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GLEISON VINICIUS SIEGA

AVALIAÇÃO DO USO DE FARINHA DE LARVAS DE TENÉBRIOS (*Tenebrio molitor)* NA DIETA DE GALINHAS POEDEIRAS EM FASE PRÉ E INICIAL DE POSTURA

ERECHIM

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Trabalho de Conclusão de Curso apresentado ao Curso de Agronomia da Universidade Federal da Fronteira Sul (UFFS), como requisito para obtenção do título de Bacharel em Agronomia.

Orientador: Prof. Dr. Bernardo Berenchtein

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Trabalho de Conclusão de Curso apresentado ao curso de graduação em Agronomia da Universidade Federal da Fronteira Sul (UFFS) como requisito parcial para obtenção do grau de bacharel em Agronomia.

Este trabalho foi defendido e aprovado pela banca em 20/12/2023.

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Dedico este trabalho aos meus pais, que não pouparam esforços para que eu pudesse concluir meus estudos.

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1.1.1.1 Avaliação do uso de farinha de larvas de Tenébrios (*Tenebrio molitor)* na dieta de galinhas poedeiras em fase pré e inicial de postura

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1.1.4 **Abstract**

Recentemente, por recomendação da FAO, novos sistemas de criação de insetos tem sido estudados e tem sido uma importante fonte de proteína para alimentação, já que não competem com o uso de terras ou recursos alimentares, e ainda, proporcionam a reciclagem de vários nutrientes, além de possuírem ciclo de vida curto, fáceis de serem produzidos, necessitando pouco espaço, quando comparados a outras culturas. A farinha de insetos é considerada um alimento protéico (46-65% de proteína), sendo rica em proteínas, superando o feijão (23,5% de proteína), lentilhas (26,7%) ou soja (41,1%). Portanto, o uso de insetos pode ser uma forma alternativa de alimentação, reduzindo ou substituindo, principalmente, o farelo de soja, na produção avícola. Dentre as principais fontes, se destaca o Tenébrio (*Tenebrio molitor*) o qual apresenta, em termos percentuais, um teor de proteína semelhante ao teor de proteína de fonte animal. O experimento foi realizado no galpão experimental de avicultura na Universidade Federal da Fronteira Sul, Campus Erechim. Diante do exposto, objetivou-se avaliar o consumo de ração, consumo diário da ração (g/dia), Conversão alimentar (kg de ração/dúzia de ovos), após o período de produção de ovos, Conversão alimentar (kg de ração/kg de ovos) e então feita a análise de produção de ovos (quantidade) e qualidade dos mesmos, sendo avaliadas o peso dos ovos (g), peso de gema (g), cor da gema, por meio de leque de cor de gema da DSM Yolk Color Fan, comprimento e altura de gema, peso do albúmen, peso da casca e espessura da casca. As análises descritas anteriormente foram avaliadas pelo SAS LAB para verificação da adequação dos dados ao modelo linear. Seguido da análise de variância pelo PROC GLM e realização do Teste T (P <0,05) para comparação entre as médias dos tratamentos pelo Software SAS. Diante do exposto, a farinha de *Tenebrio mollitor* pode ser utilizada na dieta de frangas em fase pré e inicial de postura, podendo ser utilizado como pigmentante natural, no entanto, pode reduzir a produção inicial de ovos nas aves. Novos estudos devem ser desenvolvidos com o intuito de avaliar a inclusão do mesmo durante todo o ciclo de produção de ovos.

Key-Words: Nutrição, Sustentável, Economico

1. Introduction

A cadeia avícola vem se profissionalizando desde o início da década de 1970, tendo como base os sistemas de produção americanos, extremamente tecnificados e em sistemas integrados de criação, seccionados entre bisavozeiros, avozeiros, matrizeiros e a fase comercial, tanto para galinhas poedeiras quanto para frangos de corte.

