UNIVERSIDADE FEDERAL DO RIO GRANDE DO SUL
FACULDADE DE AGRONOMIA
PROGRAMA DE PÓS-GRADUAÇÃO EM ZOOTECNIA

SUPLEMENTAÇÃO DE UM COMPLEXO ENZIMÁTICO DE CARBOIDRASES EM DIETAS MILHO-SOJA PARA FRANGOS DE CORTE

HEITOR VIEIRA RIOS
Médico Veterinário/UFRGS

Dissertação apresentada como um dos requisitos à obtenção do Grau de Mestre em Zootecnia

Área de Concentração Produção Animal

Porto Alegre (RS), Brasil
Fevereiro, 2017.

CIP - Catalogação na Publicação

Rios, Heitor Vieira
Suplementação de um complexo enzimático de carboidrases em dietas milho-soja para frangos de corte / Heitor Vieira Rios. -- 2017.
127 f.

Orientador: Sergio Luiz Vieira.

Dissertação (Mestrado) -- Universidade Federal do Rio Grande do Sul, Faculdade de Agronomia, Programa de Pós-Graduação em Zootecnia, Porto Alegre, BR-RS, 2017.

1. carboidrases. 2. frangos de corte. 3. digestibilidade. 4. energia. 5. aminoácidos. I. Vieira, Sergio Luiz, orient. II. Título.

Elaborada pelo Sistema de Geração Automática de Ficha Catalográfica da UFRGS com os dados fornecidos pelo(a) autor(a).

HEITOR VIEIRA RIOS
Médico veterinário

DISSERTAÇÃO

Submetida como parte dos requisitos
para obtenção do Grau de

MESTRE EM ZOOTECNIA

Programa de Pós-Graduação em Zootecnia
Faculdade de Agronomia
Universidade Federal do Rio Grande do Sul
Porto Alegre (RS), Brasil

Aprovada em: 10.02.2017
Pela Banca Examinadora

SÉRGIO LUIZ VIEIRA
PPG Zootecnia/UFRGS
Orientador

LÍRIS KINDLEIN
PPG Zootecnia/UFRGS

CATARINA STEFANELLO
UFSM

ALEX MAIORKA
UFPR

Homologado em: 29.03.2017
Por

PAULO CÉSAR DE FACCIO CARVALHO
Coordenador do Programa de
Pós-Graduação em Zootecnia

CARLOS ALBERTO BISSANI
Diretor da Faculdade de Agronomia

“Quando o discípulo está pronto,
o mestre aparece”

(André Luiz)

AGRADECIMENTOS

Agradeço aos meus pais, Jayme e Luiza por sempre me incentivarem e me apoiarem em minha decisões, me fornecendo todo tipo de suporte para concretizar meus projetos e sonhos, dentre eles, o mestrado.

Aos meus irmãos, João André e Gustavo por me ajudarem a progredir nos caminhos escolhidos, seja por meio de conselhos ou por meio de força, me encorajando a evoluir.

Aos meus avós, por me proporcionarem vivências e condições de estudo que me permitiram chegar até aqui.

A minha namorada, Patrícia, pelo apoio, incentivo e companheirismo, além da grande ajuda que me deu durante todos os experimentos que fui responsável por conduzir no Aviário de Ensino e Pesquisa.

Ao professor Sergio Luiz Vieira por todas as oportunidades que me possibilitou, pela orientação, pela confiança e pelos ensinamentos.

Aos colegas do Aviário de Ensino e Pesquisa durante os 6 anos que estive no setor, entre estágio e mestrado, por toda a dedicação e comprometimento com as atividades, além da grande amizade que construímos nesse período. Em especial à Catarina Stefanello, pela grande ajuda que me deu durante todo esse período, sem ela a caminhada com certeza teria sido muito mais difícil.

Aos professores e funcionários do Programa de Pós-Graduação em Zootecnia - UFRGS. Ao CNPq pela bolsa de Mestrado e a Adisseo, pelo apoio financeiro na realização desse trabalho.

Ao senhor Jairo Padilha, pela ajuda nas batidas de ração e demais atividades dos experimentos conduzidos.

Enfim, agradeço a todos brasileiros por contribuírem com um pouco do seu tempo e trabalho para me proporcionar um ensino de qualidade. Espero poder dar o merecido retorno.

Muito obrigado!

SUPLEMENTAÇÃO DE UM COMPLEXO ENZIMÁTICO DE CARBOIDRASES EM DIETAS MILHO-SOJA PARA FRANGOS DE CORTE[1]

Autor: Heitor Vieira Rios
Orientador: Sergio Luiz Vieira

Resumo – Objetivou-se avaliar o efeito da suplementação de um complexo enzimático, composto principalmente por endo 1,4 xilanase e endo 1,3(4) β-glucanases (CE), sobre o desempenho produtivo, a digestibilidade de aminoácidos (AA) e a utilização da energia em frangos de corte. Foram alojados 2.016 frangos de corte machos Cobb x Cobb 500 de um dia de idade em 72 boxes experimentais. As aves foram distribuídas em delineamento inteiramente casualizado com 9 tratamentos, 8 repetições e 28 aves por unidade experimental. Os tratamentos consistiram de uma dieta controle, formulada com níveis usuais de energia metabolizável aparente (EMA) e aminoácidos digestíveis (AA dig.) sem a inclusão do CE; e 8 dietas com reduções de EMA (-80 e -120 kcal/kg) e de AA dig. (-3% e 6%), suplementadas ou não com 50 mg/kg do CE. Foi utilizado um programa alimentar de 3 fases: inicial (1 a 21 d), crescimento (22 a 35 d) e final (36 a 42 d). Todas as dietas foram formuladas a base de milho e farelo de soja e com 1% de Celite, utilizado como indicador indigestível. Ganho de peso, consumo de ração e conversão alimentar corrigida para mortalidade (CA) foram avaliados aos 21, 35 e 42 d. Nos dias 21 e 42, 4 aves por unidade experimental foram sacrificadas para coleta de conteúdo ileal e posterior determinação da energia digestivel ileal (EDI) e da digestibilidade de AA. Os dados foram submetidos à análise de variância e, quando significativas, as médias foram comparadas pelo teste de Student-Newman-Keuls a 5% de significância. Contrastes ortogonais foram realizados entre os tratamentos com reduções nutricionais com e sem adição do CE. Frangos alimentados com dietas com reduções de energia e de AA dig. sem a adição do CE apresentaram maior CA e menor EDI quando comparados aos frangos que receberam a suplementação do CE. A suplementação do CE nas dietas aumentou a digestibilidade total de AA aos 21 d, porém não houve efeito aos 42 dias. A maior liberação de energia proporcionada pelo CE foi observada aos 21 d em frangos de corte alimentados com dietas com -120 kcal/kg AME e -6% AA dig., sendo 5,8% maior quando comparados aos alimentados com a dieta análoga sem enzima. Conclui-se que a adição do CE melhorou o desempenho produtivo e resultou em aumento da digestibilidade de AA e do aproveitamento da energia em frangos de corte aos 21 e aos 42 d.

Palavras chave: carboidrases, frangos de corte, digestibilidade, energia, aminoácidos.

[1]Dissertação de Mestrado em Zootecnia – Produção Animal, Faculdade de Agronomia, Universidade Federal do Rio Grande do Sul, Porto Alegre, RS, Brasil (127 p.), Fevereiro, 2017.

SUPPLEMENTATION OF A CARBOHYDRASES ENZYMATIC COMPLEX IN CORN-SOY BASED DIETS FOR BROILER CHICKENS[1]

Author: Heitor Vieira Rios
Advisor: Sergio Luiz Vieira

Abstract - The objective of this study was to evaluate the effect of supplementation of an enzyme complex, composed of endo 1,4 xylanase and endo 1,3 (4) β-glucanases (EC), on the productive performance, amino acid digestibility (AA) and the use of energy in broilers. A total of 2,016 one-day-old Cobb x Cobb 500 male broilers were allocated in 72 floor pens. Chicks were distributed into 9 treatments with 8 replicates of 28 birds each in a completely randomized design. Treatments consisted of a control diet formulated with usual apparent metabolizable energy (AME) and nutrient levels without enzyme supplementation as well as 8 diets having reductions in formulated AME (-80 and -120 kcal/kg) and digestible amino acids (dig. AA; -3 and -6%) supplemented or not with 50 mg/kg of the supplemental enzyme complex. A 3 phases feeding program was used: Starter (1 to 21 d), Grower (22 to 35 d) and Finisher (36 to 42 d). All diets were corn-soybean meal based with 1% of Celite, used as marker. Body weight gain, feed intake and feed conversion corrected for the weight of dead birds (FCR) were evaluated at 21, 35 and 42 d. On days 21 and 42, four birds per experimental unit were sacrificed for ileal content collection and subsequent determination of ileal digestible energy (IDE) and AA digestibility. Data were submitted to analysis of variance and, when significant, the means were compared by the Student-Newman-Keuls test at 5% significance. Orthogonal contrasts were performed between treatments with nutritional reductions with and without EC addition. Diets with AME and dig. AA reductions without enzyme had higher FCR and lower IDE ($P < 0.05$). The supplemental enzyme increased total AA digestibility at 21 d; however, no effects were observed at 42 d. The highest energy improvement provided by the supplemental enzyme was observed at 21 d on broilers fed diets with -120 kcal/kg AME and -6% dig. AA, being 5.8% higher when compared to those fed the analogous diet without enzyme. Summarizing, the addition of EC led to improvements on growth performance, digestibility of AA and energy utilization on broilers at 21 and 42 d.

Key words: carbohydrase, broilers, digestibility, energy, amino acids.

[1]Master of Science dissertation in Animal Science – Faculdade de Agronomia, Universidade Federal do Rio Grande do Sul, Porto Alegre, RS, Brazil. (127 p.), Febreuary, 2017.

SUMÁRIO

RELAÇÃO DE TABELAS

RELAÇÃO DE APÊNDICES

RELAÇÃO DE ABREVIATURAS

AA	Aminoácido
AA dig.	Aminoácidos digestíveis
CA	Conversão alimentar
CE	Complexo enzimático
CR	Consumo de ração
DIMS	Digestibilidade ileal da matéria seca
EDI	Energia digestível ileal
EMA	Energia metabolizável aparente
PNA	Polissacarídeos não amídicos

CAPÍTULO I

INTRODUÇÃO

No Brasil, a maior parte das dietas para frangos de corte é constituída por milho e farelo de soja, sendo o milho o cereal responsável por aproximadamente 65% da energia (COWIESON, 2005), enquanto o farelo de soja fornece em torno de 80% da proteína bruta das rações (BAKER, 1996). Embora esses ingredientes apresentem alta digestibilidade para frangos de corte quando comparados com aveia, cevada e trigo, os quais são ingredientes comumente utilizados em dietas europeias, eles possuem alguns fatores antinutricionais em sua composição, como os polissacarídeos não amídicos (PNA) os quais dificultam a sua digestão por não ruminantes, visto que esses animais não possuem secreção endógena capazes de degradar estes componentes (BEDFORD, 1995; CHOCT, 1997; BACH KNUDSEN, 2014).

Os PNA são carboidratos estruturais que formam a parede celular dos vegetais e constituem a maior parte da fibra das dietas. Fazem parte dessa classe de polissacarídeos: hemiceluloses, celuloses e pectinas, os quais não podem ser completamente digeridos por não ruminantes, devido à natureza das suas ligações. São constuintes da parede celular dos ingredientes vegetais utilizados na formulação das dietas para frangos de corte, e por isso, nutrientes, amido, gordura e proteína ficam encapsulados dentro da matriz celular, o que impede que sejam digeridos e absorvidos pelas aves; efeito conhecido como *cage effect* (SIMON, 1998). Adicionalmente, alguns PNA são capazes de aumentar a viscosidade da digesta devido a sua propriedade hidrofílica, o que modifica a taxa de passagem do quimo, prejudica o acesso de enzimas endógenas aos seus respectivos substratos e dificulta o processo de digestão de ingredientes e de absorção de diversos nutrientes (BEDFORD, 1995; CHOCT, 1997; SLOMINSKI, 2011).

Enzimas exógenas, como as carboidrases, são capazes de hidrolisar frações de PNA presentes nas dietas, permitir a liberação de nutrientes encapsulados dentro da matriz celular e facilitar o acesso de enzimas endógenas ao seu substrato, mitigando os efeitos antinutricionais desses compostos. (BEDFORD, 2000). As carboidrases exógenas têm o potencial de otimizar a digestibilidade dos alimentos vegetais e, com isso, aumentar a absorção dos nutrientes e o aproveitamento da energia presentes nas dietas, podendo melhorar o desempenho produtivo das aves (OLUKOSI et al., 2008). Elas podem atuar na digestão de frações de ingredientes que não podem ser degradados por secreção endógena e/ou intensificar a atuação de enzimas endógenas.

A complexidade dos carboidratos de origem alimentar presentes no trato digestivo das aves, como as diferentes frações de PNA, criam a oportunidade de utilização de complexos enzimáticos capazes de atuarem nos diferentes constituintes da fibra alimentar (MENG & SLOMINSKI, 2005). Complexos de carboidrases, contendo xilanases e glucanases, podem degradar os xilanos e β-glucanos presentes na composição dos vegetais. Essas carboidrases possuem efeitos diretos, ao degradar os respectivos polissacarídeos e aumentar a energia digestível das dietas, e efeitos indiretos, pois podem liberar nutrientes aprisionados na matriz dos vegetais, diminuir a viscosidade da digesta, facilitando o acesso de nutrientes ao enterócito e auxiliar na atuação de enzimas endógenas (ADEOLA & COWIESON, 2011).

A utilização das enzimas exógenas visa melhorar o aproveitamento dos nutrientes presentes na dieta e o desempenho produtivo dos animais. O efeito de carboidrases exógenas sobre a utilização de AA pode ocorrer devido a dois fatores principais: por meio da liberação de AA encapsulados na matriz celular dos vegetais e consequente aumento da absorção de AA (RUTHERFURD et al., 2007), e por meio da diminuição das perdas endógenas, visto que a adição de enzimas exógenas diminui a secreção de enzimas endógenas e, dessa forma, há um aumento do aproveitamento dos AA (COWIESON & RAVINDRAN, 2008a).

Para que se possa atender os objetivos da produção, é necessário o entendimento das potencialidades e limitações do uso das enzimas exógenas. Sabe-se que animais alimentados com dietas formuladas com níveis marginais de nutrientes são mais sensíveis aos potenciais benefícios das enzimas exógenas, se comparados aos animais alimentados com dietas que atendam ou excedam as suas exigências. Fato que pode ser explicado devido à essas dietas possuírem maior oportunidades para incrementos no desempenho e na digestibilidade em frangos de corte. A idade das aves é outro fator a ser observado quando se utilizam enzimas exógenas nas formulações. Animais jovens estão menos adaptados aos substratos hidrofílicos presentes nos alimentos, e por isso, a suplementação enzimática pode apresentar melhores resultados na fase inicial de vida das aves (RAVINDRAN, 2013).

Informações sobre um aditivo capaz de aumentar a absorção de nutrientes, a utilização da energia e o desempenho produtivo de frangos de corte, se tornam interessantes e promissoras para a avicultura. Muitas pesquisas acerca da utilização de carboidrases em dietas para frangos de corte contendo ingredientes viscosos tais como: o trigo, aveia e a cevada, estão disponíveis na literatura (KOCHER et al 2003; RUTHERFURD et al., 2007; LEE et al., 2010; AVILA et al., 2012). Entretanto, os efeitos da suplementação de complexos enzimáticos em dietas formuladas com ingredientes considerados de alta digestibilidade, como o milho e o farelo de soja ou dietas contendo níveis marginais de energia e AA, ainda carecem de informações. Sendo assim, objetivou-se com esse estudo, fornecer dados relevantes para maior entendimento sobre a utilização de um complexo enzimático, composto por carboidrases, em dietas milho-soja para frangos de corte.

REVISÃO BIBLIOGRÁFICA

Milho e farelo de soja em rações para frangos de corte

O milho e o farelo de soja são os principais ingredientes utilizados nas rações para frangos de corte no Brasil. O milho é a principal fonte de energia das rações para frangos de corte em todo o mundo (GEHRING et al., 2013), enquanto o farelo de soja é a principal fonte de proteína das dietas (BAKER, 1996). O principal carboidrato de reserva do milho é o amido, representando aproximadamente 60% do cereal, o qual é o maior contribuinte da energia das rações. Embora esse cereal possua baixos teores de proteína bruta (aproximadamente 8%) em comparação ao trigo e a cevada (cerca de 11%), ele é responsável por fornecer em torno de 20% do total da proteína presente nas rações para frangos de corte (COWIESON, 2005). No entanto, de acordo com Peter et al. (2000) o balanço de AA da proteína do milho é considerado pobre para aves, possuindo baixos teores de AA essenciais, como de lisina e de triptofano.

A soja *in natura* possui diversos fatores antinutricionais, como os inibidores de tripsina, e por isso necessita de um tratamento térmico adequado para que o seu farelo possa ser utilizado na ração animal. O fator crítico da qualidade do farelo ocorre devido a temperatura de processamento da soja, visto que temperaturas baixas não são capazes de eliminar a ação dos inibidores de proteases, e temperaturas excessivas provocam a reação de *Maillard*, a qual reduz o valor nutricional do alimento (GONZÁLEZ-VEGA et al., 2014). O farelo de soja possui altas concentrações de proteína bruta em sua composição, com um excelente perfil de AA que, após o processamento adequado, são altamente digestíveis para não ruminantes.

Apesar do alto valor nutritivo do milho e do farelo de soja para aves, muitos nutrientes presentes nesses vegetais não podem ser aproveitados por não ruminantes devido à presença de fatores antinutricionais, como os PNA. Segundo Bach Knudsen (2014) podem ser encontrados cerca de 9% desses compostos no milho e 21% no farelo de soja.

Polissacarídeos não amídicos

Os polissacarídeos não amídicos são carboidratos estruturais da parede vegetal dos grãos. Fazem parte dessa classe de polissacarídeos a hemicelulose, a celulose e as pectinas, as quais não podem ser completamente digeridas por não ruminantes devido a natureza das suas ligações. Consequentemente, nutrientes, tais como: amido, gordura e proteína, podem ficar encapsulados dentro da matriz celular, o que impede que sejam digeridos e absorvidos pelas aves, efeito conhecido como *cage effect* (SIMON, 1998).

Devido a sua natureza hidrofílica, os PNA podem aumentar a viscosidade da digesta e alterar a taxa de passagem do quimo no trato gastrintestinal, interferindo no processo de digestão e absorção nutrientes, por impedir o acesso de enzimas aos seus respectivos substratos e por dificultar que os produtos da digestão cheguem aos enterócitos (BEDFORD, 1995; CHOCT, 1997). Por intreferirem no aproveitamento de nutrientes das dietas, esses fatores antinutricionais podem prejudicar o desempenho produtivo das aves, causando perdas à produção (OLUKOSI et al., 2008).

Os PNAs podem ser encontrados em quantidades variáveis nos vegetais, podendo representar um importante fator antinutricional. A quantidade e a composição de PNA presentes nos grãos pode variar devido a fatores genéticos como o cultivar utilizado, e a fatores ambientais tais como: as condições climáticas do local onde o grão foi cultivado e o grau de seu processamento (CHOCT, 1997; BACH KNUDSEN, 2014).

Cereais viscosos, como aveia e cevada, possuem quantidade de fibra maior que o milho e que o farelo de soja, no entanto, os últimos possuem quantia suficiente para causar prejuízos ao processo de digestão e absorção das aves (SLOMINSKI, 2011). Segundo Bach Knudsen (2014) o milho possui 9% de PNA em sua composição, sendo cerca de 4% arabinoxilanos, os quais são compostos por arabinoses e xiloses. De acordo com o mesmo autor o conteúdo de PNA presente no farelo de soja seria de 21%, e o conteúdo de arabinoxilanos cerca de 4%. Em contrapartida, Malathi & Devegowda (2001) reportaram valores de 9,3% de PNA totais no milho, sendo 5,3% arabinoxilanos. Segundo os mesmos autores a quantidade de PNA totais no farelo de soja seria de 29%, sendo o conteúdo celulose, pectina e arabinoxilanos 5,2%, 6,2% e 4,2%, respectivamente.

Fatores antinutricionais, como os PNA, presentes no milho e no farelo de soja podem ser reduzidos com a utilização de enzimas exógenas capazes de hidrolisarem esses compostos em açúcares simples, eliminando os efeitos deletérios da fibra alimentar e promovendo melhorias no processo digestivo e absortivo das aves. As carboidrases incluídas na alimentação tem demonstrado melhorar o desempenho produtivo e aumentar a digestibilidade dessas dietas por frangos de corte (ADEOLA & COWIESON, 2011).

Carboidrases exógenas

As carboidrases são enzimas capazes de degradar os carboidratos presentes no trato gastrintestinal. Por serem específicas ao substrato que atuam, elas existem em ampla variedade na natureza, como exemplo: amilases, pectinases, β-glucanases, xilanases, celulases, as quais atuam sobre: amido, pectinas, β-glucanos, xilanos, celulose, respectivamente.

As carboidrases exógenas utilizados como aditivos na alimentação animal são produzidas geralmente por fungos e bactérias, os quais viabilizam a obtenção desse produto de forma eficiente e produtiva. Avanços na área de biotecnologia proporcionam a produção de enzimas exógenas em escala e cada vez mais eficientes, tornando viável as suas utilizações na avicultura industrial.

A suplementação de carboidrases exógenas nas dietas para frangos de corte se justifica por dois motivos principais: potencializar a ação de enzimas endógenas e fornecer enzimas que o animal não produz de forma endógena. Para Bedford (1995), os efeitos positivos observados sobre o desempenho produtivo e a digestibilidade de nutrientes ocorrem devido à diminuição da viscosidade da digesta promovidas pela atuação das carboidrases sobre PNA, o que resultaria em uma maior eficiência digestiva e absortiva pela ave.

De acordo com Bedford (2000) as razões principais para utilização dessa ferramenta seriam: aumentar o valor nutricional dos ingredientes, diminuindo inclusão de matérias primas de maior valor como o óleo e, portanto, reduzindo o custo das rações e diminuir os efeitos que a variação da composição nutricional dos ingredientes pode causar no desempenho zootécnico de frangos de corte. O efeito da suplementação enzimática é maior em alimentos de baixa digestibilidade, pois neles há uma maior oportunidade de melhora na sua digestibilidade se utilizada a estratégia de suplementação enzimática apropriada. Neste contexto, as carboidrases compreendem uma gama de enzimas que podem ser suplementadas às rações com o objetivo de melhorar o aproveitamento da energia e a digestibilidade de nutrientes.

Carboidrases que atuam sobre os PNA, como xilanases e glucanases, podem melhorar o desempenho de frangos de corte, por serem capazes atuar na fibra presente nos ingredientes vegetais, as quais não são hidrolisadas de forma eficiente pelas aves, e por auxiliar no processo de digestão e de absorção de nutrientes, incrementando o uso da energia dos animais (CHOCT, 2006; OLUKOSI et al., 2008). Entretanto, é necessário o conhecimento sobre as limitações e potencialidades das enzimas, objetivando empregar a melhor estratégia possível para que os objetivos de produção pretendidos sejam atingidos de forma satisfatória (COWIESON, 2010).

Fatores relevantes quando na utilização carboidrases exógenas

O conhecimento do mecanismo de ação das carboidrases é necessário para que a enzima possa promover melhorias ao desempenho animal. Nesse sentido, a compreensão de aspectos relacionados a enzimologia tornam-se de suma importância para aplicar a melhor estratégia, visando atingir o máximo potencial da ferramenta e possibilitar que os objetivos de produção sejam atendidos.

As enzimas são moléculas protéicas que catalisam reações de alta especificidade, atuando em substratos específicos. Elas são ativadas quando se encontram em condições de umidade, temperatura e pH favoráveis e necessitam manter a sua configuração intacta para poderem catalisar reações químicas, (LEHNINGER, 2000). Visto que enzimas são proteínas capazes de aumentar a velocidade das reações químicas, gerando um determinado produto a partir de um substrato específico, é primordial que o último esteja presente na dieta em quantidades que possibilitem a atividade enzimática.

Sabe-se que as respostas à suplementação enzimática são mais evidentes quando utilizados alimentos de baixo valor nutricional (BEDFORD, 2000). Pesquisas sobre a utilização de carboidrases em dietas para frangos de corte alimentados com ingredientes pouco digestíveis (quando comparados ao milho e ao farelo de soja), tais como: trigo, aveia, cevada, canola e resíduos secos de destilaria contendo solúveis estão disponíveis na literatura, demonstrando a eficiência dessas enzimas sobre os substratos presentes nesses ingredientes (KOCHER et al 2003; RUTHERFURD et al., 2007; LEE et al., 2010; AVILA et al., 2012; BAREKETAIN et al., 2013; KACZMAREK et al., 2014). Não obstante, trabalhos avaliando o efeito de carboidrases suplementadas em dietas milho-soja ainda são escassos e muitas vezes apresentam respostas variáveis. Como exemplo, o estudo de Yegani & Korver (2013), avaliando o efeito de diferentes carboidrases em dietas milho-soja, utilizando milhos de diferentes origens, sobre a energia digestível ileal (EDI), digestibilidade ileal da proteína bruta e de AA nas diferentes fases de vida de frangos de corte, observaram resultados inconsistentes e variáveis dependendo da origem do milho, do produto enzimático utilizado e da idade das aves. Segundo os autores, os resultados inconsistentes encontrados podem ter ocorrido devido a diversos fatores, tais como: tipo, quantidade e mecanismo de ação das enzimas usadas; estratégia de utilização dos produtos; e qualidade nutricional e forma física das rações.

