0.952–0.967, 0.843–0.910, 0.870–0.894 and 0.853–0.890, respectively.

Conclusion

AA digestibility was improved in both infected and uninfected birds given low protein diets with Met or Thr supplementation compared to birds given the 19% CP. In the case of the infected birds, this may assist in recovery.

Acknowledgements

This work was funded by an ADISSEO research grant award (Grant No. FR82439436569).

Reference

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Effect of rapeseed/field bean blend and corn fermented protein as replacement for soyabean in broiler diets on growth, meat yield, and welfare

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Application

Corn fermented protein (CFP) and a commercial rapeseed/field bean blend (RFB) together could replace soyabean meal (29% in starter crumb, 32% starter pellet, 36% grower and 44.8% finisher) in broiler diets without compromising growth performance, meat yield or litter moisture. That leads to decreasing the negative environmental impacts associated with imported soybean meal.

Introduction

Use of imported soyabean meal in European poultry nutrition is associated with increased environmental impact of meat and egg production (Kebreab et al., 2016). Using locally produced feed ingredients in replacement of soyabean would be a robust option to improve the sustainability of poultry production. The goal of the study is to determine the effect of local and non-conventional protein sources on performance, litter quality and welfare of broilers.

Material and methods

The experimental procedures of this study were approved by Nottingham Trent University Ethics Committee and recorded as ARE212253. A total of 768 one-day broilers (half male and half female) were allocated into the following treatments (8 birds/pen and 16 pens/treatment), Control (commercial broiler feed), RFB-10 (10% RFB), CFP-5 (5% CFP), CFP-7.5 (7.5% CFP), CFP-10 (10% CFP), and CFP-7.5 + RFB-10 (7.5% CFP+10% RFB), all in place of soya. Growth, performance, meat yield, and litter dry matter was recorded for each pen and analysed using 2-way ANOVA (bird sex*treatment).

Result

The experimental diets did not significantly reduce growth, FCR or meat yield of broilers. Litter dry matter of CFP-7.5 + RFB-10 was significantly better than the control in both male and female broilers (Table 1).

Conclusion

Growth performance, FCR and meat yield of broilers was not affected when CFP-7.5+ RFB-10 while improving litter dry matter.

Acknowledgement

2 Sisters Food Group Green and Plains Ltd are acknowledged for funding the feeding trial and providing CFP, respectively.

Reference

Kebreab, E., Liedke, A., Caro, D., Deimling, S., Binder, M., & Finkbeiner, M. (2016). *Journal of Animal Science*, *94*(6), 2664–2681.

Table 1. Growth performance, meat yield and litter dry matter of broilers fed corn fermented protein and rapeseed blend

	Control	RFB-10	CFP-5	CFP-7.5	CFP-10	CFP-7.5+ RFB-10	SEM
Female							
D34 bird weight (g)	2171	2280	2288	2234	2235	2195	30.9
D0-D34 bird weight gain (g)	2124	2234	2196	2187	2188	2149	28.03
D0-D34 feed intake (g)	3084	3117	3105	3116	3171	3189	41.95
D0-D34 FCR	1.37	1.35	1.33	1.33	1.38	1.39	0.02
Breast (g)	473	490	496	516	502	507	17.4
Thigh (g)	204^{b}	218^{ab}	215^{ab}	221^{ab}	221^{a}	220^{ab}	6.18
Drumstick (g)	168	182	177	179	173	175	4.93
Total meat yield (g)	844^{b}	890^{ab}	888^{ab}	917^{a}	896^{ab}	902^{ab}	22.9
D34 litter dry matter (%)	72.3^{b}	73.8^{ab}	75.8^{ab}	73.9^{ab}	76^{ab}	76.4^{a}	1.45
Male							
D34 bird weight (g)	2531	2621	2558	2560	2542	2510	30.9
D0-D34 bird weight gain (g)	2485	2574	2511	2513	2495	2464	28.03
D0-D34 feed intake (g)	3507	3551	3546	3530	3606	3467	41.95
D0-D34 FCR	1.33	1.30	1.33	1.31	1.35	1.31	0.02
Breast meat yield (g)	581	553	559	582	597	580	17.4
Thigh meat yield (g)	261^{ab}	268^{ab}	253^{b}	269^{ab}	272^{a}	259^{ab}	6.18
Drumstick meat yield (g)	215^{abc}	228^{a}	207^{b}	215^{abc}	225^{bc}	212^{bc}	4.93
Total meat yield (g)	1063^{ab}	1055^{ab}	1019^{b}	1065^{ab}	1093^{a}	1051^{ab}	22.9
D34 litter dry matter (%)	69^{c}	70.5^{bc}	74.7^{ab}	75.8^{a}	71.9^{abc}	74.6^{ab}	1.45

[a]: means in the same row having different superscripts differ significantly ($P \leq 0.05$).