Comercialmente no Brasil, diferente do que ocorre comumente no país para a avicultura de corte, os sistemas de produção de ovos, são realizados em sistemas de produção de ciclo completo, normalmente comercializados pelo próprio produtor, vendidos à um entreposto de ovos ou ainda, vendidos à cooperativas de produção, o que faz o valor individual de ovos e a lucratividade do produto ser cada vez menor, levando o produtor a buscar novas alternativas aos elevados preços acarretados pelo alto custo dos commodities tradicionais, principais fontes de energia e proteína na dieta de aves, tais como o Milho e o Farelo de Soja.

Estes dois alimentos chegam a representar 90% do total de ingredientes das rações, constituindo grande parte dos custos relativos à alimentação e, consequentemente, dos custos de produção. Tais alimentos estão sujeitos a intensas oscilações de preços. Assim, a busca por alimentos não convencionais é de fundamental importância (BARBOSA & GATTÁS, 2004). Frente a isto, ingredientes novos devem ser estudados, tais como a Farinha de diferentes insetos, visto que de forma geral, os insetos já participam da alimentação de aves que são criadas soltas, já que estas possuem o hábito de selecionar insetos de diversos tipos e consumir voluntariamente.

Recentemente, por recomendação da FAO, novos sistemas de criação de insetos tem sido estudados e tem sido uma importante fonte de proteína para alimentação, já que não competem com o uso de terras ou recursos alimentares, e ainda, proporcionam a reciclagem de vários nutrientes (REIS & DIAS, 2020), além de possuírem ciclo de vida curto, fáceis de serem produzidos, necessitando pouco espaço, quando comparados a outras culturas.

A farinha de insetos é considerada um alimento proteico (46-65% de proteína), sendo rica em proteínas, superando o feijão (23,5% de proteína), lentilhas (26,7%) ou soja (41,1%) (RAMOS-ELORDUY et al., 2012). Portanto, o o uso de insetos pode ser uma forma alternativa de alimentação, reduzindo ou substituindo, principalmente, o farelo de soja, na produção avícola. Dentre as principais fontes, se destaca o Tenébrio (*Tenebrio molitor*) o qual apresenta, em termos percentuais, um teor de proteína semelhante ao teor de proteína de fonte animal segundo Spang (2013). Inseto pertencente a ordem dos coleópteros inserido na família tenebridae. apresenta um halometabolismo (metamorfose completa) dividido em 4 fases: fase embrião (ovos), a fase larval, a fase pupa e a fase imago (adulta) (SPANG, 2013).

Estudos sobre a utilização da farinha de insetos apontam que estas possuem grande potencial como fonte de alimento devido sua composição proteica e perfil aminoacídica semelhante ou até mesmo superior ao farelo de soja (REIS & DIAS, 2020).

Diante do exposto, objetivou-se através deste estudo, avaliar o crescimento de galinhas poedeiras em fase pré-produção e a produção e a qualidade de ovos nas semanas iniciais de produção.

2. Materials and methods

O experimento foi realizado no galpão experimental de avicultura na Universidade Federal da Fronteira Sul, Campus Erechim. O galpão se situa no sentido Leste-Oeste, na área experimental do campus, com dimensões de 5m, 3m, e 2,6m sendo estas, medidas de largura, altura e pé direito respectivamente, constituindo dessa forma, uma área de 15m^2. Possui como cobertura do galpão, telha

ondulada de fibrocimento, sendo essas, capazes de manterem temperaturas em seu interior de 23 a 28°C. Ainda, as laterais do galpão podem ser abertas para passagem de ar e redução da temperatura interna do mesmo, sendo estas, feitas de lona azul impermeável. Aliado a isso, o mesmo conta com ar condicionado para um melhor controle de temperatura, e umidade relativa, auxiliando assim, para um melhor desempenho na produção de ovos e bem-estar das aves.