Após serem suplementadas nas rações, a eficiência das carboidrases depende de diversos fatores para promoverem os efeitos desejados, logo, os resultados sobre o desempenho e o aproveitamento de energia e de nutrientes possuem uma grande variabilidade, pois dependem das características e do mecanismo de atuação das enzimas, da composição dos ingredientes e dos fatores fisiológicos e digestivos das aves (RAVINDRAN, 2013). O mesmo autor suporta que o pouco tempo disponível para as enzimas atuarem sobre o seu substrato é um fator limitante da eficiência das enzimas exógenas, uma vez que a taxa de passagem da digesta é relativamente rápida em aves e que grande parte das enzimas são desnaturadas pelo baixo pH do proventrículo ou degradadas por proteases endógenas, como a pepsina e a tripsina.

Dietas formuladas com níveis nutricionais marginais para frangos de corte apresentam maior oportunidade de aumento na digestibilidade de nutrientes quando adicionado enzimas exógenas quando comparadas a dietas que tenham níveis nutricionais adequados às exigências das aves (RAVINDRAN, 2013). É provável que a redução dos níveis de EMA e AA dig. aumentem os substratos para atuação das carboidrases, pois a diminuição desses níveis implicam em menor quantidade de óleo nas dietas, e consequentemente maior espaço para a inclusão de grãos, os quais possuem em sua composição quantidades significativas de PNA. Em um estudo avaliando o efeito da suplementação de um complexo enzimático composto por protease, xilanase e amilase em uma dieta formulada com níveis nutricionais usuais e em outra formulada com -150 kcal/kg de EMA e -3% AA dig, Cowieson & Ravindran (2008b) observaram maiores incrementos em EMA, EDI e digestibilidade de AA devido a adição do produto enzimático na dieta com menor nível nutricional quando comparado a dieta controle. Em estudo similar, West et al (2007) não observaram melhora significativa no desempenho produtivo de frangos de corte com a adição de um complexo enzimático contendo xilanases e glucanases, mesmo quando os frangos foram alimentados com dietas com reduções de 66 kcal/kg de EMA e de 2,5% de AA essenciais, possivelmente porque os níveis utilizados na formulação da dieta para ser marginal em EMA e AA foi suficiente para atender a exigência das aves.

De acordo com Olukosi et al. (2007), a idade das aves é um fator relevante para ser observado. Para os autores, é provável que frangos de corte respondam melhor aos potenciais efeitos das enzimas exógenas quando jovens, devido a baixa secreção de enzimas endógenas causada pela imaturidade de seu sistema digestivo, o qual está ainda adaptado a substratos lipídicos e não ainda aos hidrofílicos presentes nas dietas. Leslie et al. (2007), adicionando uma glucanase em dietas para frangos de corte verificaram uma melhora de 3,5% na energia digestível ileal em aves aos 9 dias de vida, enquanto um aumento de 2,4% foi reportado para frangos aos 23 dias.

Segundo Acamovic & McCleary (1996) aspectos envolvendo: as condições fisiológicas do animal, como a sua temperatura corporal, o tamanho do trato gastrointestinal das aves, a atuação de enzimas endógenas sobre as exógenas, a concentração da enzima exógena em relação a quantidade de substrato, e as características dos alimentos presentes na dieta, seriam fatores relevantes a serem considerados quando no uso dessa ferramenta. Em parte, esses aspectos podem explicar porque muitos estudos avaliando a eficiência da suplementação de carboidrases em dietas para frangos de corte não indicaram efeitos significativos sobre o parâmetros produtivos e/ou de digestibilidade.

Strada et al. (2005) não observaram efeitos significativos no desempenho produtivo de frangos de corte que receberam um complexo enzimático, composto por protease, amilase e xilanase, em dietas formuladas com sorgo, milheto e farelo de soja ou em dietas milho-soja. Em corroboração, Olukosi et al. (2007) também não encontraram efeitos da adição de um produto contendo xilanase, amilase e protease sobre o desempenho zootécnico de frangos de corte, entretanto, os autores observaram que a digestibilidade de P foi maior para tratamentos com a inclusão das enzimas.

Stefanello et al. (2016), verificaram que a adição de níveis crescentes de uma xilanase (0, 50, 100, 150 e 200 FXU/kg) em dietas milho-soja melhorou a digestibilidade de nutrientes e o uso de energia em frangos de corte, contudo os melhores resultados só foram obtidos quando 200 FXU/kg foi incluído às rações, verificando-se a melhora de 6,1% na EDI e na energia metabolizável aparente (EMA) das aves, em relação ao controle negativo. Gracia (2013) verificou maior digestibilidade de nutrientes e melhora de 2,3% na EMA em frangos de corte quando adicionada uma amilase mono componente em rações milho-soja.

Os ingredientes vegetais utilizados na formulação das rações para frangos de corte possuem uma grande variedade de PNA em sua composição, o que torna viável a inclusão de diferentes carboidrases às dietas (BACH KNUDSEN, 2014). Segundo Cowieson (2010), é improvável que haja um efeito aditivo das enzimas quando incluídas em conjunto às rações, pois as frações indigestíveis do alimento diminuem à medida que uma nova enzima é adicionada, o que reduz as possibilidades de atuação de outra enzima. Não obstante, os mesmos autores afirmam que um efeito subaditivo com a suplementação de enzimas exógenas pode ser observado.

Em um estudo utilizando diferentes carboidrases em rações milho-soja para frangos de corte, Tahir et al. (2006) não encontrou melhora significativa na digestibilidade de proteína bruta e no uso da energia quando adicionadas pectinase, celulase ou hemicelulase nas rações de frangos de corte de forma isolada, contudo foi observado melhora nas variáveis supracitadas quando as enzimas foram adicionadas em conjunto nas dietas. Em corroboração a esses resultados, Meng & Slominski (2005) suportam que a complexidade dos carboidratos de origem alimentar presentes no trato digestivo das aves, como as diferentes frações de PNA, criam a oportunidade de utilização de variadas carboidrases e de complexos enzimáticos capazes de atuarem nos diferentes constituintes da fibra alimentar.

Uso de complexos enzimáticos, contendo carboidrases, em dietas para frangos de corte

A utilização de complexos enzimáticos pode ser uma estratégia eficaz para atender os objetivos de produção, visto que as enzimas são altamente específicas para o substrato em que atuam e que uma grande variedade de PNA é encontrada formando a parede celular dos vegetais. Nesse sentido, é possível encontrar complexos enzimáticos compostos por diferentes enzimas e apresentando variadas respostas.

Em um estudo avaliando a inclusão de um complexo enzimático contendo amilase, xilanase e protease, Zanella (1999) observou que a suplementação enzimática melhorou o desempenho zootécnico de frangos de corte e diminuiu a síntese de enzimas endógenas, o que pode ter possibilitado, segundo o autor, uma maior eficiência energética no processo de digestão, permitindo que mais energia fosse destinada ao crescimento das aves. Cowieson & Adeola (2005), em um estudo em frangos de corte recebendo um produto enzimático contendo xilanase, amilase e protease na dieta, observaram aumento do valor nutritivo de dietas à base de milho e farelo de soja, sugerindo que o efeito possa ter ocorrido devido a atuação dessas enzimas sobre a parede celular dos grãos.

Em estudo avaliando os efeitos de um complexo de carboidrases composto por xilanase, pectinase, glucanase, celulase, mananase e galactanase em rações milho-soja, Meng & Slominski (2005) observaram um aumento de 2,3% na energia metabolizável em frangos de corte. Dados encontrados por Cowieson & Ravindran (2008b) demonstraram que a utilização de um complexo enzimático composto por xilanase, amilase e protease, foi capaz de aumentar a energia metabolizável das dietas em 2,8%, além de melhorar a digestibilidade de AA, em frangos de corte alimentados com dietas milho-soja.

A utlização de enzimas exógenas permite a melhora na utilização dos AA pelas aves. O efeito de carboidrases exógenas sobre a utilização de AA pode ocorrer devido a dois fatores principais: por meio da liberação de AA encapsulados na matriz celular dos vegetais e consequente aumento da absorção de AA (RUTHERFURD et al., 2007); e por meio da diminuição das perdas endógenas, visto que a adição de enzimas exógenas diminui a secreção de enzimas endógenas e, dessa forma, há um aumento do aproveitamento dos AA (COWIESON & RAVINDRAN, 2008a).

Em um experimento adicionando um complexo enzimático com atividades de protease, xilanase e amilase em dietas à base de milho para frangos de corte, Cowieson & Ravindran (2008b) reportaram aumento na digestibilidade de AA, quando suplementado o produto enzimático, sendo os maiores incrementos observados nos AA: Cys (9,1%), Thr (5,2%) e Ala (4,5%). Os mesmos autores não observaram efeitos da suplementação enzimática na digestibilidade de Met, provavelmente por utilizarem na formulação das rações a forma cristalina desse AA, a qual possui elevada digestibilidade. Em estudo similar, Zanella et al. (1999) observaram maiores incrementos na digestibilidade de Thr (3,0%) e Val (2,3%) suplementando um complexo enzimático contendo protease, xilanase e amilase em dietas milho-soja para frangos de corte, não verificando efeito do produto enzimático na digestibilidade de Lys e Met. Em corroboração aos estudos anteriores Rutherfurd et al. (2007) observaram aumento na digestibilidade de AA, em frangos alimentados com dietas milho-soja contendo trigo e farelo de canola, suplementadas com um complexo enzimático composto por glucanases e xilanases, entretando esses autores, diferentemente dos demais supracitados, observaram melhora na digestibilidade de Met (3.3%).

Complexos de carboidrases, contendo xilanases e glucanases, podem degradar os xilanos e os β-glucanos presentes na composição dos vegetais. As enzimas xilanase e glucanase são praticamente ausentes no trato gastrintestinal de monogástricos, enquanto que seus respectivos substratos, arabinoxilanos e glucanos, estão presentes em relativa abundância nas rações (BEDFORD & SHULZE, 1998). Fernandes et al. (2016) observaram melhora no ganho de peso e na conversão alimentar de frangos de corte, e maior energia metabolizável aparente das dietas quando um complexo xilanase-glucanase foi suplementado em dietas para frangos de corte à base de sorgo e farelo de soja. Em contrapartida, West et al. (2007) não verificou nenhuma efeito na adição dessas enzimas sobre o desempenho produtivo de frangos de corte em dietas à base de milho e farelo de soja

O emprego de programas enzimáticos objetivando a hidrólise das variadas frações indigestíveis dos alimentos pode ser uma estratégia eficaz para otimizar o aproveitamento dos nutrientes presentes nas rações de frangos de corte, melhorar o desempenho zootécnico dos animais e reduzir o custo da alimentação animal. Adicionalmente, os recentes avanços na área de biotecnologia tornam possíveis novas perspectivas de estudo e de atuação das enzima exógenas. Sendo assim, maiores entendimentos sobre os benefícios e limitações da utilização de complexos de carboidrases em dietas para frangos de corte, principalmente quando formuladas com ingredientes de alta digestibilidade, são de grande valia para a avicultura.

HIPÓTESES E OBJETIVOS

Hipóteses

Frangos de corte alimentados com dietas contendo um complexo enzimático composto principalmente por glucanases e xilanases possuem desempenho produtivo similar aos que recebem dietas não suplementadas.

Frangos de corte alimentados com dietas suplementadas com um complexo enzimático composto principalmente por glucanases e xilanases apresentam digestibilidade de AA maior quando comparados aos que recebem dietas não suplementadas.

A utilização de energia é influenciada quando frangos de corte são alimentados com dietas suplementadas com um complexo enzimático composto principalmente por glucanases e xilanases em relação aos que recebem dietas não suplementadas.

Objetivos

Avaliar os efeitos da suplementação de um complexo enzimático, composto principalmente por endo 1,4 xilanase e endo 1,3(4) β-glucanases em dietas milho-farelo de soja formuladas com reduções de energia metabolizável aparente e de AA digestíveis para frangos de corte

Avaliar os efeitos da suplementação do complexo enzimático sobre o desempenho produtivo, sobre a energia digestível ileal e sobre a digestibilidade ileal da matéria seca e de AA em frangos de corte aos 21 e 42 dias de idade.

CAPÍTULO II[1]

Artigo elaborado conforme as normas da periódico Journal of Applied Poultry Research (Apêndice1).

Running title: carbohydrase complex for broilers

Energy and nutrient utilization of corn-soy diets supplemented with a xylanase-β-glucanase complex from *Talaromyces versatilis*

H.V. Rios*, S. L. Vieira,*[1] L. Kindlein, [†] C. Stefanello and* P. S. Carvalho*

**Department of Animal Science, Federal University of Rio Grande do Sul, Av. Bento Gonçalves, 7712, Porto Alegre, RS, Brazil, 91540-000;*

[†]*Department of Preventive Veterinary Medicine, Av. Bento Gonçalves, 8834, Porto Alegre, RS, Brazil, 91540-000;*

Section: Nutrition

Primary Audience: Nutritionists, researchers

Key words: broiler, carbohydrases complex, corn, glucanase, metabolizable energy

[1]Corresponding author: slvieira@ufrgs.br

S. L. Vieira

Department of Animal Science, Federal University of Rio Grande do Sul

Avenida Bento Gonçalves, 7712, Porto Alegre, RS, Brazil, 91540-000

Phone/FAX: +55-51-3308-6048

SUMMARY

A study was conducted to evaluate the effects of supplementing corn-soy diets with a commercial xylanase-β-glucanase complex [β-xylanase, 1,3(4)-β-glucanase, and 1,4-β-glucanase] on growth performance and ileal digestibility of broiler chickens. A total of 2,016 Cobb x Cobb 500 1-d-old male chicks were distributed into 9 treatments with 8 replicates of 28 birds each in a completely randomized design. Treatments consisted of a control diet formulated with AME and nutrient levels without enzyme supplementation as well as 8 diets having reductions in formulated AME (-80 and -120 kcal/kg) and digestible amino acids (dig. AA; -3 and -6%) supplemented or not with 50 mg/kg of the supplemental enzyme complex. Ileal content were collected at 21 and 42 d to determine ileal digestible energy (IDE) and AA digestibility. Diets with AME and dig. AA reductions without enzyme had higher FCR and lower IDE ($P < 0.05$). The supplemental enzyme increased total AA digestibility at 21 d; however, no effects were observed at 42 d. The highest total AA digestibility was observed with the control diet whereas the supplemental enzyme could equate this level in nutritional reductions diets. The addition of 50 mg/kg of the xylanase-β-glucanase complex in corn-soy diets led to improvements in performance and ileal digestibility in broilers at 21 and 42 d. The highest energy improvement provided by the supplemental enzyme was observed at 21 d on broilers fed diets with -120 kcal/kg AME and -6% dig. AA, being 5.8% higher when compared to those fed the analogous diet without enzyme.

DESCRIPTION OF PROBLEM

Corn and soybean meal (**SBM**) based diets are routinely utilized worldwide to feed commercial poultry. In this type of diet, energy is mainly originated from corn (around 65% of the AME) [1], whereas SBM alone may add 80% of total diet CP [2]. Corn-soy diets are relatively more digestible in comparison to diets containing other cereals such as barley and wheat, which compared to corn, have much higher content of non-starch polysaccharides (**NSP**) [3]. Reduction in diet digestibility induced by NSP has been reported as related to their capacity to increase digesta viscosity [3, 4]. As constituents of cell walls, NSP also play roles in the encapsulation of nutrients in what is frequently referred as "cage effect" [3, 4, 5]. This is known to reduce energy as well as digestibility of nutrients, such as amino acids (**AA)** and lipids [6, 7].

The NSP content of corn and SBM varies with genetics and is also affected by the environment where it is cultivated [3, 8]. Regardless of variation content, valuable amounts of nutrients pass through the gastrointestinal tract without being totally digested in those diets [1, 9, 10]; therefore, supplementing poultry diets with exogenous enzymes targeting NSP has been frequently referred as an efficient tool to release energy and nutrients from them [9], which can potentially increase the value of low quality corn in broiler feeds and support adequate commercial live performance objectives [1].

The actual mechanism of action of the enzymes present in commercially available supplemental complexes depend on their ability to degrade the different substrates present in feed ingredients that are targeted by them. Total NSP has estimated at 9.7 and 21.7% in corn and SBM, respectively [11]. From all NSP present in corn, arabinoxylans are the ones having the highest content, corresponding to a level of 5% of corn total composition [11]. Xylan chain degradation by xylanases leads to an increase in AME; however, the total AME increase is also due to a decrease in digesta viscosity and the release of encapsulated energy producing nutrients besides the monomeric absorption of xylans [4]. A common component of soluble NSP fractions, β-glucans are main contributors for the increased viscosity of diets having barley, rye and wheat [4]. Corn-soy diets, however, are low in β-glucan content with an estimation of 0.3% in a weight basis [12]. Benefits of supplemental multiple enzyme complexes having mixes of xylanases and β-glucanases have been reported even though β-glucanase effects alone have not been measured [13, 14].

Studies evaluating the effects of exogenous carbohydrases in the live performance of poultry as well as in nutrient digestibility have been published in increased quantities in the last years. A considerable amount of these studies, however, has been conducted with feeds having viscous cereals [15, 16, 17]. On the other hand, the interpretation of the results from studies with enzymatic complexes having carbohydrases has to be carefully done because ant performance improvement cannot be attributed to one single enzyme. However, these studies remain important to demonstrate the effectiveness of the action of several enzymes altogether, which is a very common practice in poultry nutrition. The objective of the present study was to provide additional information on the effect of all vegetable corn-SBM diets supplemented with a multiple enzyme complex, composed mainly by xylanase and β-glucanases. Growth performance as well as ileal digestibility of amino acids were evaluated in broiler chickens at 21 and 42 d.

MATERIALS AND METHODS

All procedures used in the present study were approved by the Ethics and Research Committee of the Federal University of Rio Grande do Sul, Porto Alegre, Brazil.

Experimental Facilities and Bird Husbandry

A total of 2,016 slow-feathering, Cobb × Cobb 500 one-day-old male chicks [18] (45g ± 1.0), vaccinated for Marek's disease at the hatchery were randomly placed into 72 floor pens (1.65 × 1.65 m^2). Bedding material was rice hulls and pens were equipped with a 15 kg capacity tube feeder and 3 nipple drinkers. Birds had *ad libitum* access to water and mash feeds. Average temperature was 32ºC at placement being reduced by 1ºC every 2 d targeting comfort throughout the study with the use of thermostatically controlled heaters, fans and foggers. Lighting was continuous until 14 d of age, with a 14L:10D cycle used afterwards.

Experimental Design and Diets

Feed samples of each batch were taken and analyzed to ensure the presence of the enzymatic complex (**EC**) at the formulated content. A 3-phases feeding program was used as follow: starter (1 to 21 d), grower (22 to 35 d), and finisher (36 to 42 d) (Table 1 to 3). All diets were corn-SBM based and Celite [19] was added at 1% as an indigestible marker in the starter and finisher diets. Birds were allocated into 9 dietary treatments with 8 replications of 28 birds each in a completely randomized design.

Broilers were fed a control diet (**C**) as well as 8 other diets with reductions of AME and digestible AA (**dig. AA**). The C diet was formulated to meet or exceed requirements for each feeding phase [20]. Other 4 diets had reductions of AME and dig. AA when compared to C, without enzyme supplementation, as follow: reductions of 80 kcal/kg AME and 3% dig. AA; reductions of 80 kcal/kg AME and 6% dig. AA; reductions of 120 kcal/kg AME and 3% dig. AA, and reductions of 120 kcal/kg AME and 6% dig. AA. A group of treatments formulated as the ones with reduced AME and dig. AA was supplemented with 50 mg/kg of a multiple enzyme complex produced from *Talaromyces* *versatilis*, which is composed by pectinases, cellulases, proteases and arabinofuranosidases [21]. The commercial product has registered activities of xylanase and β-glucanase respectively of 2,600 dinitrosalicylic acid (**DNS)** units and 1,800 DNS per g of product. A DNS unit of xylanase and β-glucanase is defined as the amount of enzyme that produces the equivalent of one μmol of glucose or xylose per minute from the substrate (xylan from birch wood or beta-glucan of barley, respectively) [22].

Measurements

Chicks were individually weighed and placed into groups of 28 per floor pen. Bird weights were averaged by pen and recorded at d 1, 21, 35, and 42. Body weight gain (**BWG**), feed intake (**FI**), and FCR corrected for the weight of dead birds were calculated from 1 to 21 d, 22 to 35 d, 36 to 42 d, and 1 to 42 d on a pen-basis. Mortality was recorded immediately after noticed. At 21 and 42 d, 4 birds were randomly taken from each pen and euthanized by cervical dislocation following electrical stunning at 45 V for 3 s. These birds were used for ileal digesta collection from Meckel’s diverticulum to approximately 2 cm cranial to the ileo-cecal junction. Digesta was flushed with distilled water into plastic containers, pooled by pen, immediately frozen in liquid nitrogen, and stored in a freezer at −20ºC until lyophilized. Diets as well as freeze-dried samples of ileal digesta were ground to pass a 0.5-mm grinder screen [23].

Chemical Analysis and Calculations

Dry matter analysis of samples was performed after oven drying the samples at 105ºC for 16 h [24]. Ileal digesta samples were analyzed for gross energy (**GE**) using a calorimeter calibrated with benzoic acid as a standard [25]. Analyses of AA in ingredients and diets were conducted according to the method 914.12 using an HPLC auto analyzer and employed performic acid oxidation of the feed sample prior to acid hydrolysis [24].

Calculations of ileal digestibility of dry matter (**IDM**), ileal digestible energy (**IDE**) and dig. AA were done afterwards. Acid insoluble ash concentration in the diets and ileum samples were determined using the method described by Vogtmann et al. [26] and Choct and Annison [27]. Apparent ileal digestibility and AA digestibility were calculated using the following equations [28]:

Digestibility (%) = $[1 - (M_i/M_o) \times (E_o/E_i)] \times 100$, and IDE (kcal/kg) = $GE_i - [GE_o \times (M_i/M_o)]$, where M_i is the concentration of acid insoluble ash in the diet in grams per kg of DM; M_o is the concentration of acid insoluble ash in the ileal digesta in grams per kg of DM output; E_i is the concentration of DM, AA or energy, in the diet in milligrams per kg of DM; and E_o is the concentration of DM, AA or energy, in the ileal digesta in mg/kg of DM. GE_i is GE (kcal/kg) in the diet; GE_o is the GE (kcal/kg) in the ileum content.

Statistical Analysis

Statistical analyses were performed using SAS [29]. Data were submitted to an analysis of variance and when significant, had the means compared by Student-Newman-Keuls test [30] at 5% significance. Orthogonal contrast analyses was also conducted comparing treatments with and without the EC supplementation.

RESULTS AND DISCUSSION

Analyses of the EC added to experimental diets showed level activities in agreement with the expected formulated values (Table 4). Growth performance of broilers is presented in Table 5. Cumulative BWG from 1 to 42 d was not affected by the treatments, regardless of nutrient reductions and EC supplementation. Cumulative FCR from 1 to 42 d was higher when broilers were fed diets with 120 kcal/kg of reduction without EC supplementation compared to the C diet ($P < 0.05$); however, no differences were observed when the C diet was compared to the treatments with EC supplementation. Birds fed treatments that had -120 kcal/kg AME and -3% dig. AA presented a decrease of 3.0% in FCR when diets were supplemented with the EC ($P < 0.05$) compared to those fed the analogous diet without EC. Diets formulated with -80 kcal/kg and -3% dig. AA resulted in lower FI ($P < 0.05$) when supplemented with EC for broiler from 1 to 42 d compared to the -120 kcal/kg and -6% dig. AA diets without supplementation.

The IDM and IDE at 21 and 42 d are presented in Table 6. The IDE at 21 and 42 d was higher ($P < 0.05$) when broilers were fed the C diet if compared to those fed diets with -120 kcal/kg without EC. The IDE at both ages was also increased ($P < 0.05$) when broilers were fed the -120 kcal/kg AME diet supplemented with the EC when compared to the analogous diets without EC. Estimations of IDE improvements due to EC supplementation occurred with diets formulated with -120 kcal/kg and -6 dig. AA being 5.8% higher for broilers at 21 d and 3.8% higher for birds at 42 d.