Detection of in vitro gene expression from enteroendocrine cells in chicken gut organoids

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Application

To understand satiety to address the breeder broiler paradox, increase productivity and minimize welfare concerns.

Introduction

The fast growth rate of broilers makes them reach slaughter weight quickly, but reproductive function is impaired in the breeder if they are not fed a restricted diet. However, they appear to be hungry. Understanding satiety factors may help inform strategies to ameliorate this. The aim was to establish the distribution of gastrin and CCK in embryos and if the genes expression could be detected in cultured organoids. Finally, an attempt was made to test if nutrients in the culture medium would alter expression.

Material and methods

Tissue samples (≤100 mg) from brain and gut regions from day 18 embryos (ED18, n = 4) were used to establish the tissue distribution of gastrin and CCK. Gut organoids were cultured from antrum and ileum that had the highest respective gut levels and incubated for 48 hours (Nash, Morris, Mabbott, & Vervelde, 2021). Total RNA was extracted and CCK and gastrin RNA was quantified by qPCR (Reid & Dunn, 2018). Organoids were randomly divided into control and treatment. Treatment consisted of 200 µL yolk to 1 ml of floating organoid medium. Gastrin/CCK expression was corrected for a panel of housekeeping genes. ANOVA was performed using a general linear model in Minitab.

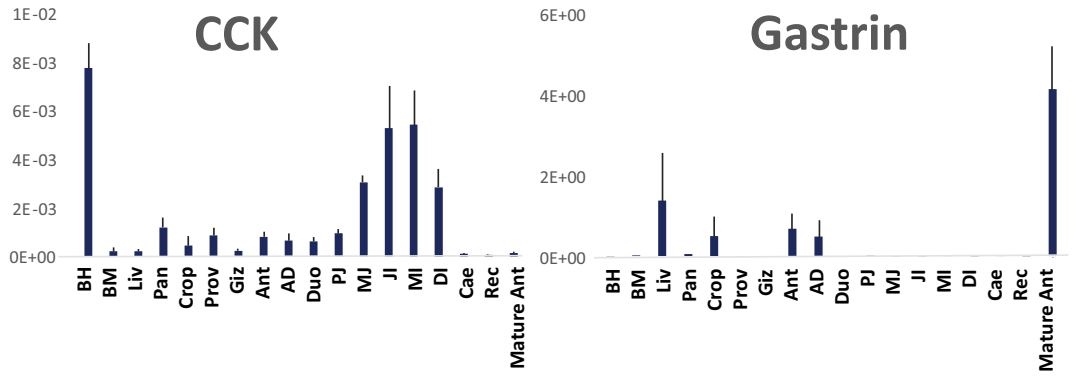

Figure 1. ED18 CCK and gastrin expressions in different tissues. BH- basal hypothalamus, BM- breast muscle, LIV- liver, PAN- pancreas, CROP PROV- proventriculus, GIZ- gizzard, ANT- antrum, AD-anterior duodenum, DUO- duodenum, PJ- proximal jejunum, MJ- middle jejunum, JI- jejunum-ileum, MI- middle ileum, DI- distal ileum, CAE- caecum, REC- rectum, Mature Ant Adult antrum.

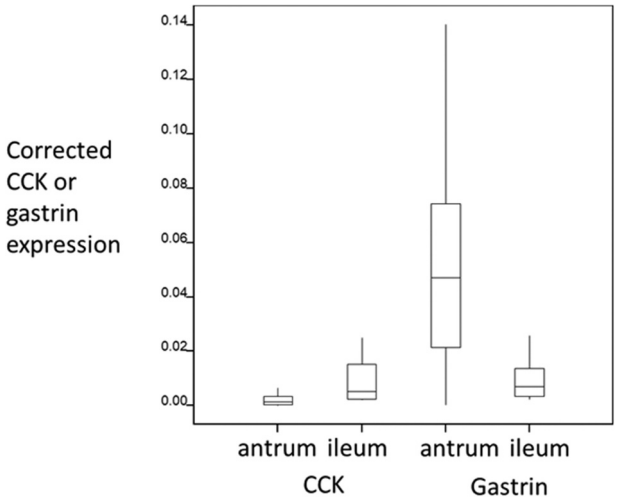

Figure 2. CCK and gastrin expression in antrum and ileum derived organoids in both experimental batches. All values are corrected to a panel of housekeeping genes.