Para o fornecimento da ração, em cada unidade experimental, utilizou-se uma balança eletrônica Prix3f/P300100 – Toledo. O fornecimento de ração, seu consumo e o recolhimento dos ovos, após o início da postura, foram calculados duas vezes ao dia, pela manhã às 08:00 horas, e também pela parte da tarde às 16:00 horas. A alimentação foi distribuída manualmente, onde essas rações foram formuladas de acordo com os valores preconizados por Rostagno, *et al*. (2017). As formulações utilizadas em cada tratamento podem ser vistas na Tabela 01 e 02.

Table 1- Valor Nutricional da Farinha de Tenébrio

VALOR NUTRITIVO	**Valor**
Matéria Seca, %	41,00
Proteína Bruta, %	51,00
Energia Bruta, Kcal/kg	4400,35
Extrato Etéreo, %	24,17
Fibra Bruta, %	2,12
Cinzas, %	3,45

Os dados foram colhidos por meio de anotações em campo, sendo organizados e tabulados posteriormente em planilhas do Microsoft Excel®. As análises descritas anteriormente foram avaliadas pelo SAS LAB para verificação da adequação dos dados ao modelo linear. Seguido da análise de variância pelo PROC GLM e realização do Teste T ($P < 0,05$) para comparação entre as médias dos tratamentos pelo Software SAS (SAS INSTITUTE, 2002).

Isto posto, para avaliação da dieta e desempenho das aves, adotaram-se alguns parâmetros para a avaliação dos mesmos, sendo eles, o consumo de ração, consumo diário da ração (g/dia), Conversão alimentar (kg de ração/dúzia de ovos), após o período de produção de ovos, Conversão alimentar (kg de ração/kg de ovos) e então feita a análise de produção de ovos (quantidade) e qualidade dos mesmos, sendo avaliadas o peso dos ovos (g), peso de gema (g), cor da gema, por meio de leque de cor de gema da DSM Yolk Color Fan, onde o leque possui uma escala de 1 a 15 em que

por comparação visual o operador atribui a cor do ovo colocando a lâmina próxima a gema e atribuindo um resultado quando encontrar a lâmina correspondente a cor analisada, comprimento e altura de gema, peso do albúmen, peso da casca e espessura da casca.

Com base nisso, ao longo do experimento, recolheram-se os resultados das diferentes respostas que as aves tiveram em relação a cada formulação fornecidas para cada tratamento, no que se diz respeito para com a avaliação da dieta e ao desempenho.

O ambiente contou com médias de temperatura entre 23 e 28°C, com umidade relativa do ar média de mínima (81%) e máxima (87%), registradas em dois períodos diários, às 8h00min e às 16h00min. Às aves receberam um total de 17 horas diárias de luz artificial, controlados com auxílio de um timer.

A coleta dos ovos foi realizada, após o início da postura, pelo menos, 2 vezes ao dia, sendo estes contabilizados referentes aos seus grupos experimentais. O experimento teve uma duração de 60 dias, com período de adaptação de 15 dias, tanto para o ambiente quanto para a dieta que iriam receber ao longo do experimento, onde então, foram fornecidos alimento de mesma formulação e água à vontade.

Dessa maneira, no mesmo ambiente, foram alocadas as gaiolas, onde as aves ficaram alojadas. As gaiolas utilizadas foram do tipo comum, com 750 cm^2 /ave, com capacidade máxima de 4 aves abrigadas por gaiola. Foram utilizadas 80 frangas poedeiras da linhagem poedeira vermelha da Globo Aves, com 12 semanas de vida, em fase pré-postura e durante a primeira e a quinta semana de postura. sendo os animais divididos em grupos de 3 ou 4 aves, alojadas em 24 gaiolas, divididas em dois grupos experimentais. Dieta convencional ou a dieta convencional com a inserção de 5% de farinha de Tenébrios.