Amino acid digestibility at 21 and 42 d are presented in Tables 7 and 8, respectively. Total AA digestibility was higher at 21 d for birds fed the EC supplemented diets compared to those fed diets not supplemented ($P < 0.05$), nevertheless no difference was observed for birds at 42 d. Diets formulated with a reduction of 6% dig. AA and not supplemented with the EC had lower ($P < 0.05$) total AA digestibility at 21 d compared with the C diet; however, no difference was observed between the C and diets supplemented with EC. Indispensable AA digestibility at 21 d was lower for diets formulated with -6% dig. AA without EC, regardless the AME level when compared to the C diet ($P < 0.05$). Additionally, the ileal digestibility of Arg, Ile, Phe, Thr and Val was similar in the C diet and diets supplemented with the EC. Digestibility of Arg, Ile and Val at 42 d was higher in the C diet when compared to diets with -6% dig. AA and without EC supplementation ($P < 0.05$), while the ileal digestibility of dispensable AA was not influenced by enzyme supplementation, energy and AA levels.

Contrasts between treatments with energy and AA reductions supplemented with EC against those not supplemented are shown in Tables 5 to 8. Contrasts among all diets with AME and dig. AA reduction with and without EC supplementation did not differ statistically on cumulative FI; however, birds fed diets with EC supplementation showed a decrease of 1.9% ($P < 0.05$) on cumulative FCR. The IDM at 21 and 42 d increased ($P < 0.05$) when diets were supplemented with the EC. Contrasts between treatments with -120 kcal/kg at 21 d showed IDE improvements of 5.8% ($P < 0.05$) when the EC was supplemented, whereas at 42 d, contrasts between diets with -120 kcal/kg showed increases of 3.3 and 3.8% ($P < 0.05$) on IDE for birds fed -3% dig. AA and -6% dig. AA, respectively, when supplemented with the EC. When comparing all diets with AME and dig. AA reduction with and without EC supplementation the IDE improvement by the EC at 21 d and 42 d was 4.3 *vs.* 2.6%, respectively. For instance, increases in digestibility of first limiting AA at 21 d were of 1.4% for Lys, 2.4% for Thr and 2.1% for Val, however Met was not influenced by treatments.

Contrasts among all diets with AME and dig. AA reduction with and without EC supplementation at 21 d showed improvements ($P < 0.05$) for the indispensable AA: Arg (1.2%), Ile (1.6%), Leu (1.4%), Lys (1,4%), Phe (1.5%), Thr (2.4%) and Val (2.1%), when EC was supplemented, however no EC effect was observed for Met and His ($P > 0.05$). For dispensable AA, was observed improvements with EC supplementation for Ala (1.6%), Glu (1.3%) and Ser (1.9%), and no effect for Asp, Cys and Gly ($P > 0.05$). The same contrast for birds at 42 d indicated no effect for any indispensable or dispensable AA digestibility with the EC supplementation ($P > 0.05$).

Some authors attribute improvements on AA digestibility obtained with exogenous carbohydrases by modifications in the secretions of endogenous enzymes as well as in the intestinal microbial environment [3, 9, 31]. The greatest improvements on AA digestibility due to EC supplementation at 21 d was observed for Thr (2.4%), Val (2.1%) and Ser (1.9%), but no responses were observed on Met, Gly and His. An intermediate effect was observed on Lys (1.4%). Cowieson and Ravindran [31] reported relevant improvements in the digestibility of Cys (9.1%), Thr (5.2%) and Ala (4.5%) when a multiple enzyme complex containing protease, xylanase and amylase was added to corn-based diets. The same authors did not observe effects of the supplemental enzyme on Met digestibility. Zanella et al [38] observed significant increase in the digestibility of indispensable AA Thr (3.0%) and Val (2.3%) supplementing a mix of amylase, xylanase and protease in corn-soy diets; however, no improvements were detected in Lys and Met. Rutherfurd et al. [16] observed improvements on AA digestibility on birds fed corn-soy diets containing wheat bran and canola meal, supplemented with a commercial product compound by amylase, β-glucanase and xylanase, although, differently from the present study, improvements in Gly (9,3%), Asp (8.4%) and Met (3.3%) were also observed. The same authors support that the improvements observed in AA digestibility due to supplemental enzymes are actual effects of protein hydrolysis and absorption of AA. According to Cowieson and Ravindran [39] it is likely that the mechanisms that actually improved AA utilization using exogenous enzymes are related to a reduction of endogenous losses due to a reduced secretion of endogenous enzymes, and not only by an improvement on the digestibility itself.

The improvements obtained with the EC supplementation on DM digestibility in the present study support the reduced FCR observed when EC was supplemented in comparison to the non supplemented diets; maybe because the higher digestibility of all nutrients at dry matter base due to the EC supplementation could made birds regulate their FI, since bird´s nutrient requirement was reached with less feed consumed.

The significative improvements of the EC on growth performance observed on birds fed the lowest nutritional diets are in agreement with research done by Cowieson and Adeola [7], who observed that a positive effect of exogenous carbohydrases would be more pronounced in diets with marginal nutrient levels, probably because there would be a larger room for enzyme improvements. In a similar study, West et al. [32] did not observe any effect of a xylanase-β-glucanase complex on growth performance of broilers fed corn-SBM based diets, presumably, because the nutrient levels of the treatments formulated to be marginal in AME and dig. AA were high enough to achieve birds' requirements. Additionally, research done by Muniaka et al. [33] indicate that feeds formulated with high digestible ingredients, such as corn and SBM, are less responsive to exogenous carbohydrases than when utilized barley, wheat and rye. In the present research, the EC provided higher improvements on AA digestibility and IDE on birds at 21 d than at 42 d, suggesting that young birds are less capable of digest the NSP present on diets [34]. This agrees with research done by Leslie et al. [35], who observed higher improvements on nutritional value of diets provided by a glucanase in 9-d-old birds than in 23-d-old birds. However, Yegani and Korver [36], using a product containing xylanase and β-glucanase, observed improvements on IDE in the grower diets, despite no improvement was noted in starter and finisher diets.

In the current study, improvements in growth performance, IDE and dig. AA were observed when broilers were fed corn-SBM basal diets with EC supplementation; however, some authors have not observed improvements on bird performance when adding supplemental enzymes [32, 37]. It is possible that the increased digestibility of energy and AA observed with the EC in the present research, led to improvements on FCR of birds, due to a better nutrient utilization. As expected, enzymes have active site specification, and therefore, the benefit obtained with the use of added supplemental enzymes can be only achieved if it is able to reach that site. The complexity of dietary carbohydrates present an opportunity to use enzymatic complexes with different enzyme activities. Although the EC utilized in the present study had registered activities of xylanases and β-glucanases, it also has producer guaranteed activities of other enzymes, such as cellulases, pectinases and proteases [21]. Even though these activities are of proportionally lower impact than the xylanase and β-glucanase, their effect cannot be totally underestimated. Therefore, the findings obtained in the present study have to be directed to the whole mix of enzymes present in the commercially available product and, unfortunately, do not allow any estimation of benefits from individual enzymes. Studies with enzyme blends have shown benefits, both in live performance as well as with specific improvements in the digestibility of nutrients, such as AA [13, 14, 15, 16, 17, 31, 38, 39, 40, 41]. An adequate comparison of the expected improvements when using blends or complexes obviously depends on the ingredients utilized in the formulated feed as well as on the type and activities of enzymes present in them such that a cost-benefit decision can be made.

CONCLUSIONS AND APPLICATIONS

1. The supplementation of a supplemental enzyme complex having registered activities of xylanases and β-glucanases, but also with minor activities of cellulases, pectinases and proteases, led to improvements in FCR, IDE and dig. AA of broiler chickens.

2. Increased energy utilization when using the enzyme complex corresponded to an uplift on the ileal digestible energy such that a diet formulated with reduction in 120 kcal/kg produced similar values as those obtained with a Control diet without energy reduction.
3. Digestibility benefits with the use of the supplemental enzyme complex were higher for broilers at 21 d when compared to those at 42 d; ileal digestible energy improvements were 4.4% and 2.6%, respectively at those ages.
4. Increased digestibility of AA at 21 d were obtained with the use of the the enzyme complex on most of dispensable and indispensable amino acids; the highest improvements were observed with Thr (2.4%), Val (2.1%) and Ser (1.9%).

REFERENCES AND NOTES

1. Cowieson, A. J. 2005. Factors that affect the nutritional value of maize for broilers. Anim. Feed Sci. Technol. 119:293–305.

2. Baker D. H. 1996. Pages 41-53 Advances in Amino Acid Nutrition and Metabolism of Swine and Poultry. in Nutrient Management of Food Animals to Enhance and Protect the Environment. E.T Kornegay., ed. CRC Press, Boca Raton, FL.

3. Choct, M. 1997. Feed non-starch polysaccharides: Chemical structures and nutritional significance. Feed Mill International. 13-26.

4. Bedford, M. R. 1995. Mechanism of action and potential environmental benefits from the use of feed enzymes. Anim. Feed Sci. Technol. 53:145–155.

5. Simon, O. 1998. The mode of action of NSP hydrolyzing enzymes in the gastrointestinal tract. Journ. Anim. Feed Sci. 7(3): 115-123.

6. Kadhem, A, M. Lourenço, E. Delezie, L. Maertens, A. Goderis, R. Mombaerts, M. Höfte , V. Eeckhaut, F. Van Immerseel, G.P. Janseens. 2016. Does release of

encapsulated nutrients have an important role in the efficacy of xylanase in broilers? Poult. Sci. 95(5):1066-76.

7. Cowieson, A. J. and O. Adeola. 2005. Carbohydrases, proteases, and phytase have an additive beneficial effect in nutritionally marginal diets for broiler chicks. Poult. Sci. 84:1860-1867.

8. Bach Knudsen, K. E. 2014. Fiber and nonstarch polysaccharides content and variation in common crops used in broiler diets. Poult. Sci. 93:2380-2393.

9. Cowieson, A. J. 2010. Strategic selection of exogenous enzymes for corn/soy-based poultry diets. J. Poult. Sci. 47:1-7.

10. Bedford M. R. 2000. Exogenous enzymes in monogastric nutrition - their current value and future benefits. Anim. Feed Sci. Technol. 86:1-13.

11. Bach Knudsen, K. E. 1997. Carbohydrate and lignin contents of plant materials used in animal feeding. Anim. Feed Sci. Technol. 67:319–338.

12. Li, S. W. C. Sauer, R. Mosenthin, B. Kerr. 1996. Effect of β-glucanase supplementation of cereal-based diets for starter pigs on the apparent digestibilities of dry matter, crude protein and energy. Anim. Feed Sci. Technol. 59:223-231.

13. Avila, E., J. Arce, C. Soto, F. Rosas, M. Ceccantini, and D. R. McIntyre. 2012. Evaluation of an enzyme complex containing nonstarch polysaccharide enzymes and phytase on the performance of broilers fed a sorghum and soybean meal diet. J. Appl. Poult. Res. 21:279–286.

14. Zou, J; P. Zheng; K. Zhang; X. Ding and S. Bai. 2013. Effects of exogenous enzymes and dietary energy on performance and digestive physiology of broilers. Journal of Animal Science and Biotechnology. 4:14.

15. Kocher, A., M. Choct, G. Ross, J. Broz, and T. K. Chung. 2003. Effects of enzyme combinations on apparent metabolizable energy of corn-soybean meal based diets in broilers. J. Appl. Poult. Res. 12:275–283.

16. Rutherfurd, S. M., T. K. Chung, P .J. Moughan. 2007. The effect of a commercial enzyme preparation on apparent metabolizable energy, the true ileal amino acid digestibility, and endogenous ileal Lysine losses in broiler chickens. Poul. Sci. 86:665-672.

17. Olukosi, O. A., A. J. Cowieson, and O. Adeola. 2008. Energy utilization and growth performance of broilers receiving diets supplemented with enzymes containing carbohydrase or phytase activity individually or in combination. Br. Poult. Sci. 99:682–690.

18 Cobb-Vantress Inc., Siloam Springs, AR.

19 Celite Corp., Lompoc, CA.

20. Rostagno, H. S., L. F. T. Albino, J. L. Donzele, P. C. Gomes, R. F. Oliveira, D. C. Lopes, A. S. Ferreira, S. L. T. Barreto, and P. F. Euclides. 2011. Tabelas brasileiras para aves e suínos. Composição de alimentos e exigências nutricionais. 3rd ed. UFV, Viçosa, MG, Brazil.

21 Rovabio® Advance T-flex; Adisseo, Alpharetta, GA.

22 Gusakov, A. V., E. G. Kondratyeva, A. P. Sinitsyn. 2011. Comparison of two methods for assaying reducing sugars in the determination of carbohydrase activities. Int. J.Anal. Chem.

23 Tecnal, TE-631/2, São Paulo, Brazil

24. AOAC International. 2006. Official Methods of Analysis. 18th ed. AOAC Int., Gaithersburg, MD.

25 IKA Werke, Parr Instruments, Staufen, Germany.

26. Vogtmann, H., P. Frirter, and A. L. Prabuck. 1975. A new method of determining metabolizability of energy and digestibility of fatty acids in broiler diets. Br. Poult. Sci. 16:531-534.

27. Choct, M., and G. Annison. 1992. Anti-nutritive effect of wheat pentosans in broiler chickens: Roles of viscosity and gut microflora. Br. Poult. Sci. 33:821-834.

28. Kong, C., and O. Adeola. 2014. Evaluation of amino acid and energy utilization in feedstuff for swine and poultry diets. Asian-australas. J. Anim. Sci. 27:917-925.

29. SAS User's Guide. 2009. Version 9.2 ed. SAS Inst. Inc., Cary, NC.

30 Keuls, M. 1952. The use of the “studentized range” in connection with an analysis of variance. Euphytica 1:112-122.

31 Cowieson, A. J., V. Ravindran. 2008. Effects of exogenous enzymes in maize-based diets varying in nutrient density for young broilers: growth performance and digestibility of energy, mineral and amino acids. Bri. Poult. Sci. 49:37-44.

32 West, M. L., A. Corzo, W. A. Dozier III, M. E. Blair, and M. T. Kidd. 2007. Assessment of dietary Rovabio Excel in practical United States broiler diets. J. Appl. Poul. Res. 16:313-321.

33 Muniaka, P. M., N. K. Nandha, E. Kiarie, C. M. Nyachoti, and E. Khafipour. 2016. Impact of combined Impact of combined *β*-glucanase and xylanase enzymes on growth performance, nutrients utilization and gut microbiota in broiler chickens fed corn or wheat-based diets. Poult. Sci. 95:528-540.

34 Noy, Y., and D. Sklan. 2001. Yolk and exogenous feed utilization in posthatch chicks. Poult. Sci. 80:1490–1495.

35 Leslie, M. A., E. T. Moran jr., and M. R. Bedford. 2007. The effect of phytase and glucanase on the ileal digestible energy of corn and soybean meal fed to broilers. Poult. Sci. 86:2350-2357.

36 Yegani, M and D. R. Korver. 2013. Effects of corn source and exogenous enzymes on growth performance and nutrient digestibility in broiler chickens. Poult. Sci. 92:1208-1220.

37. Tahir, M., F. Saleh, A. Ohtsuka, K. Hayashi. 2006. Pectinase plays an important role in stimulating digestibility of a corn-soybean meal diet in broilers. J. Poult. Sci. 43:323-329.

38. Zanella, I., N. K Sakomura, F. G. Silversides, A. Fiqueirdo, and M. Pack. 1999. Effect of enzyme supplementation of broiler diets based on corn and soybeans. Poult. Sci. 78:561-568.

39. Cowieson, A. J., V. Ravindran. 2008. Sensitivity of broiler starter to three doses of an enzyme cocktail in maize based diets. Bri. Poult. Sci. 49:340-346.

40 Meng, X., and B. A. Slominski. 2005. The nutritive value of corn soybean meal, canola meal or peas for broiler chickens as affected by a multy-carbohydrase preparation of cell wall degrading enzymes. Poult. Sci. 84:1242-1251.

41 Kaczmarek, S. A., A. Rogiewicz, M. Mogielnicka, A. Rutkowski, R. O. Jones, and B. A. Slominski. 2014. The effect of protease, amylase, and nonstarch polysaccharide-degrading enzyme supplementation on nutrient utilization and growth performance of broiler chickens fed corn-soybean meal-based diets. Poul. Sci. 93:1745-1753.

42 Englyst, H. 1989. Classification and measurement of plant polysaccharides. Anim. Feed Sci. Technol. 23:27-42.

Aknowledgements. The authors acknowledge the partial funding from Conselho Nacional de Pesquisa (CNPq – Brasilia, DF, Brazil) and Adisseo for their integrated supported in this project. The authors are also grateful to Jairo Padilha of the Aviario de Ensino e Pesquisa, Federal University of Rio Grande do Sul, Porto Alegre, RS, Brazil, for his assistance with bird management and technical assistance.

Table 1. Ingredient and nutrient composition of starter feeds having energy and AA reductions and supplemented or not with a carbohydrase complex (as-is basis).

Item	Control	Formulated value in comparison to the Control			
		-80 kcal/kg AME - 3% dig AA	-80 kcal/kg AME - 6% dig AA	-120 kcal/kg AME - 3% dig AA	-120 kcal/kg AME - 6% dig AA
Ingredient, %					
Corn	48.03	52.01	53.87	52.93	54.79
Soybean meal	40.64	38.53	36.93	38.38	36.77
Soybean oil	5.99	4.09	3.78	3.32	3.01
Dicalcium phosphate	1.74	1.75	1.77	1.75	1.77
Limestone	1.22	1.22	1.23	1.22	1.23
Salt	0.32	0.27	0.23	0.27	0.23
DL-Methionine, 99%	0.37	0.35	0.34	0.35	0.34
L-Lysine HCl,78%	0.14	0.16	0.16	0.16	0.17
Sodium bicarbonate	0.24	0.31	0.37	0.31	0.37
Vitamin and mineral mix[1]	0.21	0.21	0.21	0.21	0.21
L-Threonine, 98.5%	0.04	0.04	0.04	0.04	0.04
Choline chloride, 60%	0.05	0.05	0.06	0.05	0.06
Celite[2]	1.00	1.00	1.00	1.00	1.00
Kaolin / Carbohydrase complex[3]	0.005	0.005	0.005	0.005	0.005
Calculated nutrient composition, % or unless noted					
AME_n, kcal/kg	3,100	3,020	3,020	2,980	2,980
CP	22.62	21.97	21.39	21.98	21.40
Ca	0.90	0.90	0.90	0.90	0.90
Av. P	0.45	0.45	0.45	0.45	0.45
Na	0.22	0.22	0.22	0.22	0.22
DEB, mEq/kg	240	240	240	240	240
Choline, mg/kg	1,600	1,600	1,600	1,600	1,600
Dig. Lys[4]	1.24	1.21	1.18	1.21	1.18
Dig. TSAA	0.96	0.93	0.91	0.93	0.91

Dig. Thr	0.81	0.79	0.77	0.79	0.77
Dig. Val	0.96	0.93	0.91	0.93	0.91
Dig. Ile	0.90	0.87	0.84	0.87	0.84
Dig Leu	1.74	1.71	1.67	1.71	1.68
Dig. Arg	1.46	1.40	1.36	1.40	1.36
Dig. Trp	0.26	0.25	0.24	0.25	0.24
Non starch polysaccharides[5]					
Cellulose	4.13	4.05	3.96	4.05	3.66
Hemicellulose	4.90	4.87	4.80	4.89	4.43
Arabinoxylans	1.97	2.14	2.21	2.18	2.01
β-glucans	0.05	0.05	0.05	0.05	0.05
Pectin	2.44	2.31	2.22	2.30	2.06

[1]Composition per kg of feed: vitamin A, 9,000 UI; vitamin D_3, 2,500 UI; vitamin E, 20 UI; vitamin K_3, 2,5 mg; thiamine, 2 mg; riboflavin, 6 mg; pyridoxine, 3.8 mg; cyanocobalamin, 0.015 mg, pantothenic acid, 12 mg; niacin, 35 mg; folic acid, 1,5 mg; biotin, 0.1 mg; iron, 40 mg; zinc, 80 mg; manganese, 80 mg; copper, 10 mg; iodine, 0.7 mg; selenium, 0.25 mg; monensin 20%, 5 mg; and avylamicin 10 mg (Elanco Animal Health, Greenfield, IN).

[2]Indigestible marker (Celite, Celite Corp., Lompoc, CA).

[3]The carbohydrase complex was an enzyme product with at least 2,600 DNS units of xylanase and 1,800 DNS units of β-glucanase per gram of product (Rovabio® Advance T-flex, Adisseo).

[4]Ratios of digestible amino acids to digestible Lys were maintained at TSAA: 0.75; Thr: 0.65; Val: 0.70; Trp: 0.17; Arg: 1.08; Ile: 0.67 (Rostagno et al., 2011)

[5]Based on data from Englyst [42] and Bach Knudsen [11].

Table 2. Ingredient and nutrient composition of grower feeds having energy and AA reductions and supplemented or not with a carbohydrase complex (as-is basis).

Item	Control	Formulated value in comparison to the Control			
		-80 kcal/kg AME - 3% dig AA	-80 kcal/kg AME - 6% dig AA	-120 kcal/kg AME - 3% dig AA	-120 kcal/kg AME - 6% dig AA
Ingredient, %					
Corn	59.80	63.37	65.09	64.29	66.01
Soybean meal	30.86	29.09	27.63	28.93	27.47
Soybean oil	4.54	2.71	2.42	1.94	1.65
Dicalcium phosphate	1.45	1.46	1.47	1.46	1.47
Limestone	1.05	1.05	1.05	1.05	1.06
Salt	0.27	0.23	0.19	0.23	0.19
DL-Methionine, 99%	0.29	0.28	0.26	0.27	0.26
L-Lysine HCl, 78%	0.18	0.19	0.20	0.20	0.20
Sodium bicarbonate	0.24	0.30	0.35	0.30	0.36
Vitamin and mineral mix[1]	0.21	0.21	0.21	0.21	0.21
L-Threonine, 98.5%	0.03	0.03	0.03	0.03	0.03
Choline chloride, 60%	0.07	0.07	0.08	0.07	0.08
Celite[2]	1.00	1.00	1.00	1.00	1.00
Kaolin / Carbohydrase complex[3]	0.005	0.005	0.005	0.005	0.005
Calculated nutrient composition, % or unless noted					
AME, kcal/kg	3,150	3,070	3,070	3,030	3,030
CP	19.10	18.58	18.05	18.58	18.05
Ca	0.76	0.76	0.76	0.76	0.76
Av. P	0.38	0.38	0.38	0.38	0.38
Na	0.20	0.20	0.20	0.20	0.20
DEB, mEq/kg	200	200	200	200	200
Choline, mg/kg	1,500	1,500	1,500	1,500	1,500
Dig. Lys[4]	1.05	1.02	0.99	1.02	0.99
Dig. TSAA	0.81	0.79	0.76	0.79	0.76

Dig. Thr	0.68	0.66	0.64	0.66	0.64
Dig. Val	0.81	0.79	0.76	0.79	0.76
Dig. Ile	0.74	0.71	0.69	0.71	0.69
Dig Leu	1.54	1.51	1.48	1.51	1.48
Dig. Arg	1.18	1.14	1.10	1.14	1.10
Dig. Trp	0.21	0.20	0.19	0.20	0.19
Non starch polysaccharides[5]					
Cellulose	3.60	3.54	3.46	3.54	3.46
Hemicellulose	4.51	4.49	4.43	4.51	4.45
Arabinoxylan	2.46	2.60	2.68	2.64	2.71
β-glucan	0.06	0.06	0.07	0.06	0.07
Pectin	1.85	1.75	1.66	1.74	1.65

[1]Composition per kg of feed: vitamin A, 9,000 UI; vitamin D_3, 2,500 UI; vitamin E, 20 UI; vitamin K_3, 2,5 mg; thiamine, 2 mg; riboflavin, 6 mg; pyridoxine, 3.8 mg; cyanocobalamin, 0.015 mg, pantothenic acid, 12 mg; niacin, 35 mg; folic acid, 1,5 mg; biotin, 0.1 mg; iron, 40 mg; zinc, 80 mg; manganese, 80 mg; copper, 10 mg; iodine, 0.7 mg; selenium, 0.25 mg; monensin 20%, 5 mg; and avylamicin 10 mg (Elanco Animal Health, Greenfield, IN).

[2]Indigestible marker (Celite, Celite Corp., Lompoc, CA).

[3]The carbohydrase complex was an enzyme product with at least 2,600 DNS units of xylanase and 1,800 DNS units of β-glucanase per gram of product (Rovabio® Advance T-flex, Adisseo).

[4]Ratios of digestible amino acids to digestible Lys were maintained at TSAA: 0.75; Thr: 0.65; Val: 0.70; Trp: 0.17; Arg: 1.08; Ile: 0.67 (Rostagno et al., 2011).

[5]Based on data from Englyst [42] and Bach Knudsen [11].

Table 3. Ingredient and nutrient composition of finisher feeds having energy and AA reductions and supplemented or not with a carbohydrase complex (as-is basis).