Results

The embryonic antrum had the highest gastrin expression and the ileum had the highest expression for CCK in the gut (Figure 1). In the two experimental batches revealed less variable distribution of data in last batch and there were statistical differences between the two batches. There was more CCK in the ileum than the antrum derived organoid (0.009 ± 0.002 v 0.002 ± 0.0003) but it is not quite significant and is no more than we see for gastrin in the ileum-derived organoid (0.009 ± 0.002) (Figure 2). Gastrin expression in the antrum organoids did not differ with the addition of yolk ($p = 0.154$) nor for CCK expression in the ileum ($p = 0.849$).

Conclusion

The study demonstrated that gastrin/CCK expression could be measured at ED18 with a similar pattern to that observed in adults (Reid & Dunn, 2018). No effect of yolk, nutrient of the late embryonic gut organoid, was observed. This was a pilot study and as the technique is perfected, we hope to observe changes in response to different nutrients.

Acknowledgement

Financial support from a WPSA summer scholarship. Roslin Institute is funded by a BBSRC Institute Strategic Program Grant funding from the BBSRC (BB/P013759/1 and BBS/E/D/10002071).

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NMR-based metabolic profile of broiler serum from hatch to day 35

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Application

Improve understanding of fundamental changes in broilers systemic metabolism during early development.

Introduction

Proton nuclear magnetic resonance (1H-NMR) produces a metabolic profile which could provide insights into the bird's energy utilisation and nutrient absorption. Understanding alterations in the metabolic profile caused by development is the first step in evaluating 1H-NMR as a potential diagnostic tool.

Material and methods

After Ethical review (ARE1564170), 96 male broiler (Ross 308) chicks were raised on a standard commercial wheat/soya broiler diet fed *ad-lib*. 16 birds were blood sampled post-mortem on days 0, 7, 14, 21, 28 and 35, and a metabolic profile was established using ^{1}H NMR-based untargeted metabolomics on a Bruker Advance operating at 800.32 MHz with a standard noesypr1D pulse sequence. The metabolites were assigned with reference to spectra and tables from the human metabolome database. Spectra were separated into bins (0.01ppm bin width) from 0.72 to 10ppm with water exclusion (4.75–5.25 ppm). One-way ANOVA and Ducan determined the significant changes in metabolite levels between time points.

Results

The ^{1}H-NMR analysis of serum detected 35 metabolites that demonstrated significant changes in concentration across the sample points. Table 1 shows 6 of the identified metabolites. The post-hatch d0 birds have significantly elevated levels of creatine, methyl succinate and 3-hydroxybutyrate. These results were consistent with previous studies on energy utilisation in embryonic and newly hatched chicks (Dayan et al., 2023; Ohtsu, Sato, Nishida, & Akiba, 2003). Creatine was higher (12.27 mg/dl) in post-hatch chickens, then declined to below 0.8 mg/dl after day 7. Due to glycogen depletion, late-term embryos and hatchlings use creatine as an energy source (Dayan et al., 2023). Methyl succinate is an intermediate metabolite in the breakdown of fatty acids, and 3-Hydroxybutyrate is a biomarker for high ketone body metabolism. The high presence at hatch indicates the utilisation of the residual yolk sac fatty acids (Ohtsu et al., 2003).

Conclusion

These examples demonstrate that 1 H-NMR can provide information on the dynamic nature of the chickens'

Table 1. Broiler serum metabolite levels mg/dl (± standard error)

Metabolite	d0	d7	d14	d21	P-Value
Lysine	17.95 (2.149)^{a}	13.44 (1.931)^{b}	10.21 (1.052)^{b}	12.53 (1.005)^{b}	≥0.001
Methionine	5.33 (0.739)^{bc}	8.02 (1.046)^{a}	7.11 (0.701)^{ab}	7.76 (0.560)^{a}	≥0.001
3-Hydroxybutyrate	77.67 (8.619)^{a}	6.46 (0.662)^{b}	4.16 (0.568)^{b}	6.11 (0.541)^{b}	≥0.001
Creatine	12.27 (2.170)^{a}	3.44 (0.398)^{b}	0.72 (0.317)^{c}	0.71 (0.203)^{c}	≥0.001
Lactate	55.3 (5.89)^{c}	240.4 (22.18)^{ab}	225.0 (24.23)^{b}	287.1 (17.80)^{a}	≥0.001
Methyl succinate	1.35 (0.124)^{a}	0.81 (0.111)^{b}	0.46 (0.040)^{c}	0.34 (0.039)^{c}	≥0.001

metabolites during growth. This could be used as a database for future NMR-based metabonomic analyses in broiler studies into production and health.