Table 2- Dietas Experimentais

Ingredientes	Dietas Experimentais	
	Controle	Tenébrio

Milho Grão, kg	60,50	60,25
Farelo de Soja (45%), kg	27,00	22,00
Tenébrio	-	5,00
Calcáreo, kg	10,00	10,00
Fosfato Bicálcico, kg	1,38	1,38
Sal Comum, kg	0,44	0,44
Complexo Vitamínico, kg	1,00	1,00
Complexo Mineral, kg	1,00	1,00
DL-Metionina	2,86	2,86
TOTAL	100	100

Composição Nutricional		
Nutriente	Controle	Tenébrio
EM, Kcal/kg	2800	2800
PB, %	15,74	15,28
Metionina Total, %	0,37	0,38
Cálcio, %	3,60	3,70
Fósforo, %	0,58	0,61

3. Results

3.1 Desempenho das frangas em fase pré e produção

Após a análise dos resultados, não foram observadas diferenças significativas (P>0,05) para as variáveis de Peso Vivo Final (PVF), Ganho de Peso Diário (GPD) e Consumo Diário de Ração (CDR), conforme a Tabela 03.

Table 3– Peso Vivo Inicial (PVI), Peso Vivo Final (PFV), Ganho de Peso Diário (GPD) e Consumo Diário de Ração (CDR) de galinhas nas fases pré e iniciais de postura.

TRAT	PVI	PVF	GPD	CDR
Controle	0,983	1,56	0,009	0,110
Tenébrio	0,97	1,48	0,008	0,112
CV, %	-	11,23	10,24	12,94
P	-	NS	NS	NS

NS- Não Significativo

3.2 Produção e qualidade de ovos das galinhas nas primeiras semanas de produção

Após a análise dos resultados de produção e qualidade de ovos nas primeiras semanas de produção, foram observadas diferenças significativas (P<0,05) apenas para as variáveis de Produção de ovos e Cor da Gema, conforme demonstra a Tabela 04.

Table 4 – Desempenho de galinhas nas fases pré e iniciais de postura

TRAT	Ovos	P. OVO	GEMA	CLARA	ALT. GEMA	LARG. GEMA	COR	CASCA	ESP. CLARA
Controle	142	47,48	10,61	28,98	12,85	30,89	4,71	4,88	36,66
Tenébrio	108	46,38	10,13	29,31	12,4	29,48	5,32	4,7	35,78
CV, %	20,23	11,23	12,29	13,27	12,39	11,29	13,49	10,47	10,25
P	<0,05	NS	NS	NS	NS	NS	<0,05	NS	NS

NS – Não Significativo

4. Discussion

Existem inúmeros insetos que vem sendo testados e utilizados na alimentação animal, na avicultura, o *Tenebrio molitor* tem ganhado evidência, principalmente devido ao desempenho promovido após o seu uso. Na avicultura de postura, poucos trabalhos foram desenvolvidos, no entanto, a maioria destes obtêm resultados positivos. Dentre os principais insetos avaliados temos a Farinha de *Tenébrio molitor, a Hermetia illucens (FBS)* Farinha de Black Soldier e também o próprio bicho da seda, que ao término da fase produtiva, pode ser utilizado como alternativa protéica.

Mwaniki, *et al*. (2018), incluindo 7,5% de farinha de Black Soldier nas rações de poedeiras concluíram que qualidade da casca aumentou significativamente com a inclusão das farinhas, justificado pela maior absorção de cálcio no intestino das galinhas, e ainda, resultados encontrados por Bovera et al. (2018) que, concluíram que, a inclusão do produto promoveu resultados positivos na massa de ovos e que é possível a substituição de até 25% de larvas de Hermetia illucens (FSB) na dietas de poedeiras.

Secci, *et al*. (2018) concluíram que galinhas produziram ovos com maior proporção de gema e com maior coloração, e com menor quantidade de colesterol do que o grupo alimentado com dieta à base de soja, fato este devido à melhor absorção de produtos de origem animal por parte das aves.

Avaliando o trato gastrointestinal, Cutrignelli, *et al*. (2018) observaram maior altura de vilosidades e maior atividade ileal das enzimas sacarase e maltase nas poedeiras alimentadas com o FSB. Diante as informações, a farinha de insetos em geral pode ser considerada uma boa fonte de proteína para alimentação de galinhas poedeiras, melhorando seu estado imunológico, além de contribuir para uma maior produção de ovos contribuído com a saúde da ave (Marono et al., 2017).