Item	Control	Formulated value in comparison to the Control			
		-80 kcal/kg AME - 3% dig AA	-80 kcal/kg AME - 6% dig AA	-120 kcal/kg AME - 3% dig AA	-120 kcal/kg AME - 6% dig AA
Ingredient, %					
Corn	65.27	68.82	70.56	69.76	71.49
Soybean meal	26.03	24.26	22.80	24.10	22.64
Soybean oil	4.24	2.41	2.12	1.64	1.35
Dicalcium phosphate	1.23	1.24	1.25	1.23	1.25
Limestone	0.92	0.93	0.93	0.93	0.93
Salt	0.27	0.23	0.19	0.23	0.19
DL-Methionine, 99%	0.25	0.24	0.22	0.24	0.22
L-Lysine HCl, 78%	0.20	0.21	0.22	0.21	0.22
Sodium bicarbonate	0.25	0.31	0.36	0.31	0.36
Vitamin and mineral mix[1]	0.21	0.21	0.21	0.21	0.21
L-Threonine, 98.5%	0.03	0.03	0.03	0.03	0.03
Choline chloride, 60%	0.09	0.10	0.10	0.10	0.10
Celite[2]	1.00	1.00	1.00	1.00	1.00
Kaolin / Carbohydrase complex[3]	0.005	0.005	0.005	0.005	0.005
Calculated nutrient composition, % or unless noted					
AME, kcal/kg	3,200	3,120	3,120	3,080	3,080
CP	17.33	16.82	16.29	16.82	16.29
Ca	0.66	0.66	0.66	0.66	0.66
Av. P	0.33	0.33	0.33	0.33	0.33
Na	0.20	0.20	0.20	0.20	0.20
DEB, mEq/kg	180	180	180	180	180
Choline, mg/kg	1,500	1,500	1,500	1,500	1,500
Dig. Lys[4]	0.95	0.92	0.89	0.92	0.89
Dig. TSAA	0.73	0.71	0.69	0.71	0.69

Dig. Thr	0.62	0.60	0.58	0.60	0.58
Dig. Val	0.73	0.71	0.69	0.71	0.69
Dig. Ile	0.66	0.63	0.61	0.63	0.61
Dig Leu	1.43	1.40	1.37	1.41	1.37
Dig. Arg	1.05	1.01	0.97	1.00	0.96
Dig. Trp	0.18	0.18	0.17	0.18	0.17
Non starch polysaccharides[5]					
Cellulose	3.34	3.27	3.19	3.28	3.20
Hemicellulose	4.31	4.28	4.22	4.30	4.24
Arabinoxylan	2.68	2.83	2.90	2.87	2.94
β-glucan	0.07	0.07	0.07	0.07	0.07
Pectin	1.56	1.46	1.37	1.45	1.36

[1]Composition per kg of feed: vitamin A, 9,000 UI; vitamin D_3, 2,500 UI; vitamin E, 20 UI; vitamin K_3, 2,5 mg; thiamine, 2 mg; riboflavin, 6 mg; pyridoxine, 3.8 mg; cyanocobalamin, 0.015 mg, pantothenic acid, 12 mg; niacin, 35 mg; folic acid, 1,5 mg; biotin, 0.1 mg; iron, 40 mg; zinc, 80 mg; manganese, 80 mg; copper, 10 mg; iodine, 0.7 mg; selenium, 0.25 mg; monensin 20%, 5 mg; and avylamicin 10 mg (Elanco Animal Health, Greenfield, IN).
[2]Indigestible marker (Celite, Celite Corp., Lompoc, CA).
[3]The carbohydrase complex was an enzyme product with at least 2,600 DNS units of xylanase and 1,800 DNS units of β-glucanase per gram of product (Rovabio® Advance T-flex, Adisseo).
[4]Ratios of digestible amino acids to digestible Lys were maintained at TSAA: 0.75; Thr: 0.65; Val: 0.70; Trp: 0.17; Arg: 1.08; Ile: 0.67 (Rostagno et al., 2011).
[5]Based on data from Englyst [42] and Bach Knudsen [11].

Table 4. Declared and analysed activity of xylanase in the experimental feeds.

	Xylanase, DNS/kg^{-1}					
	Starter		Grower		Finisher	
Treatment	Declared	Analyzed	Declared	Analyzed	Declared	Analyzed
1. Control	0	<LOD	0	<LOD	0	<LOD
2. – 80 kcal – 3 % AA	0	<LOD	0	<LOD	0	<LOD
3. – 80 kcal – 6 % AA	0	<LOD	0	<LOD	0	<LOD
4. – 120 kcal – 3 % AA	0	<LOD	0	<LOD	0	<LOD
5. – 120 kcal – 6 % AA	0	<LOD	0	<LOD	0	<LOD
6. – 80 kcal – 3 % AA + EC[3]	130	213.4	130	243.0	130	223.0
7. – 80 kcal – 6 % AA + EC	130	269.6	130	233.7	130	233.7
8. – 120 kcal – 3 % AA + EC	130	196.1	130	243.0	130	247.8
9. – 120 kcal – 6 % AA + EC	130	238.5	130	248.7	130	223.7

[1] Dinitrosalicylic acid units of endo-1,4-ß-xylanase per kg of feed.

[2] Corn-soy diet formulated to meet or exceed requirements for each feeding phase.

[3] LOD = limit of detection.

[4] The carbohydrase complex was an enzyme product with at least 2,600 DNS units of xylanase and 1,800 DNS units of β-glucanase per gram of product (Rovabio® Advance T-flex, Adisseo).

Table 5. Growth performance of broiler chickens fed diets with energy and AA reductions supplemented or not with a carbohydrase complex.

	1 to 21 d			22 to 35 d			36 to 42 d			1 to 42 d		
Treatment	FI[1], g	BWG[2],g	FCR[3]	FI, g	BWG, g	FCR	FI, g	BWG, g	FCR	FI, g	BWG, g	FCR
1. Control	1,318^{ab}	978	1.348^{a}	2,170^{ab}	1,454	1.493	1,212	639	1.909	4,707^{a}	3,076	1.530^{a}
2. – 80 kcal – 3 % AA	1,322^{ab}	954	1.385^{abc}	2,182^{ab}	1,436	1.520	1,256	658	1.914	4,760^{ab}	3,047	1.562^{ab}
3. – 80 kcal – 6 % AA	1,367^{ab}	985	1.388^{abc}	2,258^{ab}	1,476	1.530	1,250	649	1.928	4,874^{ab}	3,113	1.566^{ab}
4. – 120 kcal – 3 % AA	1,321^{ab}	947	1.396^{ab}	2,200^{ab}	1,436	1.532	1,298	672	1.935	4,818^{ab}	3,035	1.587^{b}
5. – 120 kcal – 6 % AA	1,362^{ab}	961	1.419^{c}	2,263^{b}	1,476	1.533	1,282	660	1.950	4,901^{b}	3,075	1.595^{b}
6. – 80 kcal – 3 % AA + EC[4]	1,317^{a}	972	1.355^{ab}	2,139^{a}	1,439	1.490	1,229	651	1.890	4,685^{a}	3,054	1.535^{a}
7. – 80 kcal – 6 % AA + EC	1,365^{ab}	988	1.383^{abc}	2,240^{ab}	1,477	1.518	1,227	636	1.933	4,833^{ab}	3,110	1.554^{ab}
8. – 120 kcal – 3 % AA + EC	1,341^{ab}	971	1.382^{abc}	2,202^{ab}	1,454	1.515	1,245	646	1.928	4,787^{ab}	3,107	1.541^{a}
9. – 120 kcal – 6 % AA + EC	1,381^{b}	988	1.398^{bc}	2,230^{ab}	1,470	1.517	1,254	649	1.936	4,865^{ab}	3,125	1.557^{ab}
Mean	1,344	972	1.384	2,209	1,457	1.517	1,251	651	1.925	4,804	3,082	1.559
SEM	6.10	5.21	0.004	9.642	7.340	0.005	7.823	4.614	0.008	16.494	8.601	0.004
P- value	0.042	0.514	0.001	0.023	0.758	0.236	0.290	0.768	0.873	0.009	0.111	0.001
Contrasts (*P*- value)												
2 vs. 6	0.862	0.423	0.060	0.259	0.937	0.116	0.408	0.739	0.520	0.245	0.860	0.063
3 vs. 7	0.961	0.900	0.730	0.638	0.978	0.515	0.496	0.519	0.871	0.516	0.949	0.397
4 vs. 8	0.422	0.288	0.366	0.948	0.578	0.382	0.108	0.202	0.860	0.625	0.046	0.002
5 vs. 9	0.418	0.215	0.168	0.381	0.873	0.400	0.396	0.588	0.711	0.515	0.160	0.009
Enzyme vs no enzyme[5]	0.487	0.108	0.026	0.229	0.802	0.051	0.050	0.164	0.607	0.142	0.790	0.001

$^{a-b}$ Means not sharing de same letter differ significantly on Student-Newman-Keuls Test ($P < 0.05$).
[1] Feed intake.
[2] Body weight gain.
[3] Feed conversion ratio adjusted for the weight of dead birds.
[4] Carbohydrase complex with at least 2,600 DNS units of xylanase and 1,800 DNS units of β-glucanase per gram of product (Rovabio® Advance T-flex, Adisseo).
[5] Treatments with energy and AA reductions with enzyme against treatments with energy and AA reductions without enzyme

Table 6. Digestibility and IDE of broilers fed diets with energy and AA reductions supplemented or not with a carbohydrase complex [1].

	21 d		42 d	
Treatment	IDE, kcal/kg DM[2]	IDM[3], %	IDE, kcal/kg DM	IDM, %
1. Control	3,198[a]	63.9[a]	3,453[a]	71.4[ab]
2. – 80 kcal – 3 % AA	3,116[ab]	63.4[a]	3,393[ab]	70.8[ab]
3. – 80 kcal – 6 % AA	3,090[abc]	58.3[c]	3,385[ab]	70.7[ab]
4. – 120 kcal – 3 % AA	3,009[bc]	58.9[bc]	3,272[b]	70.3[ab]
5. – 120 kcal – 6 % AA	2,983[c]	58.6[bc]	3,270[b]	69.2[b]
6. – 80 kcal – 3 % AA + EC[4]	3,189[a]	63.7[a]	3,444[a]	72.0[a]
7. – 80 kcal – 6 % AA + EC	3,194[a]	61.0[abc]	3,444[a]	71.6[ab]
8. – 120 kcal – 3 % AA + EC	3,184[a]	62.2[ab]	3,382[ab]	71.1[ab]
9. – 120 kcal – 6 % AA + EC	3,157[a]	61.8[abc]	3,396[ab]	70.8[ab]
Mean	3,124	61.3	3,382	70.9
SEM	13.921	0.374	14.155	0.196
P- value	0.001	0.001	0.003	0.045
Contrasts (*P*- value)				
2 vs. 6	0.120	0.816	0.341	0.132
3 vs. 7	0.026	0.037	0.271	0.224
4 vs. 8	0.003	0.014	0.045	0.304
5 vs. 9	0.003	0.015	0.021	0.049
Enzyme vs no enzyme[5]	0.001	0.001	0.002	0.005

[a-c] Means not sharing de same letter differ significantly on Student-Newman-Keuls Test ($P < 0.05$).
[1] Means were obtained from 8 replicate floor pens using 4 birds per replicate.
[2] Ileal digestibility energy corrected for dry matter.
[3] Ileal digestibility of dry matter ileal.
[4] Carbohydrase complex with at least 2,600 DNS units of xylanase and 1,800 DNS units of β-glucanase per gram of product (Rovabio® Advance T-flex, Adisseo).
[5] Treatments with energy and AA reductions with enzyme against treatments with energy and AA reductions without enzyme

Table 7. Digestibility of AA of broilers fed diets with energy and AA reductions supplemented or not with a carbohydrase complex at 21 d, %[1].

Item	Indispensable AA									Dispensable AA						Total AA
	Arg	His	Ile	Leu	Lys	Met	Phe	Thr	Val	Ala	Asp	Cys	Glu	Gly	Ser	
Treatments																
1. Control	91.5^{a}	90.2^{a}	87.9^{a}	88.5^{a}	87.0^{a}	97.0	89.2^{a}	86.3^{a}	86.2^{ab}	85.9^{a}	88.8	87.6	89.4	84.2^{a}	83.1$^{\mathbf{ab}}$	87.8^{a}
2. – 80 kcal – 3 % AA	89.6^{a}	87.6^{ab}	86.1^{abc}	86.3^{bc}	85.0^{bc}	96.8	87.5^{abc}	82.7^{abc}	84.4^{abc}	84.0^{ab}	87.6	87.0	89.5	82.7^{ab}	81.8^{ab}	86.4^{ab}
3. – 80 kcal – 6 % AA	88.9^{b}	84.6^{b}	84.8^{c}	85.6^{bc}	83.0^{c}	96.8	86.5^{bc}	80.4^{c}	82.6^{c}	88.8^{ab}	86.1	86.9	88.9	81.0^{b}	81.3^{ab}	85.3^{b}
4. – 120 kcal – 3 % AA	89.3^{b}	87.2^{ab}	86.6^{abc}	86.1^{bc}	85.0^{bc}	96.8	87.2^{abc}	82.8^{abc}	84.3^{abc}	84.1^{ab}	86.8	87.0	88.8	82.5^{ab}	82.1^{ab}	86.2^{ab}
5. – 120 kcal – 6 % AA	89.3^{b}	87.0^{ab}	85.1^{bc}	85.4^{c}	83.1^{c}	96.8	86.2^{c}	80.9^{bc}	82.2^{c}	83.3^{b}	86.0	86.8	89.2	81.0^{b}	81.3^{b}	85.4^{b}
6. – 80 kcal – 3 % AA + EC[2]	90.7^{ab}	87.1^{ab}	88.2^{a}	87.8^{ab}	86.0^{ab}	97.1	88.4^{ab}	84.3^{ab}	86.8^{a}	85.7^{ab}	87.5	89.6	90.2	83.2^{ab}	83.3^{a}	87.3^{a}
7. – 80 kcal – 6 % AA + EC	90.4^{ab}	85.7^{ab}	87.0^{ab}	87.4^{abc}	84.4^{bc}	97.2	88.4^{ab}	82.8^{abc}	84.8^{abc}	84.8^{ab}	87.1	88.2	90.5	81.3^{b}	83.0^{ab}	86.7^{ab}
8. – 120 kcal – 3 % AA + EC	90.6^{ab}	87.0^{ab}	87.2^{ab}	87.2^{abc}	86.0^{ab}	96.9	88.3^{ab}	84.7^{a}	85.1^{ab}	86.0^{a}	88.1	86.6	90.2	82.6^{ab}	83.1^{ab}	87.2^{a}
9. – 120 kcal – 6 % AA + EC	89.7^{b}	87.1^{ab}	86.0^{abc}	85.8^{bc}	84.6^{bc}	97.1	87.3^{abc}	82.8^{abc}	84.0^{bc}	83.9^{ab}	86.9	87.7	90.1	81.4^{b}	83.2^{ab}	86.4^{ab}
Mean	90.0	87.1	86.5	86.7	84.9	97.0	87.7	83.1	84.5	84.6	87.2	87.5	89.6	82.2	82.5^{ab}	86.5
SEM	0.164	0.397	0.210	0.207	0.214	0.081	0.192	0.336	0.254	0.215	0.251	0.419	0.178	0.215	0.201	0.156
P- value	0.001	0.116	0.001	0.004	0.001	0.957	0.001	0.001	0.001	0.006	0.169	0.836	0.210	0.001	0.039	0.001
Contrasts (*P*- value)																
2 vs. 6	0.062	0.764	0.008	0.065	0.170	0.415	0.232	0.184	0.008	0.042	0.938	0.170	0.391	0.558	0.060	0.106
3 vs. 7	0.011	0.486	0.004	0.020	0.056	0.343	0.008	0.046	0.015	0.207	0.329	0.462	0.028	0.784	0.041	0.012
4 vs. 8	0.035	0.944	0.487	0.148	0.126	0.914	0.120	0.117	0.360	0.030	0.210	0.802	0.076	0.926	0.202	0.092
5 vs. 9	0.511	0.943	0.231	0.604	0.041	0.460	0.110	0.108	0.044	0.443	0.403	0.632	0.207	0.595	0.022	0.090
Enzyme vs no enzyme[3]	0.001	0.842	0.001	0.003	0.001	0.194	0.001	0.002	0.001	0.002	0.136	0.243	0.003	0.458	0.003	0.003

[a-c] Means not sharing de same letter differ significantly on Student-Newman-Keuls Test ($P < 0.05$).
[1] Means were obtained from 8 replicate floor pens using 4 birds per replicate.
[2] Carbohydrase complex with at least 2,600 DNS units of xylanase and 1,800 DNS units of β-glucanase per gram of product (Rovabio® Advance T-flex, Adisseo).
[3] Treatments with energy and AA reductions with enzyme against all treatments with energy and AA reductions without enzyme.

Table 8. Digestibility of AA of broilers fed diets with energy and AA reductions supplemented or not with a carbohydrase complex at 42 d, %[1].

Item	Indispensable AA									Dispensable AA						Total AA
	Arg	His	Ile	Leu	Lys	Met	Phe	Thr	Val	Ala	Asp	Cys	Glu	Gly	Ser	
Treatments																
1. Control	90.5^{a}	86.0	85.7^{a}	88.7	92.3	97.3	88.6	85.0	86.0^{a}	86.3	87.4	84.8	87.6	84.9	85.5	87.2^{a}
2. – 80 kcal – 3 % AA	86.8^{b}	80.9	83.6^{ab}	86.9	90.1	97.1	86.2	82.7	82.2^{b}	86.0	86.5	83.1	87.8	83.0	83.3	85.8^{ab}
3. – 80 kcal – 6 % AA	85.4^{b}	77.5	81.7^{b}	86.8	88.0	96.9	85.9	80.1	80.9^{b}	85.4	85.6	83.2	84.4	82.9	82.4	84.4^{b}
4. – 120 kcal – 3 % AA	86.5^{b}	80.7	83.0^{ab}	87.0	90.0	97.0	86.1	82.7	83.3^{b}	85.3	86.5	83.3	86.8	83.1	83.0	85.6^{ab}
5. – 120 kcal – 6 % AA	86.1^{b}	77.7	82.0^{b}	86.6	88.2	97.2	85.9	80.5	81.0^{b}	85.4	85.6	83.1	85.4	83.2	82.3	84.8^{ab}
6. – 80 kcal – 3 % AA + EC[2]	87.3^{b}	80.9	84.5^{ab}	87.3	90.2	97.3	86.2	83.6	83.4^{b}	86.3	87.4	83.7	86.9	84.5	84.5	85.9^{ab}
7. – 80 kcal – 6 % AA + EC	86.8^{b}	78.7	82.2^{b}	87.7	89.7	96.9	86.5	83.0	81.0^{b}	86.2	85.6	83.6	86.8	83.5	82.5	85.4^{ab}
8. – 120 kcal – 3 % AA + EC	87.0^{b}	80.9	83.4^{ab}	87.2	90.6	97.3	86.4	83.9	83.4^{b}	86.4	86.8	83.4	86.6	84.1	83.0	85.9^{ab}
9. – 120 kcal – 6 % AA + EC	86.4^{b}	77.9	82.4^{b}	87.3	88.9	97.0	86.6	81.0	81.2^{b}	86.2	85.7	83.3	86.2	83.8	82.3	85.2^{ab}
Mean	87.0	80.1	83.2	87.3	89.8	97.1	86.5	82.5	82.5	85.9	86.3	83.5	86.5	83.7	83.2	85.6
SEM	0.303	0.720	0.282	0.192	0.365	0.110	0.222	0.655	0.292	0.198	0.456	0.292	0.381	0.397	0.395	0.194
P- value	0.006	0.137	0.007	0.356	0.173	0.981	0.130	0.702	0.001	0.818	0.971	0.948	0.572	0.954	0.533	0.047
Contrasts (*P*- value)																
2 vs. 6	0.660	0.990	0.406	0.622	0.960	0.687	0.988	0.753	0.234	0.735	0.668	0.645	0.562	0.397	0.470	0.887
3 vs. 7	0.251	0.683	0.662	0.297	0.262	0.860	0.507	0.307	0.987	0.307	0.984	0.734	0.156	0.742	0.928	0.205
4 vs. 8	0.663	0.937	0.712	0.784	0.714	0.523	0.714	0.660	0.896	0.234	0.877	0.926	0.911	0.578	0.991	0.709
5 vs. 9	0.809	0.948	0.678	0.430	0.681	0.641	0.475	0.863	0.867	0.365	0.973	0.900	0.615	0.716	0.984	0.610
Enzyme vs no enzyme[3]	0.259	0.786	0.306	0.196	0.330	0.841	0.380	0.330	0.451	0.086	0.750	0.611	0.535	0.296	0.688	0.252

[a-c] Means not sharing de same letter differ significantly on Student-Newman-Keuls Test ($P < 0.05$).
[1] Means were obtained from 8 replicate floor pens using 4 birds per replicate.
[2] Carbohydrase complex with at least 2,600 DNS units of xylanase and 1,800 DNS units of β-glucanase per gram of product (Rovabio® Advance T-flex, Adisseo).
[3] Treatments with energy and AA reductions with enzyme against all treatments with energy and AA reductions without enzyme.

CAPÍTULO III

CONSIDERAÇÕES FINAIS

O presente trabalho reporta que a utilização de um complexo enzimático melhorou a conversão alimentar, a digestibilidade de AA e o aproveitamento da energia de frangos de corte alimentados com dietas milho-soja deficientes em energia e em aminoácidos digestíveis. A utilização do complexo enzimático composto por endo 1,4 xilanase e endo 1,3(4) β-glucanases pode ser uma estratégia eficaz para diminuir custos de produção da indústria avícola.

Foi possível observar que os frangos na fase inicial foram mais sensíveis às melhorias promovidas pela suplementação do complexo enzimático sobre o aproveitamento da energia e digestibilidade de AA do que na fase final. Acredita-se que isto pode ter ocorrido porque as aves jovens ainda não estejam completamente adaptadas aos ingredientes presentes nas rações, e as enzimas exógenas tenham auxiliado no processo digestivo dos animais.

Foi verificado que os aumentos na digestibilidade de AA, na utilização de energia e no desempenho zootécnico foram maiores em frangos alimentados com os menores níveis nutricionais quando suplementado o complexo enzimático em suas dietas. Sendo assim, é provável que os efeitos do produto enzimático utilizado seja mais visível em dietas com níveis nutricionais marginais, possivelmente porque nelas pode haver maior espaço para melhorias, pois as exigências dos frangos está mais distante de ser atendida.

Os resultados observados neste estudo contribuem para um maior conhecimento sobre a utilização de carboidrases em dietas milho-soja para frangos de corte, uma área em que os estudos ainda são recentes e escassos. Existe um grande caminho para investigar e desenvolver enzimas cada vez mais eficientes para os diferentes ingredientes usados na formulação de dietas para frangos de corte. Os reais mecanismos pelos quais as carboidrases aumentam o aproveitamento de nutrientes em ingredientes de alta digestibilidade, como o milho e o farelo de soja, e melhoram o desempenho zootécnico de frangos de corte, ainda precisam ser melhor elucidados.

REFERÊNCIAS

ACAMOVIC, T.; MC CLEARY, B.V. Optimising the response. **Feed Mix**, Doetinchen, v.4, n.4, p.14-19, 1996.

ADEOLA, O; COWIESON, A. J. Opportunities and challenges in using exogenous enzymes to improve nonruminant animal production. **Journal of Animal Science**, Champaing, v.89 p.3189-3218, 2011.

AVILA, E. et al. Evaluation of an enzyme complex containing nonstarch polysaccharide enzymes and phytase on the performance of broilers fed a sorghum and soybean meal diet. **Journal Applied of Poultry Research**, Athes, v.21, p.279-286, 2012.

BAKER, D. H. Advances in Amino Acid Nutrition and Metabolism of Swine and Poultry. In: KORNEGAY, E.T. **Nutrient Management of Food Animals to Enhance and Protect the Environment**. Florida: CRC Press, 1996. cap.5, p.41-53.

BACH KNUDSEN, K. E. Fiber and nonstarch polysaccharide content and variation in common crops used in broiler diets. **Poultry Science**, Champaign, v.93, p.2380-2393, 2014.

BAREKATAIN, M. R. et al. Interaction between protease and xylanase in broiler chicken diets containing sorghum distillers´ dried grains with solubles. **Animal Feed Science and Technology**, Amsterdam, v.182, p.71-81, 2013.

BEDFORD, M. R. Mechanism of action and potential environmental benefits from the use of feed enzymes. **Animal Feed Science and Technology**, Amsterdam, v.53, p.145-155, 1995.

BEDFORD, M. R. Exogenous enzymes in monogastric nutrition – their current value and future benefits. **Animal Feed Science and Tecnhology**, Amsterdam, v.86, p.1-13, 2000.

BEDFORD, M. R.; SCHULZE, H. Exogenous enzymes for pigs and poultry. **Nutrition Research Reviews**, Cambridge, v. 11, p. 91-114, 1998.

CHOCT, M. Feed non-starch polysaccharides: Chemical structures and nutritional significance. **Feed Milling International**, Watford, jun., p.13-26, 1997.