Acknowledgement

The Authors gratefully acknowledge Aviagen and the University of Nottingham for their support.

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Pilot Study: In vitro assessment of novel protein digestibility compared to soyabean meal for broiler chickens

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Application

Understanding the differences in digestibility of novel proteins when compared to soyabean meal aids with identifying more robust proteins to be taken forward to *in vivo* trials.

Introduction

Currently the United Kingdom (UK) is facing increasing environmental, biodiversity and welfare concerns attributed with conventional poultry meat production, highlighting the need for novel and alternative feedstuffs (CIEL, 2022). There is a wide array of alternative and novel proteins, however literature is still limited on their incorporation in the UK broiler industry. One of the main factors that will impact on the success of these alternative and novel proteins is digestibility: it is critical for a new protein to be highly digestible to the bird. As some novel proteins haven't been well researched in the context of the UK broiler industry it is unknown how well they will be digested meaning largely undigestible alternatives will have little value for the bird nutritionally and shouldn't be taken forward into *in vivo* trials.

Material and methods

To determine digestibility of a range of novel proteins the Megazyme Digestibility Kit was used. The methodology followed the Megazyme Protein Digestibility Assay Procedure protocol – Novel Method (U.S. Pat. No. 9,738,920). Protein samples were digested by pepsin in dilute HCl (pH 2) followed by digestion with trypsin and chymotrypsin in a neutral buffer to simulate the physiological conditions of gastric and intestinal digestion, respectively.

Undigested proteins were removed by precipitation with trichloroacetic acid. Amine groups of amino acids made available for reaction by the digestion were quantified by the reaction with ninhydrin to form Ruhemann's purple.

The amount of Ruhemann's purple formed in this reaction is proportional to the amount of reactive α-amino acids present in the sample and is measured by the increase in absorbance at 570 nm. When corrected for the relative reactivity of certain α-amino acids, an in-vitro digestibility score can be calculated. This digestibility score, in conjunction with the essential amino acid analysis of the sample, is used to calculate the Protein Digestibility Corrected Amino Acid Score (PDCAAS) result. Novel proteins analysed were: three types of Porcine Processed Animal Protein (PPAP) (Advanced Proteins (52.75% protein), Darling Sonac 58 (58.8% protein), Darling Lingen 60 (61.8% protein)), Ragworm, Peas, Soyabean Meal (SBM), Black Soldier Fly (BSF), and Algae (*Spirulina, Chlorella, Tetrasemis, Odontella, Dunaliella, Haematcoccus, Naanichloropsis, Phaeodactylum)*

Results

The results were presented with the variance in digestibility compared to industry-used SBM. Results show that Spirulina was the most digestible sample compared to SBM at 41% higher digestibility. The three types of PPAP are more digestible than SBM by 5–16%. Ragworm is 15% more digestible than SBM. Black Solider Fly, Nannochloropsis and Phaeodactylum are also marginally higher than SBM, ranging from 2–4% of an increase.

Conclusion

It is clear that some types of novel proteins are more digestible than others, with this work we are able to better understand how these will work in modern broiler diets and gives the industry a base for further research for these important proteins. Preference to Spirulina and PPAP should be taken when designing *in vivo* work.

Reference

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Efficacy of an oregano essential oil-based additive on the helminth burden and productivity of free-range laying hens

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Application

Oregano extract may reduce the need for anthelmintics in free-range layers whilst enhancing performance.

Introduction

With many areas of the poultry industry moving towards more natural/organic production systems, mitigating helminth infection in free range hens can pose a significant challenge. Anthelmintics have historically been used, however concerns surrounding helminth resistance mean alternatives must be identified. Orego-Stim® is a natural feed additive based on oregano essential oil (OEO). It has been shown to support performance, (Alagawany et al., 2018) however little is known about its impact on helminth control. A scientific study was performed determine the impact of OEO on helminth burden and layer performance.

Material and methods

A 41-week trial was run at North Carolina State University, USA raising layers from 0 to 41 weeks. Ethical approval was granted by the university's ethics committee. 540 Bovan brown layers were assigned to three treatments: CC = Control – basal rations in rear and lay periods, CO – basal diet in rearing (weeks 0–16) and basal diet + 300 g/t OEO in laying period (week 17–41), OO – basal diet + 300 g/t OEO in both rearing and laying periods. 3 replicates were used with 60 birds per replicate (replicates limited by free range design). Pullets were reared in barns until 12 weeks, then moved to range for the remainder of the study. Performance was measured biweekly (feed intake, lay %, FCR, mortality, egg weight) and helminth burden (tapeworm, large round worm and caecal round worm) was measured in 10 birds per treatment at weeks 16 and 41. Results were analysed by one-way ANOVA using a single bird for statistical comparison.