Por outro lado, Marono, *et al*. (2017) concluíram que o uso desta em substituição total acarreta prejuízos no consumo de ração e, consequentemente, prejudica o desempenho produtivo das galinhas.

Já utilizando outra fonte proteica, também oriunda de insetos, Brah, *et al*. (2017), avaliando a farinha de gafanhotos em substituição gradual ao farelo integral de peixes em dietas para poedeiras, relatam que dietas com 25% a 100% melhoraram unidade Haugh dos ovos e a cor da gema.

Em relação ao uso do Bicho da Seda como fonte proteica, Ullah, *et al*. (2017) observaram que não houve diferença significativa ($p>0,05$) entre os grupos que receberam os níveis de substituição de 0%, 25%, 50%, 75% e 100% do farelo de soja pelo farelo de bicho da seda. No entanto, de acordo com Sheikh et al. (2018), a farinha de pupa de bicho da seda pode substituir a farinha de

soja e a farinha de peixes em dietas para aves, pois não causa efeitos adversos sob sua produção, conforme descrito em seus resultados.

5. Conclusions

Diante do exposto, a farinha de *Tenebrio mollitor* pode ser utilizada na dieta de frangas em fase pré e inicial de postura, podendo ser utilizado como pigmentante natural, no entanto, pode reduzir a produção inicial de ovos nas aves.

Novos estudos devem ser desenvolvidos com o intuito de avaliar a inclusão do mesmo durante todo o ciclo de produção de ovos.

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NORMAS DA REVISTA ANIMAL FEED SCIENCE AND TECHNOLOGY

1.1.6 Introduction

Types of article

1. Original Research Papers (Regular Papers)
2. Review Articles
3. Short Communications
4. Book Reviews

Original Research Papers should report the results of original research. The material should not have been previously published elsewhere, except in a preliminary form.

Review Articles should cover subjects falling within the scope of the journal which are of active current interest.

A *Short Communication* is a concise but complete description of a limited investigation, which will not be included in a later paper. Short Communications should be as completely documented, both by reference to the literature and description of the experimental procedures employed, as a regular paper. They should not occupy more than six printed pages (about 12 manuscript pages, including figures, tables and references).

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Professor G. Flachowsky
Federal Research Centre of Agriculture
Institute of Animal Nutrition
Bundesallee 50
D-38116 Braunschweig
Germany

Manuscripts describing the use of commercial feed products are welcome, but should include the following information: major components, contents of active ingredients (for example enzyme activities). Independent verification, as opposed to a manufacturers guarantee, is always desirable and often avoids difficulties in the review process, especially where there are no, or few, treatment impacts. The Editors reserve the right to reject any manuscript employing such products, wherein this information is not disclosed.

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1.1.7 Before you begin

Ethics in publishing

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Reporting sex- and gender-based analyses

Reporting guidance

For research involving or pertaining to humans, animals or eukaryotic cells, investigators should integrate sex and gender-based analyses (SGBA) into their research design according to funder/sponsor requirements and best practices within a field. Authors should address the sex and/or gender dimensions of their research in their article. In cases where they cannot, they should discuss this as a limitation to their research's generalizability. Importantly, authors should explicitly state what definitions of sex and/or gender they are applying to enhance the precision, rigor and reproducibility of their research and to avoid ambiguity or conflation of terms and the constructs to which they refer (see Definitions section below). Authors can refer to the Sex and Gender Equity in Research (SAGER) guidelines and the SAGER guidelines checklist. These offer systematic approaches to the use and editorial review of sex and gender information in study design, data analysis, outcome reporting and research interpretation - however, please note there is no single, universally agreed-upon set of guidelines for defining sex and gender.