COWIESON, A. J. Factors that affect the nutritional value of maize for broilers. **Animal Feed Science and Technology**. v.119, p.293-305, 2005.

COWIESON, A. J. Strategic selection of exogenous enzymes for corn/soy-based poultry diets. **Journal of Poultry Science**, [Tsukuba], v.47, p.1-7, 2010.

COWIESON, A. J.; ADEOLA, O. Carbohydrases, proteases and phytase have an additive beneficial effect in nutritionally marginal diets for broiler chicks. **Poultry Science,** Campaign, v.84, p.1860-1867, 2005.

COWIESON, A. J.; RAVINDRAN, V. Sensitivity of broiler starter to three doses of an enzyme cocktail in maize based diets. **British Poultry Science**, Oxford, v.49, p. 340-346, 2008a.

COWIESON, A. J.; RAVINDRAN, V. Effect of exogenous enzymes in maize-based diets varying in nutrient density for young broilers: growth performance and digestibility of energy, minerals and amino acids. **British Poultry Science**, Oxford, v.49, n.1, p.37-44, 2008b.

FERNANDES, E. A. et al. Energetic values and performace of broilers feeding sorghum and soybean meal based diets supplemented with β-glucanase and β-xylanase. **Semina: Ciências Agrárias**, Londrina, v.37, n.2, p. 959-968, 2016.

GEHRING, C. K. et al. Identifiyng variation in the nutritional value of corn based on chemical kernel characteristics. **World´s Poultry Science Journal**, Ithaca, v. 69, p. 299-312, 2013.

GRACIA, M., et al. Alpha amylase supplementation of broiler diets based on corn. **Poultry Science,** Champaing, v.82, n.3, p.436-442, 2003.

GONZÁLEZ-VEGA, J. C. Amino acid digestibility in heated soybean meal fed to growing pigs. **Journal of Animal Science**, Champaing, v.89, p.3617-3625, 2014.

LEE, S. Y. et al. Effects of multiple enzyme (ROVABIO®Max) containing carbohydrolases and phytase on growth performance and intestinal viscosity in broiler chicks fed corn-wheat-soybean meal based diets. **Asian-Autralian Journal of Animal Science**, Champaing, v.23, n.9, p.1198-1204, 2010.

LEHNINGER, A.L.; NELSON, D.L.; COX, M.M. **Lehninger principles of biochemistry**. 3.ed. New York: Worth Publishers, 2000. 1152p.

LESLIE, M. A. et al. The effect of phytase and glucanase on the ileal digestible energy of corn and soybean meal fed to broilers. **Poultry Science**, Champaing, v.86, p.2350-2357, 2007.

KACZMAREK, S. A. et al. The effect of protease, amylase, and nonstarch polysaccharide-degrading enzyme supplementation on nutrient utilization and growth performance of broiler chickens fed corn-soybean meal-based diets. **Poultry Science**, Champaing, v.93, p.1745-1753, 2014.

KOCHER A. et al. Effects of Enzyme Combinations on apparent metabolizable energy of corn–soybean meal-based diets in broilers. **Journal Applied Poultry Research**, v.12, p.275-283, 2003.

MALATHI, V.; DEVEGOWDA, G. In vitro evaluation of nonstarch polysaccharide digestibility of feed ingredients by enzymes. **Poultry Science**, v.80, p.302-305, 2001.

MENG, X.; SLOMINSKI, B. A. The nutritive value of corn, soybean meal, canola meal or peas for broiler chickens as affected by a multi-carbohydrase preparation of cell wall degrading enzymes. **Poultry Science**, v.84, p.1242–1251, 2005.

OLUKOSI, O. A. et al. Age-related influence of a cocktail of xylanase, amylase, and protease or phytase individually or in combination in broilers. **Poultry Science**, v.86, n.1, p.77-86, 2007.

OLUKOSI, O. A. et al. Energy utilization and growt performance of broilers receiving supplemented with enzymes containing carbohydrase or phytase individually or in combination. **British Journal of Nutrition**, v.99, p.682-690, 2008.

PETER, C. M. et al. Limiting order of amino acids and the effects of phytase on protein quality in maize gluten meal fed to young chicks. **Journal of Animal Science**, Champaign, v.78, p.2150-2156, 2000.

RAVINDRAN, V. Feed enzymes: The science, practice, and metabolic realities. **Journal Applied Poultry Research,** Athens, v.22, p.628-636, 2013.

RUTHERFURD, S. M. et al. The effect of a commercial enzyme preparation on apparent metabolizable energy, the true ileal amino acid digestibility, and endogenous ileal lysine losses in broiler chickens. **Poultry Science,** Champaign, v.86, p.665-672, 2007.

SLOMINSKI, B. A. Recent advances in research on enzymes for poultry diets. **Poultry Science**, Campaign, v.90, p.2013–2023, 2011.

SIMON, O. The mode of action of NSP hydrolyzing enzymes in the gastrointestinal tract. **Journal of Animal and Feed Science**, Jablonna, v.7, n.3. p.115-123, 1998.

STEFANELLO, C. et al. Energy and nutrient utilization of broiler chickens fed corn-soybean and corn-based diets supplemented with xylanase. **Poultry Science**, Champaign, v.95, n.8, p.1881-1887, 2016.

STRADA, E. S. O. et al. Uso de enzimas na alimentação de frangos de corte. **Revista Brasileira de Zootecnia**, Viçosa, v.34, n.6, p. 2369-2375, 2005.

TAHIR, M. et al. Pectinase plays an important role in stimulating digestibility of a corn-soybean meal diet in broilers. **Journal of Poultry Science**, [Tsukuba], v 43, p.323-329, 2006.

WEST, M. L.et al. Assessment of dietary Rovabio Excel in practical United States broiler diets. **Journal Applied Poultry Research**, Athes, v.16 p.313–321, 2007.

YEGANI, M., KORVER, D. R. Effects of corn source and exogenous enzymes on growth performance and nutrient digestibility in broiler chickens. **Poultry Science**, Champaign, v.92, p.1206-1220, 2013.

ZANELLA, I. et al. Effect of enzyme supplementation of broiler diets based on corn and soybeans. **Poultry Science**, Champaign, v.78, n.4, p.561-568, 1999.

APÊNDICES

Apêndice 1: Normas para publicação de artigos no periódico Journal of Applied Poultry Research

Journal of Applied Poultry Research

Instructions to Authors

I. Scope and general information

A. Scope

The mission of The Journal of Applied Poultry Research (JAPR) is to provide practical, reliable, and timely information to those whose livelihoods are derived from the commercial production of poultry and those whose research benefits this sector; address topics of near-term application based on appropriately designed studies and critical observations; encourage scientific approaches to practical problem solving; and present information comprehensible to a broad readership. Opinions or views expressed in papers published by JAPR are those of the authors and do not necessarily represent the opinion of the Poultry Science Association or the editor-inchief.

B. Submission

All manuscripts are submitted and reviewed via the journal's Scholar One Manuscripts submission site at http://mc.manuscriptcentral.com/japr. New authors should create an account prior to submitting a manuscript for consideration.

C. Contact information for journal staff

For information on the scientific content of the journal, contact the editor-in-chief, Dr. John Carey, Texas A&M University Department of Poultry Science, 101 Kleberg Center, 2472 TAMU, College Station, TX 77843-2472; e-mail: mailto:jcarey@poultry.tamu.ed. For assistance with ScholarOne Manuscripts and manuscript submission, contact David Busboom at david.busboom@poultryscience.org. For assistance with article proofs, copyright forms, published manuscripts, contact Matthew Marusak at mailto:poultry.science@oup.com. For assistance with invoicing, contact mailto:production.invoicing@oup.com.

D. Types of articles

i.) Research reports

Most papers published in JAPR are research reports. The journal emphasizes the importance of good scientific writing and clarity in presentation of the concepts, apparatus, and sufficient background information that would be required for thorough understanding by scientists in other disciplines. The results of experiments published in JAPR must be replicated, either by replicating treatments within experiments or by repeating experiments.

ii.) Field reports

Field reports will be published when adequate background is available and conclusions can be supported by quantifiable laboratory or diagnostic results. The manuscript should follow the format outlined in the Style and Form section of this document. It should include a section titled Field Report in which the observations are explained and discussed under subheadings of Materials and Methods and Results and Discussion. Authors are encouraged to include subheadings for all major areas in this section.

iii.) Review articles

Articles submitted to this section may cover new developments in a field, describe the evolution of a currently accepted management practice, propose changes in management based on current research, or describe procedures. Clear distinctions should be made between firmly established practices and unresolved questions. Articles should begin with a concise description of the topic, followed by a critical evaluation of the important references. Review articles, whether solicited or unsolicited, will be subject to a stringent review process. Review articles should follow the general format outlined in the Style and Form, when appropriate, and include brief subheadings to separate main ideas. A Conclusions and Applications section should be included in most cases.

iv.) Symposium and workshop articles

Manuscripts presented at the annual meeting as part of a symposium or workshop may be submitted with prior agreement by the editor-in-chief. These submissions will be subject to peer review and may be accepted or rejected in the same manner as other submissions. The format may be similar to reviews, research reports, or field reports, as outlined in the Style and Form.

v.) Letters and commentaries

The journal accepts letters, book reviews, and other free-form communications (used to correct errors, provide clarification, or offer other points of view on pertinent issues). Submissions may be edited in consultation with the author.

II. Journal Policies

A. Peer review process

The journal uses a two-stage review process. All manuscripts will first receive a preliminary review to ensure appropriateness for the journal. The second review will be a more detailed scrutiny by individuals knowledgeable in the specific subject area of the paper. Additional examination of the manuscript will be made by the editors. The review process will be stringent. Names of authors will be made known to reviewers; reviewers may contact the authors directly with questions, suggestions, and comments if such contact will improve the paper or streamline the review process. The subject editors will handle all initial correspondence with authors during the review process; the editor-in-chief will notify the author of the final decision to accept or reject.

B. Pre-review language editing If your first language is not English, to ensure that the academic content of your paper is fully understood by journal editors and reviewers, we recommend using an external language editing service. Language editing is optional and does not guarantee that your manuscript will be accepted for publication. For further information on this service, please click here. Several specialist language editing companies offer similar services and you can also use any of these. Authors are liable for all costs associated with such services

C. Ethics Authors should observe high standards with respect to publication ethics as set out by the Commission on Publication Ethics (COPE). Falsification or fabrication of data, plagiarism, including duplicate publication of the authors' own work without proper citation, and misappropriation of the work are all unacceptable practices. Any cases of ethical misconduct are treated very seriously and will be dealt with in accordance with the COPE guidelines. By submission of a manuscript, the authors guarantee to the journal that the work described has not been published before (except in the form of an abstract or as part of a published lecture, review, thesis, or dissertation); that it is not under consideration for publication elsewhere; and that its publication has been approved by all coauthors, if any, as well as by the responsible authorities at the institute where the work has been carried out. Appropriate identification of previously published preliminary reports should be provided in a title page footnote.

D. Care and use of animals

Authors must make it clear that experiments were conducted in a manner that avoided unnecessary discomfort to the animals by the use of proper management and laboratory techniques. Experiments shall be conducted in accordance with the principles and specific guidelines presented in Guide for the Care and Use of Agricultural Animals in Research and Teaching, 3rd edition, 2010; and, if applicable, Guide for the Care and Use of Laboratory Animals (United States Department of Human Health and Services, National Institutes of Health, Publication Number ISBN 0-309-05377-3, 1996); or Guide to the Care and Use of Experimental Animals, 2nd ed. Volume 1, 1993 (Canadian Council on Animal Care). Methods of killing experimental animals must be described in the text. In describing surgical procedures, the type and dosage of the anesthetic agent must be specified. Intra-abdominal and intrathoracic invasive surgery requires anesthesia. This includes caponization. The editor-in-chief of Poultry Science may refuse to publish manuscripts that are not compatible with these guides. If rejected solely on that basis, however, the paper may be resubmitted for reconsideration when accompanied by a written verification that a committee on animal care in research has approved the experimental design and procedures involved.

D. Third-party copyright

In order to reproduce any third party material, including tables, figures, or images, in an article authors must obtain permission from the copyright holder and be compliant with any requirements the copyright holder may have pertaining to this reuse. When seeking to reproduce any kind of third party material authors should request the following:

i.) non-exclusive rights to reproduce the material in the specified article and journal;

ii.) print and electronic rights, preferably for use in any form or medium;

iii.) the right to use the material for the life of the work; and

iv.) world-wide English-language rights. It is particularly important to clear permission for use in both the print and online versions of the journal, and we are not able to accept permissions which carry a time limit because we retain journal articles as part of our online journal archive.

E. Third-party content in Open Access papers

If you will be publishing your paper under an Open Access license but it contains material for which you do not have Open Access re-use permissions, please state this clearly by supplying the following credit line alongside the material:

Title of content

Author, Original publication, year of original publication, by permission of [rights holder]

G. Conflict of interest Oxford University Press requires declaration of any conflict of interest upon submission online. If the manuscript is published, conflict of interest information will be communicated in a statement in the published paper.

H. Permissions regarding reuses of OUP material

i.) Rights & Permissions

Global Business Development and Rights: At Oxford University Press (OUP), it is a core part of our objective to encourage the widest possible dissemination of our journal content. We offer a comprehensive suite of licensing services to meet the needs of institutions, pharmaceutical and healthcare companies, and publishers worldwide. Please see below for more information on the licensing options available.

ii.) Permissions

Permission for reuse or republication of Oxford Journals figures, abstracts, or articles, can be granted for a range of re-uses, including:

1. Republication in a book/ journal
2. eBook
3. PowerPoint presentation
4. Academic course packs
5. Thesis

The fastest and most efficient way to obtain permission to reuse Oxford Journals content is by using our Rightslink automated permissions system.

iii.) Oxford Open – Open Access

Articles published under our Oxford Open - Open Access model are clearly labeled, and made freely available online immediately upon publication, without subscription barriers to access. In addition, the majority of articles that are made available under Oxford Open, will also allow readers to reuse, republish, and distribute the article in a variety of ways, depending upon the license used. For further detail on Oxford Open and the activities permitted under our Open Access licenses, please click here.

iv.) STM Permissions Guidelines and signatories A key part of our efforts to minimize the administration that is often involved in permission clearances while ensuring that any re-use of limited amounts of content from our journals is fair and the original source of the material fully attributed. It should be emphasized here that these are just guidelines.

v.) Rights and permissions guidelines for Authors

For details of our Publication Rights policies and obtaining third party permission please download our Guidelines for Author Permissions. Selfarchiving policies are specific to each journal, but details of these polices and their terms and conditions can be found on the journals' homepage.

vi.) Translation rights

1. Reprints Reprints are powerful promotional tools, not only at industry-specific exhibitions, conferences and meetings, but also for sales representatives and medical professionals in the field. Content Ed Net is OUP's current authorised provider for translated article reprints for the pharma industry. For more information on how to obtain translation reprints for your market/ territory, please contact us.
2. Local Excerpted editions
   Local Editions provide an excellent opportunity to disseminate important research to healthcare professionals who may not otherwise have access to Oxford Journals content. OUP currently licenses Local Edition rights in more than a dozen territories across the globe. Publishing partners can select articles of interest to a specific market and distribute sponsored issues in the local language. For more information on our translation licensing activities, please contact us.

vii.) Business development – Digital licensing

OUP has an active digital licensing policy across our full range of journals and books. The Business Development group works to establish strategic partnerships and digital licensing relationships with companies all over the world. These activities are heavily focused on maximizing the dissemination, usage, and discoverability of Oxford content worldwide, while also incubating new business models and routes to market. To this end, the Business Development group licenses material into a wide range of digital platforms, including:

1. Online Aggregators
2. Mobile technologies
3. Discoverability services
4. Text Mining databases
5. Abstract and Indexing services
6. For more information or to discuss licensing OUP content, please contact us.

I. Self-archiving policy

i.) Author’s original version

The author’s original version is defined here as the un-refereed author version of an article that is considered by the author to be of sufficient quality to be submitted for formal peer review by a second party. The author accepts full responsibility for the article, which may have a version number or date stamp and the content and layout is set out by the author. Prior to acceptance for publication in the journal, authors retain the right to make their original version of the article available on their own personal website and/or that of their employer and/or in free public servers of original version articles in their subject area, provided that, upon acceptance, they acknowledge that the article has been accepted for publication as follows:

This article has been accepted for publication in [Journal Title] Published by Oxford University Press.

ii.) Version of record

The version of record is defined here as a fixed version of the journal article that has been made available by OUP by formally and exclusively declaring the article "published". This includes any "early release" article that is formally identified as being published even before the compilation of a volume issue and assignment of associated metadata, as long as it is citable via some permanent identifier(s). This does not include any "early release" article that has not yet been "fixed" by processes that are still to be applied, such as copy-editing, proof corrections, layout, and typesetting. Authors of Oxford Open articles are entitled to deposit their original version or the version of record in institutional and/or centrally organized repositories and can make this publicly available immediately upon publication, provided that the journal and OUP are attributed as the original place of publication and that correct citation details are given. Authors should also deposit the URL of their published article, in addition to the PDF version. The journal strongly encourages Oxford Open authors to deposit the version of record instead of the original version. This will guarantee that the definitive version is readily available to those accessing your article from such repositories, and means that your article is more likely to be cited correctly. Oxford Journals automatically deposits open access articles in PMC for the majority of journals participating in Oxford Open. For a list of journals involved and for the latest information on the status of PMC deposits for individual journals please see journals which offer an open access model. In case of query please contact Journals Permissions.

J. Copyright

The Poultry Science Association, Inc. retains the copyright to all materials accepted for publication in the journal unless an Open Access license is selected. Authors will be asked to complete a Copyright Transfer Agreement following acceptance of their paper through the journal's Author Services website.

K. Open Access

After your manuscript is accepted, the corresponding author will be required to complete a mandatory license to publish agreement. As part of the licensing process you will be asked to indicate whether or not you wish to pay for Open Access. If you do not select the open access option, your paper will be published with standard subscriptionbased access and you will only be charge page charges. JAPR authors have the option to publish their paper under the Oxford Open initiative; whereby, for a charge, their paper will be made freely available online immediately upon publication.

i.) Licenses RCUK/Wellcome Trust/COAF funded authors publishing in JAPR can use the Creative Commons Attribution license (CC BY) for their articles. All other authors may use a Creative Commons Non-Commercial license (CC BY-NC). Please click here for more information about Creative Commons licenses.

ii.) Charges

The Open Access charges are as follows:

1. PSA Members: $1,500 (if at least one author is a current PSA member)
2. Standard charge: $2,000
3. Reduced Rate Developing country charge*: $1,000
4. Free Developing country charge*: $0

Visit our developing countries page to view a list of qualifying countries. Authors can pay Open Access charges using our Author Services site. This will enable you to pay online with a credit/debit card, or request an invoice by email or mail. Please note that if an author elects to publish Open Access, page charges do not apply. However, Open Access charges are in addition to any color charges that may apply. Orders from the UK will be subject to the current UK VAT charge. For orders from the rest of the European Union, OUP will assume that the service is provided for business purposes. Please provide a VAT number for yourself or your institution, and ensure you account for your own local VAT correctly.

III.Preparation of manuscript

A. Manuscript format and structure/style

i.) General Papers must be written in English. The text and all supporting materials must use American spelling and usage as given in The American Heritage Dictionary, Webster's Third New International Dictionary, or the Oxford American English Dictionary. Authors should follow the style and form recommended in Scientific Style and Format: The CSE Manual for Authors, Editors, and Publishers. 2006. 7th ed. Style Manual Committee, Council of Science Editors, Reston, VA.

ii.) Preparing the manuscript file Manuscripts should be typed double-spaced, with lines and pages numbered consecutively, using Times New Roman font at 12 points. All special characters (e.g., Greek, math, symbols) should be inserted using the symbols palette available in this font. Complex math should be entered using MathType from Design Science (www.dessci.com). Tables and figures should be placed in separate sections at the end of the manuscript (not placed within the text). Metric or English units (or both) are acceptable. Authors should use units appropriate for the intended audience. Energy content of feeds will be expressed as calories.

iii.) Headings

1. Major headings Major headings are centered, boldface, in all capital letters, and consist of SUMMARY, DESCRIPTION OF PROBLEM, MATERIALS AND METHODS, RESULTS AND DISCUSSION, CONCLUSIONS AND APPLICATIONS, and REFERENCES AND NOTES. Major headings in review articles, field reports, and symposium articles may vary from those listed here, but should include SUMMARY, CONCLUSIONS AND APPLICATIONS, and REFERENCES AND NOTES.

2. First subheadings
   First subheadings are boldface and italic, on a separate line beginning at the left margin, and have the first letter of each important word capitalized. Text that follows a first subheading should be in a new paragraph.
3. Second subheadings Second subheadings begin the first line of a paragraph. They are indented, boldface, italic, and followed by a period. The first letter of each important word is capitalized. The text follows immediately after the final period of the subheading.

iv.) Title page The title should be indicative of the content. It should capture the interest of all who might benefit from information in the manuscript. However, the length of the title should be kept to a minimum. The running title should be 30 characters or less, including spaces. Address and affiliation of authors (listed by first name or initials, middle initial, and last name) should be included. Indicate to whom correspondence should be directed by means of a footnote, with the notation "Corresponding author: (e-mail address)" at the bottom of the title page. List 3 to 8 key words or phrases to identify the most important subjects covered by the paper. Statement of primary audience. To determine appropriateness for the journal and to assist in selecting reviewers, the author should indicate clearly what sector(s) within the poultry com- munity (e.g., flock supervisors, nutritionists, quality assurance personnel, researchers, plant managers, veterinarians) could benefit most from the content of this article.

v.) Summary The Summary (maximum of 250 words) is not an abstract. It is intended to give readers with diverse backgrounds a general appreciation of the manuscript contents. It should be written so that even those not directly interested in the topic will enjoy reading at least this section to keep abreast of areas other than their own. This section should not include details of materials and methods or a detailed review of the results. Keep the summary free-flowing, giving the reader a general, not specific, idea of what the study revealed. Do not include reference citations in the summary.

vi.) Description of problem This section will acquaint the reader with the problem, citing field experiences where appropriate. Readability is of utmost importance. Detailed literature reviews may not be appropriate for this section. A more extensive citation of references should be included in the Results and Discussion or References and Notes section. This section should end with a statement of the objective(s) of the study.

vii.) Materials and methods The author(s) should clearly establish in the Materials and Methods section why the problem was approached in a particular way. The rationale for including each treatment should be clearly stated. Detailed laboratory and bird management procedures should be described in the References and Notes section and not in the Materials and Methods section. Sources of stock, equipment, and materials should be listed in the References and Notes section and referred to in text by citation number. A brief statement of the statistical methods should be included, with more detailed descriptions placed in the References and Notes section. In manuscripts using several treatments, a description of treatments should be included as Table 1.

viii.) Results and discussion This section begins with observed results and their interpretation. Descriptive subheadings may precede all major paragraphs and changes in subject emphasis. This section should discuss specifically how findings address the problem described in the Description of Problem section and how they are related to published works. Statements regarding statistically significant differences between treatments in results should be included in the text, tables, and figures. Statements regarding differences should be avoided unless they are supported by statistical analyses and meet the stated level of probability (e.g., $P < 0.05$).

ix.) Conclusion and applications Conclusions and recommendations of the author(s) should be listed numerically. Each statement should be clear, concise, and without discussion. Authors are encouraged to summarize their significant findings, to identify further research needs, and to describe the constraints, economics, and other factors associated with using the results in scientific or commercial applications. Do not include references in this section.

x.) References and notes (with Acknowledgements) References and notes should be cited in text, by number within an editorial bracket (e.g., [1]). In the References and Notes section, citations should be listed in the order they appear and are numbered in the text (not alphabetically). Authors are encouraged to use reference management software (e.g., EndNote or Reference Manager) to facilitate renumbering or inserting references by the editor or inserting references during the revision process. Manuscripts may be returned to authors before review for renumbering of references if not cited in numerical order. Include details such as statistical analysis; detailed procedures; sources of birds, instruments, or items; details of designed instruments; a literature review; and other tangential matters. Cite acknowledgments at the end of this section in a subsection called Acknowledgments. These entries are not numbered.

xi.) Sample references

1. Journal Article

1. Dansky, L. M., and F. W. Hill. 1952. Application of the chromic oxide indicator method to balance studies with growing chicks. J. Nutr. 47:449–459.

2. Snow, J. L., M. W. Douglas, and C. M. Parsons. 2003. Phytase effects on amino acid digestibility in molted laying hens. Poult. Sci. 82:474–477.

3. Witter, R. L., and I. M. Gimeno. 2006. Susceptibility of adult chickens, with and without prior vaccination, to challenge with Marek's disease virus. Avian Dis. 50:354–365. doi:10.1637/7498- 010306R.1

2. Monograph

4. NRC. 1994. Nutrient Requirements of Poultry. 9th rev. ed. Natl. Acad. Press, Washington, DC.

3. Dissertation

5. Heskett, E. A. 2003. Efficacy of a recombinant herpes virus of turkeys vector vaccine, expressing genes to Newcastle disease virus and Marek's disease virus, in chickens and turkeys against exotic Newcastle disease virus challenge. PhD Diss. Univ. Florida, Gainesville.