Results

Performance in the laying period are shown in Table 1. These showed no significant difference in the rate of lay. However, there was a significant ($p = 0.045$) reduction in feed intake for the CO and OO treatments compared to the CC treatment. This resulted in a significant ($p = 0.016$) improvement in feed conversion for the CO and OO birds compared to the OO birds.

The helminth burden results (Table 2) demonstrated that at week 41 the OO and CO birds had numerically lower counts ($p > 0.05$) of caecal round worms compared to the CC treatment. The large round worm results showed that the OO birds had the lowest count and for the tapeworm, the CO and OO treatments both had lower counts compared to the CC birds.

Conclusion

The study results demonstrate that the supplementation of OEO in either the rear and lay periods or the lay period only can significantly enhance the efficiency of free-range laying hens compared to unsupplemented control and may help to reduce helminth burden in free range laying hens.

Reference

Alagawany, M., Abd El-Hack, M. E., Farag, M. R., Shaheen, H. M., Abdel-Latif, M. A., Noreldin, A. E., & Patra, A. K. *World's Poultry Science Journal*, *74*(3):463–474. 2018

Table 1. Laying Period Performance Results

Treatment	Rate of Lay (%)	Feed intake (g/b/d)	Feed Conversion (kg feed/kg eggs)	Mortality (%)	Egg Weight (g)
CC	87.03	115.71[a]	1.603[a]	0.093	59.19
CO	87.55	112.81[b]	1.547[b]	0.093	58.95
OO	87.97	112.53[b]	1.538[b]	0.556	58.66
p-Value	0.575	0.045	0.009	0.249	0.327
SEM	0.890	0.964	0.016	0.223	0.243

abc: means in the same column having different superscripts differ significantly ($p<0.05$)

Table 2. Helminth counts – no statistical differences between treatments

Treatment	Caecal round worm Count/bird (SEM)	Large round worm Count/bird (SEM)	Tapeworm % hens infected (SEM)
CC	79.30 (24.05)	14.90 (3.34)	56.67 (9.20)
CO	69.83 (12.74)	22.63 (5.38)	33.33 (8.75)
OO	68.07 (12.24)	11.07 (2.67)	43.33 (9.20)

Impact of exogeneous enzyme supplementation on growth, digestibility, and litter moisture of broilers fed rye-based grower diet

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Application

Exogenous enzyme supplementation cannot compensate for the challenges to growth and litter dry matter in broilers transferred from a wheat-based starter to rye-based diet at day 10 post-hatch.

Introduction

The use of rye as an alternative to traditional wheat/corn soy-based diets for poultry is gaining attention. However, the high level of non-soluble polysaccharide (NSP) in rye (Rodehutscord et al., 2016) decreases nutrient digestibility and growth, plus feeding rye increases litter moisture, leading to foot pad lesions, reduces meat quality and compromises bird welfare. Feed enzymes can ameliorate some of these issues. However, no studies have investigated the use of exogenous enzymes on growth performance and litter moisture of broilers when introduced to rye-based diets following feeding a lower viscosity diet. The goal of this study was to determine the role of an enzyme cocktail in mitigating the dietary challenges associated with introducing rye into grower phase diets for broilers and its implication on growth and litter dry matter.

Material and methods

The study was approved by Nottingham Trent University's ethical review committee. Eighty-eight Ross 308 one day old broilers were randomly allocated to 8 pens (11 birds /pen). The pens Were equally divided into two dietary treatments, 'Control' (Rye 45%, Dried distillers' grain and solubles, Barley 20%, Rapeseed Full fat 15.56% and Soybean meal 15.42%), 'EX-enzyme' (Control with added Mannanase 25 g/t, Xylanase 1 g/t and Phytase 5000FTU/t). Data on bird weight, bird weight gain, feed intake, feed conversion ratio, total dry matter digestibility and the litter moisture content were recorded. Independent sample t-test was used to analyse data using SPSS v29 (IBM incorporation).

Results

There was no significant effects of the dietary treatment on bird weight, bird weight gain, feed intake, feed conversion ratio, total dry matter digestibility or the litter moisture content (Table 1).

Conclusion

In this small study, enzyme addition was of no benefit to broilers fed rye-soy based diet when dietary treatments started at day 10. Rosen (2003) points to the detrimental effect of introducing an enzyme after day of hatch suggesting chicks may need to be exposed to rye and or the enzyme earlier in life.