Definitions

Sex generally refers to a set of biological attributes that are associated with physical and physiological features (e.g., chromosomal genotype, hormonal levels, internal and external anatomy). A binary sex categorization (male/female) is usually designated at birth (""sex assigned at birth""), most often based solely on the visible external anatomy of a newborn. Gender generally refers to socially constructed roles, behaviors, and identities of women, men and gender-diverse people that occur in a historical and cultural context and may vary across societies and over time. Gender influences how people view themselves and each other, how they behave and interact and how power is distributed in society. Sex and gender are often incorrectly portrayed as binary (female/male or woman/man) and unchanging whereas these constructs actually exist along a spectrum and include additional sex categorizations and gender identities such as people who are intersex/have differences of sex development (DSD) or identify as non-binary. Moreover, the terms ""sex"" and ""gender"" can be ambiguous—thus it is important for authors to define the manner in which they are used. In addition to this definition guidance and the SAGER guidelines, the resources on this page offer further insight around sex and gender in research studies.

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1.1.8 Preparation

Queries

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Use past tense for current findings, and the present tense for "truths" and hypotheses.

Article Structure

Manuscripts should have **numbered lines**, with wide margins and **double spacing** throughout, i.e. also for abstracts, footnotes and references. **Every page of the manuscript, including the title page, references, tables, etc., should be numbered continuously.** However, in the text no reference should be made to page numbers; if necessary, one may refer to sections. Avoid excessive usage of italics to emphasize part of the text.

Introduction

State the objectives of the work and provide an adequate background, avoiding a detailed literature survey or a summary of the results.

Material and methods

Provide sufficient details to allow the work to be reproduced by an independent researcher. Methods that are already published should be summarized, and indicated by a reference. If quoting directly from a previously published method, use quotation marks and also cite the source. Any modifications to existing methods should also be described.

If reference is made to AOAC, ISO or similar analytical procedure(s), the specific procedure identification number(s) must be cited. A number of references for neutral and acid detergent fibre (NDF, ADF) assays exist, and an alternative reference to the now out-of-print USDA Agriculture Handbook 379 must be used. There are many options for NDF and ADF assays (e.g. sodium sulfite, alpha amylase, residual ash), which must be specified in the text. For more details see the editorial in Vol. 118/3-4.

The following definitions should be used, as appropriate:
a. aNDFom-NDF assayed with a heat stable amylase and expressed exclusive of residual ash.
b. NDFom-NDF not assayed with a heat stable amylase and expressed exclusive of residual ash.
c. aNDF-NDF assayed with a heat stable amylase and expressed inclusive of residual ash.
d. NDF-NDF assayed without a heat stable amylase and expressed inclusive of residual ash.
e. ADFom-ADF expressed exclusive of residual ash.
f. ADF-ADF expressed inclusive of residual ash.
g. Lignin (sa)-Lignin determined by solubilization of cellulose with sulphuric acid.
h. Lignin (pm)-Lignin determined by oxidation of lignin with permanganate.

While expressions of NDF and ADF inclusive of residual ash will continue to be acceptable (i.e., the terms aNDF, NDF and ADF above), the Editors-in-Chief highly recommend reporting all fibre values, including digestibilities, on an OM basis. Silica is partially soluble in ND, is quantitatively recovered in AD, and so may contribute to the 'fibre' values and to subsequent digestibility coefficients.

Reporting 'hemicellulose' values as the difference between NDF and ADF is generally only acceptable if the analyses have been sequential on the same sample. Crude fibre (CF), nitrogen-free extract (NFE) and total digestible nutrients (TDN) are not acceptable terms for describing feeds and should only be referred to in a historical context.

Results

Results should be clear and concise.

Discussion

This should explore the significance of the results of the work, not repeat them. Avoid extensive citations and discussion of published literature. Combined 'Results and Discussion' sections are only acceptable for 'Short Communications', except under compelling circumstances.

Conclusions

The main conclusions of the study may be presented in a short Conclusions section, which may stand alone or form a subsection of a Discussion or Results and Discussion section.