4. Trade Publication

6. Wilgus, H. S. 1973. Temperature-programmed feeding schedules and other means of conserving protein in market turkey production. Feedstuffs 45(27):27–31.

5. Book or Chapter in Book

7. AOAC International. 2007. Official Methods of Analysis of AOAC International. 18th ed. Rev. 2. AOAC Int., Gaithersburg, MD.

8. Whittow, G. C. 1976. Regulation of body temperature. Pages 146–173 in Avian Physiology. P. Sturkie, ed. Springer-Verlag, New York, NY.

6. Proceedings

9. Hruby, M., J. C. Remus, and E. E. M. Pierson. 2004. Nutritional strategies to meet the challenge of feeding poultry without antibiotic growth promotants. Pages 3–5 in Proc. 2nd Mid-Atlantic Nutr. Conf., Timonium, MD. Univ. Maryland, College Park.

7. Federal Register

10. USDA, Animal and Plant Health Inspection Service. 2004. Blood and tissue collections at slaughtering and rendering establishments, final rule. 9CFR part 71. Fed. Regist. 69:10137– 10151.

8. Laboratory Procedure

11. The extract was added to 30 mL of hexane, made to 100 mL with 10% aqueous Na_2SO_4.

9. Personal Communication

12. Wilson, H. R. 2005. Univ. Florida, Gainesville. Personal communication.

10. Proprietary Product

13. Avizyme TX, Finnfeed International, Marlborough, Wiltshire, UK.

14. Thymol, 99% purity, Acros Organics, Geel, Belgium.

11. Statistical Procedure If a note has an embedded reference, the reference is cited by number (as in the text) or parenthetically within the note:

15. Data were analyzed by ANOVA with flock as the independent variable. When differences among flocks were significant, means were separated using Duncan's multiple range test (SAS User's Guide, 2001, Version 8 ed., SAS Institute Inc., Cary, NC). Pearson product-moment correlation coefficients were calculated between average percentage cracks from each flock recorded every week and average values for egg-specific gravity, breaking strength, percentage shell, shell thickness, and shell weight per unit of surface area. Significance implies P < 0.05.

12. Statistical Software

16. SAS User's Guide. 2001. Version 8 ed. SAS Inst. Inc., Cary, NC.

13. US Patent

17. El Halawani, M. E., and I. Rosenboim. 2004. Method to enhance reproductive performance in poultry. Univ. Minnesota, assignee. US Pat. No. 6,766,767.

14. Website

18. Dyro, F. M. 2005. Arsenic. WebMD. Accessed Feb. 2006. http://www.emedicine.com/neuro/ topic20.htm.

15. Acknowledgments

19. The advice and technical assistance of Thomas Jones (affiliation, location) are acknowledged.

B. Tables

Number tables consecutively according to the citation in the text. Tables must be created using the Microsoft Word table feature and inserted in the manuscript after the references section. Each table must be placed on a separate page and must have a clear descriptive heading so that the meaning of the data will be understandable without reference to the text. Indicate footnotes to tables with numbers, beginning with 1. Statistical notation should be made with lowercase and uppercase superscript letters or with asterisks, as appropriate. Statistical notation should place the superscript "a" on the largest mean. Probability values may be indicated as follows: *P ≤ 0.05, **P ≤ 0.01, ***P ≤ 0.001, and †P ≤ 0.10. Consult a recent issue of the journal for examples of tables.

C. Miscellaneous usage notes

i.) Abbreviations

The following abbreviations may be used without definition in JAPR. Plurals do not require "s." Chemical symbols and 3-letter abbreviations for amino acids do not need definition. Other abbreviations should be defined at first use in the summary and the main text, as well as in each table or figure in which they appear. Author-defined abbreviations are boldface at first use in the main text. Abbreviations should not be used in the manuscript title, running title, or to begin a paragraph or sentence. They can be used in section headings if previously defined. This list appears inside the back cover of each issue of the journal. The following abbreviations may be used without definition in JAPR:

ADF acid detergent fiber
ADFI average daily feed intake
ADG average daily gain
AME apparent metabolizable energy
AMEn nitrogen-corrected apparent metabolizable energy
ANOVA analysis of variance
AOAC Association of Official Analytical Chemists
BSA bovine serum albumin
BW body weight
°C Celsius
cDNA complementary DNA
CF crude fiber
cfu colony-forming units (following a numeral)
CI confidence interval
CP crude protein
cpm counts per minute
CV coefficient of variation
d day
df degrees of freedom
DM dry matter
DNA deoxyribonucleic acid
EDTA ethylenediaminetetraacetate
EE ether extract
ELISA enzyme-linked immunosorbent assay
°F Fahrenheit
FCR feed conversion ratio
FE feed efficiency
ft foot
g gram
gal gallon
G:F gain-to-feed ratio
GLM general linear model
h hour
HEPES N-(2-hydroxyethyl)piperazine-N′-2-ethanesulfonic acid
HPLC high-performance (high-pressure) liquid chromatography
ICU international chick units Ig immunoglobulin
IL interleukin
i.m. intramuscular
in. inch
i.p. intraperitoneal
IU international units
i.v. intravenous
kcal kilocalorie
L liter (also capitalized with any combination, e.g., mL)
lb pound
L:D hours of light:hours of darkness in a photoperiod
LSD least significant difference
m meter

μ micro
M molar
ME metabolizable energy
MEn nitrogen-corrected metabolizable energy
MHC major histocompatibility complex
mRNA messenger ribonucleic acid
min minute
mo month
MS mean squares n number of observations
NADH reduced form of NAD
NDF neutral detergent fiber
NRC National Research Council
NS not significant
PBS phosphate-buffered saline
PCR polymerase chain reaction
ppm parts per million
r correlation coefficient
r2 coefficient of determination, simple
R2 coefficient of determination, multiple
RH relative humidity
RIA radioimmunoassay
RNA ribonucleic acid
rpm revolutions per minute
s second
SAS Statistical Analysis System
s.c. subcutaneous
SD standard deviation
SE standard error
SEM standard error of the mean
SNP single nucleotide polymorphism
SRBC sheep red blood cells
TBA thiobarbituric acid
T cell thymic-derived cell
TME true metabolizable energy
TMEn nitrogen-corrected true metabolizable energy
TSAA total sulfur amino acids
USDA United States Department of Agriculture
UV ultraviolet
vol/vol volume to volume
vs. versus
wt/vol weight to volume
wt/wt weight to weight
wk week
yr year

ii.) SNP Nomenclature The increasing number of SNP association studies and the improvements in chicken genome annotation require a standardized SNP nomenclature for unequivocal and correct SNP identification. Additionally, information regarding the

SNP investigated should be easily accessible in a publicly available database. Therefore, all relevant SNP included in a study should be listed with their unique RefSNP (rs) or submitted SNP (ss) number (if rs number is not yet available) as indicated in the public domain NCBI dbSNP database (http://www.ncbi.nlm.nih.gov/snp). If the SNP investigated do not yet have an entry in the NCBI dbSNP database, the authors of the manuscript are responsible for submitting all the required information to NCBI (see http://www.ncbi.nlm.nih.gov/projects/SNP/) for depositing the SNP into this database and obtaining a unique ss number for the SNP. In the text of the manuscript, use of the rs/ss number of the SNP or an alternative standardized nomenclature is recommended.

D. Figures/Illustrations

i.) Permissions

All copyright permission must be cleared and, if necessary, paid for by the author; this includes applications and payments to DACS (Data Access Control System), ARS (Artists Rights Society), and similar licensing agencies where appropriate. It is also the author's responsibility to include acknowledgements as stipulated by particular institutions.

ii.) Requirements

Submission of figures in an electronic format will help us to ensure that your work is produced to the highest possible standard. This page contains information on how best to prepare your artwork for electronic submission. Most figure file formats are acceptable, although TIFF is preferable. TIFFs (Tagged Image File Format) are used for bitmap, greyscale, and colour images. To save files in TIFF format, go to the 'Save As' or 'Export' commands under 'File'. Before submitting artwork, please make sure that your image(s) fulfil the following criteria

iii.) Formats A number of different file formats are acceptable, including:

1. Tagged Image File Format (.tif)* (please check settings when exporting to Tiff from the original application).
2. Encapsulated PostScript (.eps)*
3. Rich Text Format (.rtf)
4. (Editable) Microsoft Word (.doc/.docx) (image files embedded into Word are often not good quality).
5. (Editable) Microsoft PowerPoint (.ppt/.pptx) (image files embedded into PoerPoint are often not good quality).
6. Microsoft Excel (.xls/.xlsx)
7. editable Portable Document Format (PDF)
8. Postscript (.ps)
9. Photoshop (.psd)
10. Adobe Illustrator (.ai)
11. Graphics Interchange Format (.gif)
12. Portable Network Graphics (.png) *preferred file format. Note that .jpg is not a file format listed as files produced as

JPGs condense every time they are opened (and thus lose quality).

iv.) A note about resolution and quality: PPI vs. DPI

1. The quality of an image is not dependent upon DPI. Typically when an image is of low quality (even though the resolution is within standards), the image contains pixelated text. This means that the figure should be redrawn using a standard font and that care should be taken to ensure the font is embedded.
2. DPI pertains to the print version of the image; PPI to the online version. The compositor will take care to convert the accepted figure files accordingly. It is important to note that maximum size should be set at 1081 width by 1280 height for PPI / 600 DPI for line drawings and a minimum 300 DPI for colour or tone images.
3. Graphics downloaded from the Web are not acceptable for print reproduction. These graphics are low-resolution images (usually 72 dpi) that are suitable for screen display but far below acceptable standards for print reproduction.
4. Please take care that images you supply are not simply low resolution figures that have been expanded. These types of images will appear pixelated when maximised.

v.) Specific types of artwork

1. Bar graphs
   Avoid the use of gray or color in bar graphs. Instead, please use solid black, solid white, and patterned (e.g., horizontally or diagonally striped) bars.
2. Line art
   Line art is best reproduced when it is submitted as crisp blackand-white images and contains no unnecessary gray shading.
3. Patterns
   If your image requires the use of many lines (as line graphs often do), please choose patterns that are easily distinguished from each other. Patterns with similar characteristics are hard to differentiate after reduction. For additional useful information on preparing your figures for publication, go to http://cpc.cadmus.com/da.
4. Equations and tables
   All equations to be formatted using MathType only; image versions should be avoided. All tables to be in editable format in either Word or Excel; image and pdf versions should be avoided.

vi.) Requirements

Follow these rules for figures:

1. Number them consecutively following the sequence in which they are mentioned in the text.

2. Include scale bars where appropriate. These should not be placed in the legend.
3. Size figures for publication:

Design	Page size	Nº of columns	Required figure processing width	
			Single column	Double column
Large format	279 x 216 mm	Double	90 mm	180 mm
Medium foram	246 x 189 mm	Double	80 mm	160 mm
Small format	234 x 156 mm	Single	130 mm	

4. Figures must:
- Be submitted for publication at resolutions of 600 dots per inch for line figures/black&white images and 300 dots per inch for half tones/color figures.
- Use the same font type for all figures; use standard fonts such as Times, Courier, Arial, Helvetica, or Symbol. • Have embedded fonts. Embedding the fonts ensures that the text is retained within the figure during production.
- Have uniform lettering style and ensure that figure locants are consistently sized throughout. Figures will not be redrawn by the publisher.
- Have legends that define abbreviations and contain enough information so the figure can be understood independently of the text. Legends should be listed one after the other at the end of the main text document.
- Be converted to grayscale if originally created in color but intended to be printed in black and white BEFORE acceptance.
- Be saved in a separate file.
- Always use the latest version of the software program available. Files from older versions often lose integrity when opened in newer versions.
- Have layers flattened into one layer, if using any files consisting of layers (e.g., .eps).
- Be saved as clearly named files so that they can easily be identified in terms of manuscript, figure number, and format (e.g. [first author surname]Fig1.tif).
- Have figure legends/captions included at the end of the main text file. Please ensure that figures and figure legends/captions are in agreement. Symbols must NOT be included in figure legends; ALL symbols used in figures should be described in the legend/caption using words (e.g., filled triangle, open circle). Symbols may be used in the key within the figure artwork.

- Have line weights between 0.35 pt and 1.5 pt; if there are multiple lines in use, use patterns to differentiate them. Do not use lines that are thinner than 2 points, including the “hairline” width option in some programs.
- Have colour supplied in CMYK and not RGB. Please note that the use of red and green in figures is particularly problematic for approximately 5% of the male population. Advice on the preparation of colour-friendly figures is provided at: http://jfly.iam.utokyo.ac.jp/html/manuals/pdf/color_blind.pdf.
- Have all data included within the illustration area.
- Avoid placing labels over a shaded area of the image.

E. Supplementary data

Submit all material to be considered as Supplementary Material online at the same time as the main manuscript. Ensure that the supplementary material is referred to in the main manuscript at an appropriate point in the text. Supplementary material will be available online only and will not be copyedited, so ensure that it is clearly and succinctly presented, and that the style conforms to the rest of the paper. Also ensure that the presentation will work on any Internet browser. It is not recommended for the files to be more than 2 MB each, although exceptions can be made at the editorial office’s discretion.

IV. Charges

A. Open Access charges

After your manuscript is accepted, the corresponding author will be required to complete a mandatory license to publish agreement. As part of the licensing process you will be asked to indicate whether or not you wish to pay for Open Access. If you do not select the open access option, your paper will be published with standard subscription-based access and you will only be charge page charges. JAPR authors have the option to publish their paper under the Oxford Open initiative; whereby, for a charge, their paper will be made freely available online immediately upon publication.

i.) Licenses RCUK/Wellcome Trust/COAF funded authors publishing in JAPR can use the Creative Commons Attribution license (CC BY) for their articles. All other authors may use a Creative Commons Non-Commercial license (CC BY-NC.

ii.) Charges The Open Access charges are as follows:

1. PSA Members: $1,500 (if at least one author is a current PSA member)
2. Standard charge: $2,000
3. Reduced Rate Developing country charge*: $1,000
4. Free Developing country charge*: $0 *Visit our developing countries page to view a list of qualifying countries.

Authors can pay Open Access charges using our Author Services site. This will enable you to pay online with a credit/debit card, or request an invoice by email or mail. Please note that if an author elects to publish Open Access, page charges do not apply. However, Open Access charges are in addition to any color charges that may apply. Orders from the UK will be subject to the current UK VAT charge. For orders from the rest of the European Union, OUP will assume that the service is provided for business purposes. Please provide a VAT number for yourself or your institution, and ensure you account for your own local VAT correctly.

B. Conventional page charges

The current charge for publication is $60 per printed page (or fraction thereof) in the journal if at least one author is a professional member of PSA. If no author is a member of PSA, the publication charge is $85 per journal page. The corresponding author shall be financially responsible for insuring payment of relevant page charges in a timely manner. The Editorial Office reserves the right to deny further publication to the corresponding author until such time as payment is received. Waivers of page charges must be requested in advance of submission and will only be considered from authors from the approved list of developing countries.

C. Color changes

The cost to publish in color in the print journal is $600 per color image. Color versions of figures will be included in the online PDF and full-text article at no charge.

V. Additional information about accepted manuscripts

A. Charges

For charges relating to publication in JAPR please access https://academic.oup.com/japr/

B. Proofs

Authors will receive a link to the PDF proof of their manuscript on our online system by email, and it is essential that a current email address is supplied with all manuscripts. Proofing instructions will accompany the PDF file but the proof should be checked immediately upon receipt and uploaded in accordance with covering instructions. Only essential corrections should be made at the proof stage.

C. Advance access For JAPR, manuscripts arrive at OUP and go through the production process until the final versions are ready to publish. These are then published on the journal’s Advance Access page: http://japr.oxfordjournals.org/content/early/recent. They will remain on the page up until the issue that they are assigned to is published.

D. Offprints

All contributors of published articles will have free online access to the PDF and HTML version of their article, to which links can be created from an institutional or firm website. Authors of accepted articles can order paper offprints during the publication process. All authors are sent an individual link (after acceptance) to the Author Services site, where they are able to order offprints and single issues.

E. CrossRef Funding Data registry In order to meet your funding requirements authors are required to name their funding sources, or state if there are none, during the submission process. For further information on this process or to find out more about the CHORUS initiative please acess https://academic.oup.com/journals/pages/open_access/funder_policies/chorus

Apêndice 2. Desempenho zootécnico dos frangos de corte no período de 1 a 21 dias

Tratamento	GP, kg	CA, g:g	CR, kg
Dieta controle	0,939	1,398	1,313
Dieta controle	1,013	1,325	1,341
Dieta controle	0,989	1,329	1,314
Dieta controle	0,977	1,339	1,309
Dieta controle	1,070	1,305	1,397
Dieta controle	0,955	1,344	1,284
Dieta controle	0,924	1,344	1,242
Dieta controle	0,958	1,401	1,343
C – 80 kcal – 3 % AA	0,962	1,378	1,325
C – 80 kcal – 3 % AA	0,979	1,370	1,340
C – 80 kcal – 3 % AA	0,973	1,356	1,319
C – 80 kcal – 3 % AA	0,954	1,397	1,333
C – 80 kcal – 3 % AA	0,964	1,375	1,326
C – 80 kcal – 3 % AA	0,932	1,380	1,286
C – 80 kcal – 3 % AA	0,950	1,382	1,314
C – 80 kcal – 3 % AA	0,920	1,444	1,329
C – 80 kcal – 6 % AA	1,040	1,357	1,411
C – 80 kcal – 6 % AA	1,009	1,381	1,393
C – 80 kcal – 6 % AA	1,002	1,395	1,398
C – 80 kcal – 6 % AA	1,003	1,379	1,383
C – 80 kcal – 6 % AA	0,970	1,395	1,353
C – 80 kcal – 6 % AA	1,010	1,383	1,397
C – 80 kcal – 6 % AA	0,981	1,395	1,369
C – 80 kcal – 6 % AA	0,865	1,422	1,230
C –120 kcal – 3 % AA	1,029	1,386	1,427
C –120 kcal – 3 % AA	0,945	1,410	1,332
C –120 kcal – 3 % AA	0,915	1,393	1,275
C –120 kcal – 3 % AA	1,002	1,373	1,375
C –120 kcal – 3 % AA	0,979	1,344	1,315
C –120 kcal – 3 % AA	0,866	1,434	1,242
C –120 kcal – 3 % AA	0,940	1,408	1,323
C –120 kcal – 3 % AA	0,899	1,420	1,278
C –120 kcal – 6 % AA	1,025	1,396	1,431
C –120 kcal – 6 % AA	0,915	1,446	1,323
C –120 kcal – 6 % AA	0,985	1,342	1,322
C –120 kcal – 6 % AA	1,017	1,411	1,435
C –120 kcal – 6 % AA	1,000	1,401	1,402
C –120 kcal – 6 % AA	0,890	1,471	1,310
C –120 kcal – 6 % AA	0,969	1,398	1,354
C –120 kcal – 6 % AA	0,884	1,489	1,316
C – 80 kcal – 3 % AA + CE	0,914	1,373	1,255
C – 80 kcal – 3 % AA + CE	0,974	1,342	1,308
C – 80 kcal – 3 % AA + CE	1,007	1,316	1,325
C – 80 kcal – 3 % AA + CE	0,950	1,316	1,251

C – 80 kcal – 3 % AA + CE	1,028	1,360	1,398
C – 80 kcal – 3 % AA + CE	0,996	1,315	1,309
C – 80 kcal – 3 % AA + CE	0,973	1,414	1,375
C – 80 kcal – 3 % AA + CE	0,935	1,409	1,317
C – 80 kcal – 6 % AA + CE	0,998	1,371	1,369
C – 80 kcal – 6 % AA + CE	0,908	1,386	1,259
C – 80 kcal – 6 % AA + CE	1,051	1,348	1,416
C – 80 kcal – 6 % AA + CE	0,987	1,391	1,373
C – 80 kcal – 6 % AA + CE	1,004	1,438	1,443
C – 80 kcal – 6 % AA + CE	1,030	1,349	1,389
C – 80 kcal – 6 % AA + CE	0,935	1,399	1,309
C – 80 kcal – 6 % AA + CE	0,987	1,383	1,365
C –120 kcal – 3 % AA + CE	0,936	1,388	1,298
C –120 kcal – 3 % AA + CE	0,974	1,375	1,339
C –120 kcal – 3 % AA + CE	0,940	1,362	1,279
C –120 kcal – 3 % AA + CE	0,999	1,389	1,387
C –120 kcal – 3 % AA + CE	0,958	1,390	1,332
C –120 kcal – 3 % AA + CE	1,057	1,349	1,426
C –120 kcal – 3 % AA + CE	0,998	1,362	1,358
C –120 kcal – 3 % AA + CE	0,905	1,441	1,305
C –120 kcal – 6 % AA + CE	1,027	1,409	1,447
C –120 kcal – 6 % AA + CE	0,984	1,407	1,384
C –120 kcal – 6 % AA + CE	0,989	1,387	1,371
C –120 kcal – 6 % AA + CE	1,009	1,368	1,381
C –120 kcal – 6 % AA + CE	0,982	1,405	1,380
C –120 kcal – 6 % AA + CE	0,960	1,406	1,350
C –120 kcal – 6 % AA + CE	0,988	1,398	1,381
C –120 kcal – 6 % AA + CE	0,969	1,401	1,358

Apêndice 3. Desempenho zootécnico dos frangos de corte no período de 22 a 35 dias.

Tratamento	GP, kg	CA, g:g	CR, kg
Dieta controle (C)	1,521	1,455	2,214
Dieta controle	1,499	1,442	2,161
Dieta controle	1,419	1,485	2,108
Dieta controle	1,439	1,476	2,125
Dieta controle	1,406	1,561	2,194
Dieta controle	1,385	1,539	2,131
Dieta controle	1,496	1,477	2,209
Dieta controle	1,466	1,513	2,218
C – 80 kcal – 3 % AA	1,355	1,545	2,094
C – 80 kcal – 3 % AA	1,418	1,573	2,230
C – 80 kcal – 3 % AA	1,432	1,465	2,097
C – 80 kcal – 3 % AA	1,445	1,526	2,205
C – 80 kcal – 3 % AA	1,421	1,493	2,121
C – 80 kcal – 3 % AA	1,406	1,545	2,173
C – 80 kcal – 3 % AA	1,566	1,453	2,277

C – 80 kcal – 3 % AA	1,447	1,562	2,260
C – 80 kcal – 6 % AA	1,398	1,571	2,196
C – 80 kcal – 6 % AA	1,468	1,551	2,277
C – 80 kcal – 6 % AA	1,507	1,501	2,261
C – 80 kcal – 6 % AA	1,469	1,541	2,264
C – 80 kcal – 6 % AA	1,476	1,530	2,258
C – 80 kcal – 6 % AA	1,483	1,513	2,243
C – 80 kcal – 6 % AA	1,473	1,539	2,267
C – 80 kcal – 6 % AA	1,535	1,497	2,298
C –120 kcal – 3 % AA	1,436	1,532	2,199
C –120 kcal – 3 % AA	1,405	1,503	2,112
C –120 kcal – 3 % AA	1,476	1,530	2,258
C –120 kcal – 3 % AA	1,424	1,577	2,245
C –120 kcal – 3 % AA	1,436	1,532	2,199
C –120 kcal – 3 % AA	1,344	1,537	2,065
C –120 kcal – 3 % AA	1,553	1,484	2,303
C –120 kcal – 3 % AA	1,414	1,564	2,211
C –120 kcal – 6 % AA	1,621	1,534	2,487
C –120 kcal – 6 % AA	1,475	1,534	2,263
C –120 kcal – 6 % AA	1,358	1,533	2,082
C –120 kcal – 6 % AA	1,491	1,610	2,400
C –120 kcal – 6 % AA	1,467	1,539	2,257
C –120 kcal – 6 % AA	1,461	1,484	2,169
C –120 kcal – 6 % AA	1,451	1,521	2,207
C –120 kcal – 6 % AA	1,479	1,515	2,241
C – 80 kcal – 3 % AA + CE	1,241	1,570	1,948
C – 80 kcal – 3 % AA + CE	1,496	1,433	2,143
C – 80 kcal – 3 % AA + CE	1,377	1,565	2,154
C – 80 kcal – 3 % AA + CE	1,506	1,468	2,210
C – 80 kcal – 3 % AA + CE	1,383	1,515	2,095
C – 80 kcal – 3 % AA + CE	1,530	1,451	2,221
C – 80 kcal – 3 % AA + CE	1,502	1,478	2,219
C – 80 kcal – 3 % AA + CE	1,477	1,437	2,123
C – 80 kcal – 6 % AA + CE	1,469	1,499	2,203
C – 80 kcal – 6 % AA + CE	1,506	1,444	2,175
C – 80 kcal – 6 % AA + CE	1,484	1,531	2,272
C – 80 kcal – 6 % AA + CE	1,518	1,511	2,294
C – 80 kcal – 6 % AA + CE	1,366	1,578	2,156
C – 80 kcal – 6 % AA + CE	1,529	1,484	2,268
C – 80 kcal – 6 % AA + CE	1,439	1,568	2,256
C – 80 kcal – 6 % AA + CE	1,503	1,527	2,296
C –120 kcal – 3 % AA + CE	1,454	1,515	2,202
C –120 kcal – 3 % AA + CE	1,582	1,482	2,345
C –120 kcal – 3 % AA + CE	1,475	1,492	2,201
C –120 kcal – 3 % AA + CE	1,421	1,535	2,180
C –120 kcal – 3 % AA + CE	1,478	1,510	2,231
C –120 kcal – 3 % AA + CE	1,427	1,549	2,211

C –120 kcal – 3 % AA + CE	1,411	1,489	2,101
C –120 kcal – 3 % AA + CE	1,382	1,550	2,143
C –120 kcal – 6 % AA + CE	1,428	1,572	2,244
C –120 kcal – 6 % AA + CE	1,576	1,452	2,287
C –120 kcal – 6 % AA + CE	1,370	1,529	2,096
C –120 kcal – 6 % AA + CE	1,491	1,502	2,240
C –120 kcal – 6 % AA + CE	1,504	1,519	2,285
C –120 kcal – 6 % AA + CE	1,489	1,495	2,226
C –120 kcal – 6 % AA + CE	1,420	1,515	2,152
C –120 kcal – 6 % AA + CE	1,484	1,556	2,309

Apêndice 4. Desempenho zootécnico dos frangos de corte no período de 35 a 42 dias.