Acknowledgements

The authors gratefully acknowledge the funding from AB Vista for funding the trial.

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Table 1. Effect of exogeneous enzyme supplementation on growth, digestibility, and litter moisture of broilers fed rye-based diet starting at day 10

	Control	EX-enzyme	SE	P value
Day 10–35 Weight gain (g)	1455	1536	53	0.486
Day 10–35 Feed Intake (g)	2670	2750	40.5	0.365
Day 10–35 FCR	1.67	1.62	0.052	0.704
Day 17 litter Moisture content %	36.1	34.9	2.72	0.389
Day 31 litter Moisture content %	41.1	44	4.1	0.379
Day 11 Dry matter Digestibility (%)	71	74.2	1.90	0.447
Day 14 Dry matter Digestibility (%)	81	79.6	0.531	0.187
Day 21 Dry matter Digestibility (%)	82	83.7	0.946	0.430

Does feeding sprouted barley to laying hens affect feed intake, egg production and egg quality?

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Application

Feeding sprouted barley could be offered to laying hens as a dietary supplement but further investigation is required on its effects on egg production and quality, with refined amounts.

Introduction

With aims to 1) end routine beak trimming in commercial hens, 2) reduce production costs and environmental impact, and 3) maintain producing high-quality eggs, producers are looking for sustainable solutions to these sometimes-conflicting issues. Hydroponic (sprouted) barley (SB) might be useful for these aims as a nutritional enrichment. Anecdotal information suggests that supplementing laying hens with SB reduces feed intake while maintaining bird productivity and improving feather quality. However, these expectations are yet to be confirmed with a UK-based scientific study. The objectives of this study were to assess the impact of feeding varying quantities of SB to laying hens on egg production, egg quality, feed efficiency, and body weight.

Material and methods

This study was approved by SRUC's ethical review committee. Lohmann Brown hens (age 46 weeks) were housed in 24 litter-floor pens (2 m^2; 5 hens/pen) in a single room. Each pen had a feed hopper, bell drinker, nest box and perch. Mash feed was provided *ad libitum* (11.6 MJ/kg AME, 17.5% CP, 3.8% Ca) and fresh SB (5.7% crude protein, 2.9% crude fibre) was offered from d0–42 at 0, 15, 30 or 45 g SB/hen/day in a randomised block design. Daily batches of SB were prepared through barley grain rinsing, soaking (8–12 h), then spread onto plastic trays and kept at 23°C under white LED lights (lights on: 06:00–21:00). Grains were rinsed daily until d4, followed by water misting until d7 or 8, when sprouted mats were harvested (based on root quality) and cut to the required weight. Collected data included daily barley intake and egg production, averaged over d0–21, d22–42, and d0–42, with body weights, egg quality and feed intake recorded on d0, d21 and d42. Data were analysed in Genstat using ANOVA with orthogonal polynomial contrasts for linear and quadratic effects of SB level, and a binary contrast for the effect of SB *per se*, with block as random effect and initial bodyweight as covariate. Data are shown with standard error of difference (SED). Means are significant where $P \leq 0.05$ and tending towards significance at $P \leq 0.10$.

Results

Data from pen 24 was omitted due to poor performance (treatment 45 g). All SB was eaten daily from d11. SB intake did not affect body weights at d21 ($\bar{x}$ 1.85–1.88 kg, 0.04 SED) or d42 ($\bar{x}$ 1.85–1.87 kg, 0.04 SED; both $P > 0.05$ for all tests), but linearly reduced feed intake during d21–42 (Table 1), with a tendency over d0-42. There were no significant effects of SB on egg weights at any age (range over SB treatments: $\bar{x}$ 60.8–61.5 g d0-42, $P > 0.05$ for all tests). Laying rate linearly decreased with increased SB levels during d22-42 and d0-42. SB feeding did not impact albumin and yolk measurements, and only 15 cracked eggs were recorded over all treatments and days (data not shown) but SB significantly reduced shell strength at both d21 (binary) and d42 (quadratic and binary), largely due to treatment 15.

Conclusion

Feeding SB linearly reduced feed intake and laying rate, largely due to the highest level of SB. Despite reduced shell strength (though within the acceptable range for table eggs, Kashimori, 2017), mainly attributed to the 15 g/d treatment, no difference in cracked eggs was recorded. This study suggests that further exploration on the optimal level of SB feeding should be done.