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The abstract should be clear, descriptive and not longer than 400 words. It should contain the following specific information: purpose of study; experimental treatments used; results obtained, preferably with quantitative data; significance of findings; conclusions; implications of results if appropriate.

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Although a graphical abstract is optional, its use is encouraged as it draws more attention to the online article. The graphical abstract should summarize the contents of the article in a concise, pictorial form designed to capture the attention of a wide readership. Graphical abstracts should be submitted as a separate file in the online submission system. Image size: Please provide an image with a minimum of 531 × 1328 pixels (h × w) or proportionally more. The image should be readable at a size of 5 × 13 cm using a regular screen resolution of 96 dpi. Preferred file types: TIFF, EPS, PDF or MS Office files. You can view Example Graphical Abstracts on our information site.

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Immediately after the abstract, provide a maximum of 6 keywords, using American spelling and avoiding general and plural terms and multiple concepts (avoid, for example, 'and', 'of'). Be sparing with abbreviations: only abbreviations firmly established in the field may be eligible. These keywords will be used for indexing purposes.

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Define abbreviations that are not standard in this field in a footnote to be placed on the first page of the article. Such abbreviations that are unavoidable in the abstract must be defined at their first mention there, as well as in the footnote. Ensure consistency of abbreviations throughout the article.

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Collate acknowledgements in a separate section at the end of the article before the references and do not, therefore, include them on the title page, as a footnote to the title or otherwise. List here those individuals who provided help during the research (e.g., providing language help, writing assistance or proof reading the article, etc.).

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List funding sources in this standard way to facilitate compliance to funder's requirements:

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ambiguous for certain acids. If analytical standards have been used, they should be specified by name (e.g. yeast RNA) and form (e.g. lactose monohydrate). Percents should only be used when describing a relative increase or decrease in a response. Proportions should be maximum 1.0 or ≤1.0. For more details see the editorial in Vol. 118/3-4.

Percent is *only* used to indicate relative changes. For composition, both w/w (often solids composition g/kg) and w/v (e.g. g/L), v/v (e.g. m/L), mol/mol or M can be accepted depending on the circumstances. Specify units (e.g. g/L) and never as percent.

Digestibility/metabolisability and degradability should always be expressed as a coefficient (not %), and the content of, for example, the digestible component should be expressed as g/kg: thus, the coefficient of digestibility of dry matter is 0.8, while the content of digestible dry matter is 800g/kg. A distinction between true and apparent digestibility should be made, as well as between faecal and ileal (e.g. coefficient of total tract apparent digestibility - CTTAD). The terms 'availability' and 'bioavailability' should be avoided without definition in context.

In chemical formulae, valence of ions should be given as, e.g. Ca^{2+}, not as Ca^{++}. Isotope numbers should precede the symbols e.g. ^{18}O. The repeated use of chemical formulae in the text is to be avoided where reasonably possible; instead, the name of the compound should be given in full. Exceptions may be made in the case of a very long name occurring very frequently or in the case of a compound being described as the end product of a gravimetric determination (e.g. phosphate as P_2O_5).

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Please submit math equations as editable text and not as images. Present simple formulae in line with normal text where possible and use the solidus (/) instead of a horizontal line for small fractional terms, e.g., X/Y. In principle, variables are to be presented in italics. Powers of e are often more conveniently denoted by exp. Number consecutively any equations that have to be displayed separately from the text (if referred to explicitly in the text).

If differences between treatments are statistically significant, this should be indicated by adding the actual 'P' value obtained. If $0.10 > P > 0.05$, then differences can be considered to suggest a trend, or tendency, to a difference, but the actual 'P' value should be stated. Further information on this issue can be found in *Animal Feed Science and Technology* Vol. 129/1-2.

Spaces should be used between all values and units, except for the following: Between the value and degrees or percent. In equations around * and /. In probability expressions ($P<0.05$). When probability values are given, the 'P' should be a capital letter.

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General points

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