Tratamento	GP, kg	CA, g:g	CR, kg
Dieta controle (C)	0,632	1,851	1,170
Dieta controle	0,682	1,925	1,313
Dieta controle	0,639	1,909	1,219
Dieta controle	0,596	1,858	1,107
Dieta controle	0,595	2,016	1,199
Dieta controle	0,636	1,852	1,178
Dieta controle	0,701	1,933	1,355
Dieta controle	0,629	1,925	1,210
C – 80 kcal – 3 % AA	0,590	1,880	1,108
C – 80 kcal – 3 % AA	0,658	1,914	1,256
C – 80 kcal – 3 % AA	0,656	1,855	1,216
C – 80 kcal – 3 % AA	0,713	1,865	1,330
C – 80 kcal – 3 % AA	0,594	2,049	1,217
C – 80 kcal – 3 % AA	0,640	2,026	1,297
C – 80 kcal – 3 % AA	0,658	1,906	1,254
C – 80 kcal – 3 % AA	0,755	1,816	1,370
C – 80 kcal – 6 % AA	0,654	1,961	1,284
C – 80 kcal – 6 % AA	0,681	1,805	1,230
C – 80 kcal – 6 % AA	0,653	1,978	1,292
C – 80 kcal – 6 % AA	0,629	1,919	1,206
C – 80 kcal – 6 % AA	0,633	1,913	1,210
C – 80 kcal – 6 % AA	0,638	1,997	1,274
C – 80 kcal – 6 % AA	0,669	1,840	1,231
C – 80 kcal – 6 % AA	0,635	2,001	1,271
C –120 kcal – 3 % AA	0,672	1,935	1,298
C –120 kcal – 3 % AA	0,625	1,972	1,233
C –120 kcal – 3 % AA	0,656	1,941	1,272
C –120 kcal – 3 % AA	0,592	2,049	1,212
C –120 kcal – 3 % AA	0,771	2,037	1,570
C –120 kcal – 3 % AA	0,732	1,782	1,305
C –120 kcal – 3 % AA	0,653	1,983	1,295
C –120 kcal – 3 % AA	0,673	1,780	1,198
C –120 kcal – 6 % AA	0,660	1,950	1,282

C –120 kcal – 6 % AA	0,619	1,995	1,236
C –120 kcal – 6 % AA	0,656	1,845	1,211
C –120 kcal – 6 % AA	0,609	2,100	1,278
C –120 kcal – 6 % AA	0,660	1,950	1,282
C –120 kcal – 6 % AA	0,660	1,950	1,282
C –120 kcal – 6 % AA	0,639	1,989	1,272
C –120 kcal – 6 % AA	0,776	1,820	1,413
C – 80 kcal – 3 % AA + CE	0,594	1,876	1,115
C – 80 kcal – 3 % AA + CE	0,651	1,890	1,229
C – 80 kcal – 3 % AA + CE	0,690	1,851	1,278
C – 80 kcal – 3 % AA + CE	0,654	1,893	1,239
C – 80 kcal – 3 % AA + CE	0,578	2,045	1,181
C – 80 kcal – 3 % AA + CE	0,678	1,816	1,231
C – 80 kcal – 3 % AA + CE	0,705	1,927	1,359
C – 80 kcal – 3 % AA + CE	0,658	1,819	1,197
C – 80 kcal – 6 % AA + CE	0,765	1,926	1,474
C – 80 kcal – 6 % AA + CE	0,667	1,867	1,246
C – 80 kcal – 6 % AA + CE	0,617	2,002	1,235
C – 80 kcal – 6 % AA + CE	0,565	2,156	1,217
C – 80 kcal – 6 % AA + CE	0,688	1,714	1,179
C – 80 kcal – 6 % AA + CE	0,518	2,017	1,045
C – 80 kcal – 6 % AA + CE	0,683	1,843	1,260
C – 80 kcal – 6 % AA + CE	0,606	1,947	1,179
C –120 kcal – 3 % AA + CE	0,646	1,928	1,245
C –120 kcal – 3 % AA + CE	0,624	1,906	1,190
C –120 kcal – 3 % AA + CE	0,646	1,928	1,245
C –120 kcal – 3 % AA + CE	0,685	1,836	1,257
C –120 kcal – 3 % AA + CE	0,626	1,987	1,243
C –120 kcal – 3 % AA + CE	0,640	1,954	1,250
C –120 kcal – 3 % AA + CE	0,655	1,959	1,283
C –120 kcal – 3 % AA + CE	0,646	1,928	1,245
C –120 kcal – 6 % AA + CE	0,649	1,936	1,254
C –120 kcal – 6 % AA + CE	0,610	2,058	1,256
C –120 kcal – 6 % AA + CE	0,649	1,936	1,254
C –120 kcal – 6 % AA + CE	0,688	1,921	1,322
C –120 kcal – 6 % AA + CE	0,601	2,096	1,259
C –120 kcal – 6 % AA + CE	0,628	1,843	1,157
C –120 kcal – 6 % AA + CE	0,689	1,853	1,278
C –120 kcal – 6 % AA + CE	0,678	1,846	1,251

Apêndice 5. Desempenho zootécnico dos frangos de corte no período de 1 a 42 dias.

Tratamento	GP, kg	CA, g:g	CR, kg
Dieta controle (C)	3,093	1,519	4,697
Dieta controle	3,193	1,508	4,815
Dieta controle	3,075	1,509	4,641
Dieta controle	3,013	1,507	4,541

Dieta controle	3,071	1,560	4,790
Dieta controle	2,976	1,543	4,593
Dieta controle	3,121	1,540	4,807
Dieta controle	3,063	1,558	4,771
C – 80 kcal – 3 % AA	2,906	1,558	4,527
C – 80 kcal – 3 % AA	3,047	1,584	4,826
C – 80 kcal – 3 % AA	3,060	1,514	4,633
C – 80 kcal – 3 % AA	3,112	1,564	4,868
C – 80 kcal – 3 % AA	2,979	1,566	4,664
C – 80 kcal – 3 % AA	2,978	1,597	4,756
C – 80 kcal – 3 % AA	3,175	1,526	4,844
C – 80 kcal – 3 % AA	3,121	1,589	4,959
C – 80 kcal – 6 % AA	3,092	1,582	4,891
C – 80 kcal – 6 % AA	3,158	1,552	4,899
C – 80 kcal – 6 % AA	3,162	1,566	4,951
C – 80 kcal – 6 % AA	3,101	1,565	4,853
C – 80 kcal – 6 % AA	3,097	1,557	4,821
C – 80 kcal – 6 % AA	3,131	1,569	4,914
C – 80 kcal – 6 % AA	3,123	1,558	4,866
C – 80 kcal – 6 % AA	3,035	1,581	4,799
C –120 kcal – 3 % AA	3,034	1,623	4,924
C –120 kcal – 3 % AA	2,975	1,572	4,677
C –120 kcal – 3 % AA	3,047	1,577	4,805
C –120 kcal – 3 % AA	3,017	1,602	4,832
C –120 kcal – 3 % AA	3,135	1,622	5,085
C –120 kcal – 3 % AA	2,942	1,568	4,612
C –120 kcal – 3 % AA	3,146	1,565	4,922
C –120 kcal – 3 % AA	2,986	1,569	4,687
C –120 kcal – 6 % AA	3,075	1,691	5,200
C –120 kcal – 6 % AA	3,062	1,575	4,822
C –120 kcal – 6 % AA	3,000	1,538	4,615
C –120 kcal – 6 % AA	3,116	1,641	5,113
C –120 kcal – 6 % AA	3,076	1,606	4,941
C –120 kcal – 6 % AA	3,076	1,548	4,760
C –120 kcal – 6 % AA	3,059	1,580	4,833
C –120 kcal – 6 % AA	3,139	1,583	4,970
C – 80 kcal – 3 % AA + CE	2,750	1,570	4,318
C – 80 kcal – 3 % AA + CE	3,054	1,532	4,679
C – 80 kcal – 3 % AA + CE	3,074	1,547	4,756
C – 80 kcal – 3 % AA + CE	3,110	1,511	4,700
C – 80 kcal – 3 % AA + CE	2,988	1,564	4,674
C – 80 kcal – 3 % AA + CE	3,204	1,486	4,761
C – 80 kcal – 3 % AA + CE	3,180	1,558	4,953
C – 80 kcal – 3 % AA + CE	3,069	1,511	4,637
C – 80 kcal – 6 % AA + CE	3,233	1,561	5,046
C – 80 kcal – 6 % AA + CE	3,082	1,519	4,680
C – 80 kcal – 6 % AA + CE	3,151	1,562	4,923

C – 80 kcal – 6 % AA + CE	3,070	1,591	4,884
C – 80 kcal – 6 % AA + CE	3,059	1,562	4,778
C – 80 kcal – 6 % AA + CE	3,077	1,528	4,702
C – 80 kcal – 6 % AA + CE	3,058	1,578	4,825
C – 80 kcal – 6 % AA + CE	3,096	1,563	4,840
C –120 kcal – 3 % AA + CE	3,107	1,527	4,745
C –120 kcal – 3 % AA + CE	3,180	1,533	4,874
C –120 kcal – 3 % AA + CE	3,107	1,521	4,725
C –120 kcal – 3 % AA + CE	3,104	1,554	4,825
C –120 kcal – 3 % AA + CE	3,062	1,570	4,806
C –120 kcal – 3 % AA + CE	3,124	1,564	4,887
C –120 kcal – 3 % AA + CE	3,063	1,548	4,742
C –120 kcal – 3 % AA + CE	3,107	1,510	4,693
C –120 kcal – 6 % AA + CE	3,125	1,582	4,945
C –120 kcal – 6 % AA + CE	3,170	1,554	4,927
C –120 kcal – 6 % AA + CE	3,125	1,510	4,721
C –120 kcal – 6 % AA + CE	3,189	1,550	4,943
C –120 kcal – 6 % AA + CE	3,087	1,595	4,923
C –120 kcal – 6 % AA + CE	3,077	1,538	4,732
C –120 kcal – 6 % AA + CE	3,098	1,553	4,811
C –120 kcal – 6 % AA + CE	3,131	1,571	4,917

Apêndice 6. Energia digestível ileal (EDI) e digestibilidade ileal da MS (DIMS) nos frangos de corte aos 21 dias.

Tratamento	EDI, kcal/kg	DIMS, %
Dieta controle (C)	3025	63,55
Dieta controle	3301	65,01
Dieta controle	3199	61,33
Dieta controle	3224	61,99
Dieta controle	3246	62,84
Dieta controle	3178	68,34
Dieta controle	3224	63,99
Dieta controle	3190	64,45
C – 80 kcal – 3 % AA	3086	60,16
C – 80 kcal – 3 % AA	3202	66,26
C – 80 kcal – 3 % AA	2989	59,48
C – 80 kcal – 3 % AA	3194	63,49
C – 80 kcal – 3 % AA	2945	61,38
C – 80 kcal – 3 % AA	3112	65,16
C – 80 kcal – 3 % AA	3201	66,26
C – 80 kcal – 3 % AA	3204	65,18
C – 80 kcal – 6 % AA	3091	57,46
C – 80 kcal – 6 % AA	3192	57,32
C – 80 kcal – 6 % AA	3086	59,63
C – 80 kcal – 6 % AA	3137	60,37
C – 80 kcal – 6 % AA	3068	57,97
C – 80 kcal – 6 % AA	2924	57,07

C – 80 kcal – 6 % AA	3086	58,05
C – 80 kcal – 6 % AA	3134	58,67
C –120 kcal – 3 % AA	2973	59,01
C –120 kcal – 3 % AA	3009	54,80
C –120 kcal – 3 % AA	2873	54,37
C –120 kcal – 3 % AA	2964	56,04
C –120 kcal – 3 % AA	3190	62,66
C –120 kcal – 3 % AA	3079	64,66
C –120 kcal – 3 % AA	2935	58,55
C –120 kcal – 3 % AA	3046	61,47
C –120 kcal – 6 % AA	2919	57,79
C –120 kcal – 6 % AA	2877	57,21
C –120 kcal – 6 % AA	2999	56,48
C –120 kcal – 6 % AA	2905	59,11
C –120 kcal – 6 % AA	3081	59,56
C –120 kcal – 6 % AA	2829	55,58
C –120 kcal – 6 % AA	3135	60,37
C –120 kcal – 6 % AA	3117	62,77
C – 80 kcal – 3 % AA + CE	3160	62,32
C – 80 kcal – 3 % AA + CE	3111	63,05
C – 80 kcal – 3 % AA + CE	3095	59,61
C – 80 kcal – 3 % AA + CE	3426	68,96
C – 80 kcal – 3 % AA + CE	3024	61,12
C – 80 kcal – 3 % AA + CE	3314	64,35
C – 80 kcal – 3 % AA + CE	3056	62,92
C – 80 kcal – 3 % AA + CE	3323	67,40
C – 80 kcal – 6 % AA + CE	3261	60,16
C – 80 kcal – 6 % AA + CE	3089	58,31
C – 80 kcal – 6 % AA + CE	3255	61,19
C – 80 kcal – 6 % AA + CE	3049	60,46
C – 80 kcal – 6 % AA + CE	3169	58,69
C – 80 kcal – 6 % AA + CE	3187	63,95
C – 80 kcal – 6 % AA + CE	3293	63,74
C – 80 kcal – 6 % AA + CE	3250	61,68
C –120 kcal – 3 % AA + CE	3228	61,30
C –120 kcal – 3 % AA + CE	3161	61,89
C –120 kcal – 3 % AA + CE	3195	63,61
C –120 kcal – 3 % AA + CE	3161	61,24
C –120 kcal – 3 % AA + CE	3181	61,93
C –120 kcal – 3 % AA + CE	3208	62,09
C –120 kcal – 3 % AA + CE	3117	61,18
C –120 kcal – 3 % AA + CE	3217	64,01
C –120 kcal – 6 % AA + CE	3098	59,68
C –120 kcal – 6 % AA + CE	3097	62,84
C –120 kcal – 6 % AA + CE	3165	60,86
C –120 kcal – 6 % AA + CE	3114	60,62
C –120 kcal – 6 % AA + CE	3241	65,66

C –120 kcal – 6 % AA + CE	3157	59,71
C –120 kcal – 6 % AA + CE	3157	58,12
C –120 kcal – 6 % AA + CE	3229	66,80

Apêndice 7. Energia digestível ileal (EDI) e digestibilidade ileal da MS (DIMS) nos frangos de corte aos 42 dias.

Tratamento	EDI, kcal/kg	DIMS, %
Dieta controle (C)	3499	71,81
Dieta controle	3356	71,42
Dieta controle	3560	71,27
Dieta controle	3427	71,21
Dieta controle	3360	71,70
Dieta controle	3503	70,39
Dieta controle	3588	71,81
Dieta controle	3331	71,42
C – 80 kcal – 3 % AA	3302	68,64
C – 80 kcal – 3 % AA	3445	72,57
C – 80 kcal – 3 % AA	3203	70,85
C – 80 kcal – 3 % AA	3437	70,54
C – 80 kcal – 3 % AA	3387	70,91
C – 80 kcal – 3 % AA	3509	72,94
C – 80 kcal – 3 % AA	3288	67,23
C – 80 kcal – 3 % AA	3573	73,08
C – 80 kcal – 6 % AA	3445	70,67
C – 80 kcal – 6 % AA	3319	69,41
C – 80 kcal – 6 % AA	3395	71,34
C – 80 kcal – 6 % AA	3452	72,21
C – 80 kcal – 6 % AA	3485	71,07
C – 80 kcal – 6 % AA	3364	67,43
C – 80 kcal – 6 % AA	3148	70,67
C – 80 kcal – 6 % AA	3472	72,57
C –120 kcal – 3 % AA	3243	69,77
C –120 kcal – 3 % AA	3263	68,69
C –120 kcal – 3 % AA	3264	69,45
C –120 kcal – 3 % AA	3254	70,27
C –120 kcal – 3 % AA	3332	72,08
C –120 kcal – 3 % AA	3333	72,40
C –120 kcal – 3 % AA	3210	69,64
C –120 kcal – 3 % AA	3276	70,11
C –120 kcal – 6 % AA	3189	67,59
C –120 kcal – 6 % AA	3055	66,87
C –120 kcal – 6 % AA	3256	68,04
C –120 kcal – 6 % AA	3287	72,89
C –120 kcal – 6 % AA	3325	70,36
C –120 kcal – 6 % AA	3340	70,54
C –120 kcal – 6 % AA	3351	68,84
C –120 kcal – 6 % AA	3355	68,91

C – 80 kcal – 3 % AA + CE	3331	69,87
C – 80 kcal – 3 % AA + CE	3220	72,04
C – 80 kcal – 3 % AA + CE	3505	73,36
C – 80 kcal – 3 % AA + CE	3491	72,66
C – 80 kcal – 3 % AA + CE	3616	74,08
C – 80 kcal – 3 % AA + CE	3304	69,18
C – 80 kcal – 3 % AA + CE	3582	73,64
C – 80 kcal – 3 % AA + CE	3507	71,51
C – 80 kcal – 6 % AA + CE	3199	71,63
C – 80 kcal – 6 % AA + CE	3538	73,36
C – 80 kcal – 6 % AA + CE	3383	70,27
C – 80 kcal – 6 % AA + CE	3660	73,83
C – 80 kcal – 6 % AA + CE	3318	69,00
C – 80 kcal – 6 % AA + CE	3449	71,04
C – 80 kcal – 6 % AA + CE	3562	73,17
C – 80 kcal – 6 % AA + CE	3447	70,76
C –120 kcal – 3 % AA + CE	3341	71,85
C –120 kcal – 3 % AA + CE	3289	70,90
C –120 kcal – 3 % AA + CE	3440	73,62
C –120 kcal – 3 % AA + CE	3326	71,13
C –120 kcal – 3 % AA + CE	3363	70,43
C –120 kcal – 3 % AA + CE	3584	71,11
C –120 kcal – 3 % AA + CE	3395	70,87
C –120 kcal – 3 % AA + CE	3315	68,99
C –120 kcal – 6 % AA + CE	3445	71,95
C –120 kcal – 6 % AA + CE	3365	69,82
C –120 kcal – 6 % AA + CE	3438	71,42
C –120 kcal – 6 % AA + CE	3322	69,15
C –120 kcal – 6 % AA + CE	3346	69,02
C –120 kcal – 6 % AA + CE	3469	71,91
C –120 kcal – 6 % AA + CE	3424	71,03
C –120 kcal – 6 % AA + CE	3361	72,34

Apêndice 8. Digestibilidade ileal de aminoácidos essencias dos frangos de corte aos 21 d, %.

Tratamentos	Arg	His	Ile	Leu	Lys	Met	Phe	Thr	Val
Dieta controle (C)	93.8	92.5	88.9	89.3	91.4	98.1	89.3	88.5	87.0
Dieta controle	92.4	94.5	89.8	89.6	88.8	97.4	90.6	88.8	87.9
Dieta controle	89.0	92.8	86.2	88.5	86.5	96.1	87.8	86.2	84.7
Dieta controle	92.4	84.1	88.4	89.2	86.8	97.7	90.3	86.9	87.2
Dieta controle	91.9	87.4	87.9	87.7	84.5	96.6	89.0	84.5	86.7
Dieta controle	91.7	92.9	88.9	88.9	87.6	96.9	90.1	84.5	86.4
Dieta controle	89.2	86.9	85.4	87.2	85.1	96.1	87.1	85.0	83.3
Dieta controle	91.4	90.3	87.9	87.9	85.3	96.9	89.0	85.6	86.0
C – 80 kcal – 3 % AA	89.0	80.6	86.3	86.9	84.5	96.7	87.0	80.6	85.3
C – 80 kcal – 3 % AA	91.2	93.9	88.3	88.1	87.3	97.2	89.2	86.8	86.2
C – 80 kcal – 3 % AA	87.2	92.0	84.1	84.0	84.5	97.0	85.8	83.6	82.4
C – 80 kcal – 3 % AA	91.8	83.7	87.7	88.6	86.4	97.7	89.6	85.7	86.5
C – 80 kcal – 3 % AA	90.3	85.4	85.5	85.2	82.1	96.1	86.7	80.9	84.1
C – 80 kcal – 3 % AA	90.9	92.5	87.9	87.9	86.5	96.8	89.1	82.5	85.2
C – 80 kcal – 3 % AA	89.0	87.2	85.3	85.7	85.0	96.2	86.9	81.7	83.3
C – 80 kcal – 3 % AA	87.2	85.5	83.8	84.3	83.8	96.9	85.9	79.9	82.1
C – 80 kcal – 6 % AA	89.4	79.4	85.7	86.5	83.3	96.5	86.7	79.8	83.9
C – 80 kcal – 6 % AA	89.2	82.9	84.7	87.0	83.9	97.8	88.2	80.5	82.9
C – 80 kcal – 6 % AA	87.9	89.8	82.2	82.7	83.0	95.7	84.1	81.8	80.9
C – 80 kcal – 6 % AA	90.1	84.0	85.9	85.3	82.6	97.0	86.8	82.8	83.6
C – 80 kcal – 6 % AA	88.6	85.5	85.6	86.8	82.8	97.4	86.5	82.4	84.1
C – 80 kcal – 6 % AA	88.8	84.1	84.1	85.2	82.8	98.1	85.2	81.7	81.7
C – 80 kcal – 6 % AA	87.8	86.5	84.2	84.7	82.4	96.3	86.4	75.7	80.9
C – 80 kcal – 6 % AA	89.2	84.6	85.9	86.3	83.3	95.9	87.8	78.3	82.7
C –120 kcal – 3 % AA	90.5	83.8	86.5	87.0	84.4	97.1	87.5	82.0	84.8
C –120 kcal – 3 % AA	90.6	90.6	86.9	85.2	84.9	96.0	86.4	85.9	83.2
C –120 kcal – 3 % AA	88.9	89.3	85.8	85.8	88.1	97.0	87.7	84.2	84.3