Acknowledgements

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Reference

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Table 1. Effects of sprouted barley feeding to hens from d0-42 on feed intake, egg laying rate and shell strength

Parameter	Day(s)	Sprouted barley feeding (g/d/hen)					P-values		
		0	15	30	45	SED	Linear	Quadratic	Binary
Mean daily feed intake (g/d/hen)	0–21	145	173	145	133	22	0.395	0.228	0.761
	21-42	136	133	118	98	13	0.008	0.364	0.094
	0-42	142	153	132	116	16	0.065	0.254	0.510
Egg laying rate (%)	0-21	93.8	92.6	88.9	89.3	3.9	0.181	0.783	0.283
	22-42	91.8	89.3	86.5	85.2	2.9	0.028	0.781	0.064
	0-42	92.8	91.4	88.1	87.7	2.6	0.042	0.790	0.104
Shell strength (kg f)	21	4.91	4.28	4.97	4.51	0.14	0.285	0.427	0.016
	42	5.37	4.33	4.79	4.80	0.27	0.173	0.016	0.005

Antioxidant feed stabilisers improve performance in meat poultry

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Application

Antioxidant feed stabilisers may improve broiler performance and meat yield.

Introduction

Commercial poultry production is correlated with an array of stressors including nutritional, environmental, biological, and technological (Surai, 2020), which can impact the health and growth performance of poultry (Pashtetsky et al., 2019). Antioxidants (AOX) and other dietary factors play a key role in sustaining immune-competence, high growth rates and general health and survival of the animal (Masood et al., 2013). Poultry have developed an 'antioxidant system', which is a defence mechanism that protects cells from free radicals and maintains antioxidant-prooxidant balance (Surai, 2020). By adding AOX to the diet it may affect meat yield and improve meat quality. This study investigates the effect of supplementing dry or liquid antioxidants into a standard poultry diet and the subsequent effects on performance and meat yield of broilers.

Material and methods

288 male Ross 308 broiler chicks were randomly allocated into groups of 6 birds in 48 floor pens, 16 replicates per treatment in an environmentally controlled room. Pellet diets were formulated based on wheat (50% inclusion) and soybean meal with added oil, vitamins, minerals, and amino acids, to meet the requirements of the age and strain of the birds. The birds were fed crumbed starter diet from D0-D7, pelleted starter from D8-D22 and pelleted finisher from D22 until the end of the trial at D37. The dietary treatments were as follows: standard poultry diet; standard plus dry Paradigmox green and standard plus liquid Paradigmox green and each diet was allocated randomly to 16 pens. Paradigmox green is a natural antioxidant containing a synergistic combination of natural tocopherols and rosemary extract ingredients and each type of this AOX was homogenously incorporated into their respective diets, at an inclusion rate of 1000 g/t. Feed and water were provided ad libitum. Bird body weight gain (BWG) and feed intake (FI) were measured at D0, D7, D14, D21, D28, D34 and D37 and meat yield was measured for both D34 and D37. The trial protocol was approved by the University's ethical review group prior to starting. One-way ANOVA was used to determine the effect of dietary treatment on all parameters measured using R.

Result

Birds fed diets with an AOX feed stabiliser, dry or liquid, significantly showed an improved FCR for D0-21 compared to non-supplemented birds (Table 1), though these differences were not maintained till D37. The birds fed diet including liquid AOX also demonstrated a significantly higher breast meat yield in comparison to the birds fed on the control diet or dry AOX.

Conclusion

Adding a liquid AOX feed stabiliser significantly improved feed efficiency in the starter period and breast meat yield. It is notable that this study had to be terminated 5 days early due to the substantial growth of all birds involved in the study, above breed standards by some margin. However, this study suggests that enriching a broiler diet with antioxidants can be beneficial. Further investigation needs to be conducted, to identify what dosage is most suitable for optimal performance and meat yield, while considering cost efficacy.

Acknowledgement

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Table 1. Effect of antioxidant (AOX) addition at 1000 g/t on bird performance and carcass yield

	D0-21 BWG (g)	D0-21 FI (g)	D0-21 FCR	D21-37 BWG (g)	D21-37 FI (g)	D21-37 FCR	Breast Yield (g)	Carcass yield (g)
Control	1101	1470	1.34[b]	2066	2978	1.44	757[b]	1393
Dry AOX	1133	1425	1.24[a]	2061	2993	1.45	802[ab]	1436
Liquid AOX	1128	1430	1.27[a]	2084	2978	1.43	814[a]	1438
SEM	11.1	17.0	0.016	25.4	30.2	0.016	15.3	22.9
P value	0.099	0.139	0.002	0.807	0.924	0.630	0.018	0.187

Broiler farmers' perceptions of slow growing broiler production in Great Britain

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Application

Despite positive perception of slow growing broilers among British poultry farmers, further work is required to explore the barriers preventing wide adoption by the industry.

Introduction

Slow growing broilers are distinguishable from fast growing broilers by growth rate (Van der Eijk et al., 2023). Uptake of slow growing broilers is likely to increase after 130 UK companies signed The Better Chicken Commitment, requiring 100% use of slow growing broilers by 2026. This study aimed to evaluate British poultry farmer understanding of slow growing broilers and describe the current interest in their production and the drivers for this.

Material and methods

This study was approved by Harper Adams University Research Ethics Committee. A twelve question online survey was sent to broiler farmers in Great Britian from major companies via the British Poultry Council. Multiple choice, rating and free text questions were used to determine farmer knowledge about differences between fast and slow growing broilers and their opinions about comparative statements. Respondents rated positive and negative statements on a scale from 1 to 4 based on their opinion: 1 (disagree) to 4 (agree). The mean average scores were calculated to determine the biggest advantages (highest scoring positive factors) and the biggest disadvantages (highest scoring negative factors). Fishers exact tests were performed in R (version 4.3.2) to analyse the drivers of these opinions, and results were displayed graphically (MS Excel). Differences were considered significant at $P < 0.05$.

Results

Results are shown in Figure 1. There were thirty-five useable responses and the majority (30–34 respondents) correctly distinguished the differences between fast and slow growing broilers based on three associated questions. The biggest advantages of slow growing broilers to farmers were perceived high animal welfare (27) and a high-quality end product (24). The biggest disadvantages were increased heating costs (19) and increased feed costs (15). There were no significant associations between the biggest advantages/disadvantages and other factors.

Conclusion

British broiler farmers consider slow growing broilers to have advantages and therefore there is positive interest in adopting them. However, barriers remain for farmers and further research is required to alleviate these.

Acknowledgements

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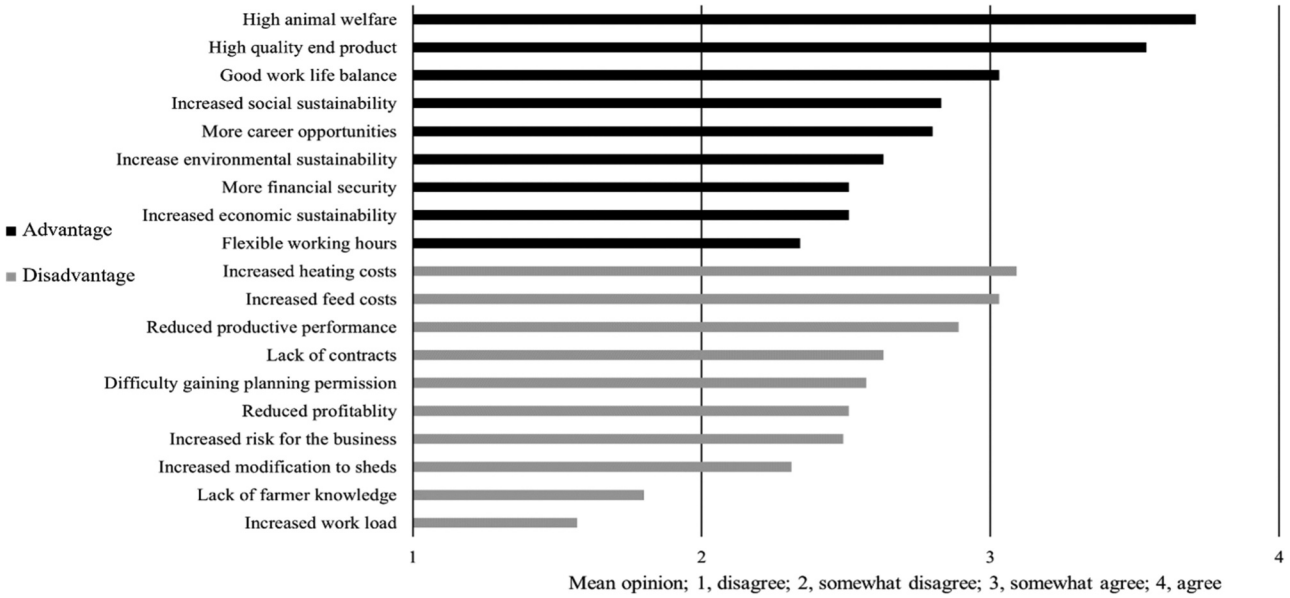

Figure 1. Mean score given by GB broiler farmers about advantages and disadvantages of slow growing broilers