C –120 kcal – 3 % AA	88.6	91.0	86.6	84.3	84.3	96.8	86.1	83.0	82.8
C –120 kcal – 3 % AA	90.0	82.3	86.4	86.6	85.3	96.8	87.9	82.4	84.9
C –120 kcal – 3 % AA	89.2	86.8	86.5	85.6	83.6	96.5	86.8	78.0	85.0
C –120 kcal – 3 % AA	88.1	87.7	85.2	86.1	84.1	97.3	87.2	81.9	82.2
C –120 kcal – 3 % AA	88.3	85.7	89.1	88.1	85.1	97.3	88.0	85.0	87.5
C –120 kcal – 6 % AA	89.5	86.6	86.1	86.1	83.3	96.9	87.3	78.5	81.4
C –120 kcal – 6 % AA	89.0	84.9	85.4	85.4	83.3	96.7	86.7	82.0	82.8
C –120 kcal – 6 % AA	88.7	89.0	84.2	86.5	84.5	96.9	84.3	84.3	80.5
C –120 kcal – 6 % AA	89.2	86.2	83.0	83.7	80.4	95.7	83.9	82.2	80.5
C –120 kcal – 6 % AA	88.9	85.1	84.8	84.2	81.9	98.6	85.2	80.9	83.5
C –120 kcal – 6 % AA	89.3	87.9	84.5	83.7	84.1	96.2	86.0	77.8	79.9
C –120 kcal – 6 % AA	89.8	88.8	87.3	86.7	83.7	96.9	88.0	79.4	84.8
C –120 kcal – 6 % AA	90.1	87.7	85.3	86.9	83.8	96.6	88.0	82.1	84.2
C – 80 kcal – 3 % AA + CE	90.0	84.5	87.2	85.3	86.1	97.3	86.7	84.2	85.9
C – 80 kcal – 3 % AA + CE	90.1	84.5	86.9	86.5	85.2	96.4	87.4	83.5	86.3
C – 80 kcal – 3 % AA + CE	90.8	91.0	87.4	85.1	85.9	96.3	86.1	83.5	83.6
C – 80 kcal – 3 % AA + CE	91.8	87.9	88.8	89.4	86.7	97.3	89.2	87.0	87.7
C – 80 kcal – 3 % AA + CE	88.1	84.2	84.4	84.7	84.4	96.3	86.0	81.2	82.5
C – 80 kcal – 3 % AA + CE	93.2	91.5	91.1	90.7	87.1	98.2	91.4	86.7	89.8
C – 80 kcal – 3 % AA + CE	89.4	87.4	89.0	89.4	85.2	96.3	89.1	82.8	87.8
C – 80 kcal – 3 % AA + CE	92.4	86.1	90.5	91.0	87.1	98.9	91.2	85.6	90.4
C – 80 kcal – 6 % AA + CE	90.2	83.0	86.8	88.7	82.3	98.8	88.0	83.5	84.7
C – 80 kcal – 6 % AA + CE	89.8	87.6	85.1	88.3	84.2	96.6	86.1	77.7	83.3
C – 80 kcal – 6 % AA + CE	90.5	88.2	90.0	86.9	82.3	98.4	90.3	87.6	87.7
C – 80 kcal – 6 % AA + CE	89.4	79.5	84.6	85.4	84.9	97.0	86.7	86.9	81.9
C – 80 kcal – 6 % AA + CE	90.8	82.0	86.8	86.6	83.6	96.6	88.0	83.0	84.6
C – 80 kcal – 6 % AA + CE	93.0	86.3	88.2	87.1	85.9	96.8	90.4	84.2	86.4
C – 80 kcal – 6 % AA + CE	89.0	87.8	85.4	87.2	85.0	97.2	87.7	78.8	82.6

C – 80 kcal – 6 % AA + CE	90.9	91.5	89.4	88.7	86.6	96.2	90.1	81.0	86.7
C –120 kcal – 3 % AA + CE	91.1	85.6	86.9	87.1	86.0	96.8	87.6	83.3	85.3
C –120 kcal – 3 % AA + CE	89.8	83.9	85.8	86.0	86.3	97.3	87.1	81.7	84.7
C –120 kcal – 3 % AA + CE	89.4	91.6	87.1	87.2	86.4	96.9	88.0	85.8	84.4
C –120 kcal – 3 % AA + CE	90.5	85.6	87.1	86.1	87.6	96.9	88.5	87.7	85.2
C –120 kcal – 3 % AA + CE	92.5	84.6	88.6	88.7	87.2	97.4	89.8	87.7	86.7
C –120 kcal – 3 % AA + CE	90.3	87.2	86.6	86.7	84.4	97.0	87.8	84.7	84.7
C –120 kcal – 3 % AA + CE	90.3	89.3	87.6	88.1	85.8	95.8	89.2	81.7	84.6
C –120 kcal – 3 % AA + CE	90.8	88.5	87.6	87.5	84.8	97.1	88.7	85.0	85.5
C –120 kcal – 6 % AA + CE	89.7	84.1	86.7	87.3	83.2	96.6	86.9	79.4	85.8
C –120 kcal – 6 % AA + CE	89.7	89.7	86.4	86.4	84.8	97.0	88.6	83.2	82.9
C –120 kcal – 6 % AA + CE	89.3	86.4	84.6	84.8	83.8	96.8	86.8	85.1	83.5
C –120 kcal – 6 % AA + CE	90.2	85.1	86.9	86.6	86.1	97.0	85.5	81.8	82.4
C –120 kcal – 6 % AA + CE	89.1	88.6	84.5	86.3	85.3	97.5	87.0	83.7	83.2
C –120 kcal – 6 % AA + CE	90.6	91.9	86.7	86.9	84.8	97.0	88.8	84.4	85.8
C –120 kcal – 6 % AA + CE	90.0	85.3	85.8	82.7	83.7	97.6	87.4	80.2	84.1
C –120 kcal – 6 % AA + CE	89.2	85.9	86.1	85.3	84.8	97.3	87.5	85.1	84.1

Apêndice 9. Digestibilidade ileal de aminoácidos não essencias e total dos frangos de corte aos 21 d, %.

Tratamentos	Ala	Asp	Cys	Glu	Gly	Ser	Total AA
Dieta controle (C)	87.0	91.3	82.1	85.6	87.7	84.0	88.3
Dieta controle	88.2	90.6	87.1	91.5	86.7	85.3	89.6
Dieta controle	85.0	89.0	86.3	89.3	83.5	82.8	87.2
Dieta controle	87.1	87.3	86.6	90.1	83.9	81.4	88.0
Dieta controle	85.2	85.0	89.6	87.9	82.1	83.4	86.7
Dieta controle	86.3	91.1	91.3	92.0	85.0	84.8	88.9
Dieta controle	82.4	87.4	90.2	89.6	80.7	81.2	86.3
Dieta controle	85.7	88.6	87.4	89.3	84.0	82.0	87.5
C – 80 kcal – 3 % AA	85.6	84.7	84.8	89.6	83.7	81.1	85.8

C – 80 kcal – 3 % AA	86.5	89.5	85.1	90.4	85.1	83.7	88.2
C – 80 kcal – 3 % AA	82.8	87.6	84.1	88.0	81.5	80.9	85.2
C – 80 kcal – 3 % AA	86.4	86.9	85.7	89.7	83.3	81.0	87.3
C – 80 kcal – 3 % AA	82.3	86.0	87.4	87.8	81.7	79.4	85.2
C – 80 kcal – 3 % AA	85.1	90.5	90.4	91.5	84.0	84.0	88.1
C – 80 kcal – 3 % AA	82.4	87.6	90.0	89.8	81.0	81.7	86.1
C – 80 kcal – 3 % AA	80.9	87.7	88.7	89.4	81.4	82.0	85.2
C – 80 kcal – 6 % AA	85.0	85.2	80.0	88.6	80.6	77.9	85.1
C – 80 kcal – 6 % AA	84.8	86.1	91.1	89.7	81.1	82.2	85.9
C – 80 kcal – 6 % AA	82.0	84.9	81.3	86.8	80.7	80.8	83.8
C – 80 kcal – 6 % AA	85.2	84.9	91.3	89.0	81.1	82.9	85.6
C – 80 kcal – 6 % AA	84.9	87.4	88.9	88.9	84.7	82.3	86.1
C – 80 kcal – 6 % AA	83.4	86.5	91.9	88.1	81.1	81.3	85.1
C – 80 kcal – 6 % AA	81.6	85.9	85.1	89.2	79.1	81.0	84.5
C – 80 kcal – 6 % AA	83.2	87.7	85.6	90.5	80.0	82.3	85.9
C –120 kcal – 3 % AA	86.0	86.7	81.3	89.5	83.8	79.5	86.4
C –120 kcal – 3 % AA	83.6	86.9	87.6	86.8	82.5	81.8	85.8
C –120 kcal – 3 % AA	84.6	90.2	84.7	88.9	86.9	83.6	87.1
C –120 kcal – 3 % AA	83.8	86.6	86.2	88.4	81.2	82.4	85.7
C –120 kcal – 3 % AA	84.3	83.4	85.3	86.9	81.5	83.0	85.4
C –120 kcal – 3 % AA	81.9	87.5	91.0	89.9	81.3	80.8	86.0
C –120 kcal – 3 % AA	83.6	87.5	86.7	91.3	81.8	83.7	86.5
C –120 kcal – 3 % AA	85.2	85.9	93.4	89.1	81.0	81.9	86.7
C –120 kcal – 6 % AA	82.9	86.6	80.2	88.1	81.9	79.8	85.0
C –120 kcal – 6 % AA	83.9	86.3	82.2	89.0	82.6	82.9	85.6
C –120 kcal – 6 % AA	82.1	86.0	85.0	88.6	80.6	81.6	85.2
C –120 kcal – 6 % AA	82.5	86.9	86.8	88.4	79.3	81.2	84.5
C –120 kcal – 6 % AA	82.7	85.9	95.3	89.3	82.1	81.1	85.5

C –120 kcal – 6 % AA	82.7	85.2	88.1	89.3	80.4	81.1	84.8
C –120 kcal – 6 % AA	83.7	86.8	89.0	91.1	79.4	82.1	86.5
C –120 kcal – 6 % AA	85.5	84.5	88.3	89.5	81.6	80.4	86.1
C – 80 kcal – 3 % AA + CE	83.1	86.6	83.8	88.7	81.1	81.8	86.0
C – 80 kcal – 3 % AA + CE	85.6	86.5	84.1	90.3	81.6	81.6	86.4
C – 80 kcal – 3 % AA + CE	84.3	87.1	85.9	88.3	82.0	81.8	85.9
C – 80 kcal – 3 % AA + CE	87.7	91.9	93.8	92.2	85.2	87.2	89.5
C – 80 kcal – 3 % AA + CE	81.7	80.6	86.4	85.0	83.5	81.5	83.7
C – 80 kcal – 3 % AA + CE	88.5	90.6	88.6	93.0	83.8	85.7	90.1
C – 80 kcal – 3 % AA + CE	85.7	88.0	96.7	90.9	85.3	81.2	87.6
C – 80 kcal – 3 % AA + CE	89.2	88.5	97.2	92.9	82.9	85.5	89.4
C – 80 kcal – 6 % AA + CE	86.8	90.3	91.9	91.1	83.1	84.4	87.7
C – 80 kcal – 6 % AA + CE	83.4	83.6	82.6	88.3	80.0	82.2	85.0
C – 80 kcal – 6 % AA + CE	87.9	87.3	94.1	91.4	79.4	84.7	87.3
C – 80 kcal – 6 % AA + CE	82.9	84.8	87.5	89.4	81.4	81.4	85.5
C – 80 kcal – 6 % AA + CE	84.0	83.6	85.3	90.9	80.2	80.4	85.9
C – 80 kcal – 6 % AA + CE	83.7	88.7	89.5	90.6	82.2	83.5	87.5
C – 80 kcal – 6 % AA + CE	84.3	87.5	88.5	90.6	80.7	83.2	86.5
C – 80 kcal – 6 % AA + CE	85.6	90.9	86.7	91.8	83.1	84.3	88.3
C –120 kcal – 3 % AA + CE	86.1	89.6	85.9	90.5	82.3	85.8	87.3
C –120 kcal – 3 % AA + CE	85.2	85.3	84.3	89.2	80.6	83.2	85.9
C –120 kcal – 3 % AA + CE	86.2	88.4	87.1	91.0	83.1	83.0	87.4
C –120 kcal – 3 % AA + CE	85.7	89.1	87.8	89.6	84.1	84.4	87.2
C –120 kcal – 3 % AA + CE	86.8	87.4	87.1	89.9	82.5	81.4	87.9
C –120 kcal – 3 % AA + CE	85.6	87.6	85.8	89.5	81.8	81.1	86.5
C –120 kcal – 3 % AA + CE	85.8	89.3	87.9	91.5	83.2	83.9	87.8
C –120 kcal – 3 % AA + CE	86.3	88.5	86.5	90.3	83.1	82.3	87.4
C –120 kcal – 6 % AA + CE	84.7	84.9	83.8	89.7	80.2	83.5	86.0

C –120 kcal – 6 % AA + CE	83.3	88.6	87.1	89.5	82.2	80.2	86.4
C –120 kcal – 6 % AA + CE	84.2	88.4	87.2	89.8	81.3	82.7	86.1
C –120 kcal – 6 % AA + CE	83.2	85.5	88.3	89.8	79.8	83.7	85.9
C –120 kcal – 6 % AA + CE	84.6	85.2	87.1	90.8	82.5	83.6	86.5
C –120 kcal – 6 % AA + CE	85.1	85.2	90.5	90.5	82.7	83.9	87.1
C –120 kcal – 6 % AA + CE	81.4	87.6	88.4	89.5	80.1	82.3	85.6
C –120 kcal – 6 % AA + CE	84.8	89.8	89.4	91.2	82.5	85.3	87.2

Apêndice 10. Digestibilidade ileal de aminoácidos essencias dos frangos de corte aos 42 d, %.

Tratamentos	Arg	His	Ile	Leu	Lys	Met	Phe	Thr	Val
Dieta controle (C)	85.6	89.1	85.3	90.3	91.9	98.3	88.8	78.3	85.9
Dieta controle	89.7	82.2	85.8	89.3	91.4	98.5	89.1	82.6	85.5
Dieta controle	89.4	78.6	88.2	90.8	91.0	97.7	89.1	83.2	87.8
Dieta controle	90.6	83.5	85.5	88.6	91.4	97.9	87.5	82.4	86.0
Dieta controle	94.7	93.7	82.9	85.9	90.8	97.4	86.8	84.2	82.1
Dieta controle	92.7	92.3	87.6	90.0	95.0	97.6	90.7	93.6	88.2
Dieta controle	92.0	92.3	87.7	89.9	93.9	97.8	90.8	92.3	88.0
Dieta controle	89.4	76.6	82.5	84.9	92.8	92.8	85.8	83.4	84.1
C – 80 kcal – 3 % AA	87.2	77.0	83.7	86.9	87.9	97.3	85.3	80.0	82.3
C – 80 kcal – 3 % AA	86.2	80.4	83.9	87.4	86.9	96.9	86.0	82.6	82.3
C – 80 kcal – 3 % AA	84.2	77.1	81.0	85.2	85.3	95.9	83.9	77.8	79.1
C – 80 kcal – 3 % AA	87.6	77.9	85.7	87.9	90.3	98.6	88.0	80.3	84.2
C – 80 kcal – 3 % AA	86.4	78.5	82.8	86.4	89.3	97.5	85.9	80.2	80.4
C – 80 kcal – 3 % AA	88.1	88.8	83.5	87.0	94.0	97.3	86.8	91.1	83.3
C – 80 kcal – 3 % AA	87.5	86.6	83.7	86.6	93.4	97.5	86.6	89.8	83.0
C – 80 kcal – 3 % AA	87.0	81.2	84.7	88.1	94.2	95.8	86.8	80.0	82.9
C – 80 kcal – 6 % AA	85.9	84.1	79.2	87.2	90.3	98.0	86.3	87.8	81.9
C – 80 kcal – 6 % AA	85.8	76.6	82.1	88.2	87.4	97.1	87.1	75.2	79.6

C – 80 kcal – 6 % AA	82.6	72.8	83.7	86.3	88.1	96.6	84.6	78.5	79.3
C – 80 kcal – 6 % AA	87.6	73.8	85.9	89.9	89.8	97.2	87.8	84.7	83.5
C – 80 kcal – 6 % AA	85.7	73.1	82.4	86.6	86.9	96.3	86.7	78.6	81.2
C – 80 kcal – 6 % AA	84.0	83.5	76.3	83.3	90.1	95.7	82.8	81.7	80.9
C – 80 kcal – 6 % AA	84.9	82.4	77.9	84.1	86.4	96.6	84.2	74.8	78.0
C – 80 kcal – 6 % AA	86.9	73.9	86.0	88.9	85.2	98.0	87.8	79.2	83.1
C –120 kcal – 3 % AA	87.3	74.7	83.6	88.7	89.7	95.9	86.1	82.6	85.7
C –120 kcal – 3 % AA	84.9	77.5	80.4	86.1	87.3	97.4	84.1	80.8	81.0
C –120 kcal – 3 % AA	85.2	76.9	82.4	86.9	90.0	96.6	85.7	81.9	82.9
C –120 kcal – 3 % AA	85.2	76.4	83.7	86.5	88.5	96.9	87.1	82.4	83.7
C –120 kcal – 3 % AA	86.6	84.5	82.7	87.2	89.4	96.9	86.3	86.1	81.9
C –120 kcal – 3 % AA	89.7	91.6	84.0	88.3	95.1	97.8	88.0	83.9	84.4
C –120 kcal – 3 % AA	87.5	87.6	81.9	85.8	93.0	97.2	86.0	81.9	82.4
C –120 kcal – 3 % AA	85.3	76.1	85.1	86.6	87.4	97.3	85.4	81.7	84.3
C –120 kcal – 6 % AA	86.7	75.7	85.9	88.2	90.1	97.0	86.8	76.9	83.8
C –120 kcal – 6 % AA	82.4	71.5	79.7	85.4	84.9	97.1	83.3	78.7	80.3
C –120 kcal – 6 % AA	87.1	76.6	80.8	86.2	88.2	97.0	84.2	81.4	78.1
C –120 kcal – 6 % AA	85.3	78.0	80.9	87.1	87.4	97.2	86.9	80.9	84.0
C –120 kcal – 6 % AA	86.9	78.9	83.7	86.8	88.3	97.6	87.4	76.5	82.5
C –120 kcal – 6 % AA	85.9	78.3	80.4	86.4	89.8	96.9	85.9	89.9	79.9
C –120 kcal – 6 % AA	86.4	79.6	82.0	86.6	89.0	97.3	86.1	80.7	80.2
C –120 kcal – 6 % AA	88.5	82.9	82.3	86.5	88.4	97.6	86.8	79.1	79.2
C – 80 kcal – 3 % AA + CE	84.5	81.1	82.8	86.2	87.0	97.4	84.3	77.3	80.7
C – 80 kcal – 3 % AA + CE	83.4	72.6	80.7	84.3	83.8	96.6	80.6	70.8	84.4
C – 80 kcal – 3 % AA + CE	86.5	74.5	85.5	88.1	87.4	98.3	86.6	79.7	83.9
C – 80 kcal – 3 % AA + CE	85.7	76.9	84.0	87.2	89.8	97.3	84.1	89.2	80.9
C – 80 kcal – 3 % AA + CE	90.8	90.3	85.8	89.2	95.2	97.8	88.9	92.1	83.5
C – 80 kcal – 3 % AA + CE	88.5	88.4	83.4	86.7	94.2	97.3	86.2	91.6	81.1

C – 80 kcal – 3 % AA + CE	91.4	88.6	89.1	90.0	95.4	97.8	91.7	92.9	88.4
C – 80 kcal – 3 % AA + CE	87.6	74.8	85.1	87.0	89.0	95.9	87.0	75.4	84.3
C – 80 kcal – 6 % AA + CE	85.5	74.1	80.7	87.5	88.2	96.5	84.9	71.9	79.6
C – 80 kcal – 6 % AA + CE	85.2	77.3	84.2	88.9	89.6	96.5	85.9	83.6	82.4
C – 80 kcal – 6 % AA + CE	84.3	69.7	80.6	86.8	84.9	97.4	85.1	75.7	78.9
C – 80 kcal – 6 % AA + CE	87.2	75.9	85.2	89.6	90.2	97.1	88.4	80.8	84.0
C – 80 kcal – 6 % AA + CE	86.2	74.4	81.1	86.2	86.7	96.0	85.7	79.5	78.2
C – 80 kcal – 6 % AA + CE	87.4	86.2	81.1	87.0	92.5	96.4	86.6	90.6	80.5
C – 80 kcal – 6 % AA + CE	90.5	87.4	82.3	88.3	93.5	97.8	88.0	91.8	81.8
C – 80 kcal – 6 % AA + CE	87.7	85.0	82.1	87.1	92.4	97.2	87.5	90.1	82.2
C –120 kcal – 3 % AA + CE	89.7	80.4	83.9	90.0	91.5	98.1	86.8	82.9	83.0
C –120 kcal – 3 % AA + CE	86.7	79.1	81.8	88.0	91.6	97.6	86.0	83.0	81.9
C –120 kcal – 3 % AA + CE	86.7	79.8	84.6	87.3	87.0	98.2	86.4	83.6	84.5
C –120 kcal – 3 % AA + CE	86.8	81.0	82.9	87.6	90.5	96.9	85.4	85.9	83.4
C –120 kcal – 3 % AA + CE	80.8	75.1	79.9	82.7	84.1	97.8	85.8	77.9	80.6
C –120 kcal – 3 % AA + CE	91.7	87.4	85.6	89.9	96.2	96.0	89.5	86.8	86.0
C –120 kcal – 3 % AA + CE	86.3	82.1	84.7	85.4	91.6	97.4	85.3	85.4	84.5
C –120 kcal – 3 % AA + CE	87.2	82.3	83.6	86.8	92.3	96.4	86.1	85.9	83.4
C –120 kcal – 6 % AA + CE	87.1	69.8	83.5	88.1	87.8	97.7	87.0	75.9	80.5
C –120 kcal – 6 % AA + CE	81.3	69.0	79.4	86.9	88.6	97.6	83.4	78.3	79.4
C –120 kcal – 6 % AA + CE	86.2	74.4	81.8	87.4	85.1	95.2	85.9	75.5	79.6
C –120 kcal – 6 % AA + CE	83.7	73.0	80.0	86.0	84.7	94.6	84.9	73.5	78.5
C –120 kcal – 6 % AA + CE	84.5	75.2	82.5	86.1	86.1	98.4	86.3	75.3	81.0
C –120 kcal – 6 % AA + CE	88.6	88.7	82.1	87.3	93.6	97.5	87.5	91.1	81.7
C –120 kcal – 6 % AA + CE	90.2	84.4	85.2	88.0	91.0	97.1	88.6	86.7	84.1
C –120 kcal – 6 % AA + CE	89.7	88.8	84.7	88.5	94.0	97.9	89.2	91.6	84.5

Apêndice 11. Digestibilidade ileal de aminoácidos não essencias e total dos frangos de corte aos 42 d, %.

Tratamento	Ala	Asp	Cys	Glu	Gly	Ser	Total AA
Dieta controle (C)	85.6	83.1	90.3	90.1	79.5	83.2	86.8
Dieta controle	86.5	75.6	82.8	90.2	83.4	84.0	86.2
Dieta controle	89.6	95.0	87.6	90.9	83.7	84.7	89.0
Dieta controle	87.2	89.0	86.5	92.7	84.0	86.7	88.2
Dieta controle	82.1	86.1	76.4	79.9	87.3	80.5	84.6
Dieta controle	88.3	90.1	86.0	85.7	91.1	89.5	89.1
Dieta controle	87.5	87.7	89.7	85.6	90.2	88.6	88.4
Dieta controle	84.0	92.2	79.1	86.1	80.1	87.1	85.7
C – 80 kcal – 3 % AA	86.8	82.8	78.8	89.5	82.1	82.3	85.5
C – 80 kcal – 3 % AA	86.5	86.3	84.2	91.5	82.3	82.6	86.3
C – 80 kcal – 3 % AA	83.4	84.4	80.0	90.4	79.1	80.7	84.2
C – 80 kcal – 3 % AA	86.3	90.9	84.7	87.2	81.2	80.5	86.6
C – 80 kcal – 3 % AA	84.9	75.8	85.2	88.4	80.9	81.1	83.9
C – 80 kcal – 3 % AA	86.1	89.3	83.6	83.9	88.8	87.2	86.6
C – 80 kcal – 3 % AA	85.8	86.5	86.3	82.8	87.5	85.6	85.6
C – 80 kcal – 3 % AA	88.1	96.3	82.3	89.0	82.3	86.2	88.0
C – 80 kcal – 6 % AA	86.2	87.5	81.7	84.6	88.4	86.6	85.8
C – 80 kcal – 6 % AA	84.8	78.2	82.1	88.6	78.7	79.9	84.2
C – 80 kcal – 6 % AA	84.9	86.7	84.8	85.1	79.3	78.7	83.7
C – 80 kcal – 6 % AA	89.0	88.8	84.9	86.3	82.4	81.3	86.4
C – 80 kcal – 6 % AA	84.8	85.9	83.5	86.1	80.3	80.8	84.6
C – 80 kcal – 6 % AA	82.0	82.9	80.8	77.2	85.8	82.0	81.7
C – 80 kcal – 6 % AA	83.1	81.1	84.4	78.1	86.1	85.1	81.9
C – 80 kcal – 6 % AA	88.2	93.4	83.0	89.3	82.5	84.5	87.0
C –120 kcal – 3 % AA	85.9	85.4	81.8	89.4	83.0	80.8	86.0
C –120 kcal – 3 % AA	84.1	83.7	82.2	89.1	81.1	80.5	84.6
C –120 kcal – 3 % AA	85.3	84.7	83.5	90.2	80.4	83.1	85.6

C –120 kcal – 3 % AA	84.8	85.4	83.6	89.1	82.6	80.9	85.4
C –120 kcal – 3 % AA	85.6	84.7	84.3	88.6	81.7	83.5	85.8
C –120 kcal – 3 % AA	86.9	90.6	85.0	84.6	89.3	88.6	87.8
C –120 kcal – 3 % AA	84.9	85.8	83.5	78.9	85.1	84.9	84.6
C –120 kcal – 3 % AA	85.1	91.6	82.8	84.1	81.8	81.5	84.9
C –120 kcal – 6 % AA	85.9	81.7	82.9	85.2	80.7	83.3	85.2
C –120 kcal – 6 % AA	83.4	83.5	81.4	87.1	82.7	82.7	83.6
C –120 kcal – 6 % AA	87.6	86.1	82.9	82.4	81.2	80.5	83.5
C –120 kcal – 6 % AA	85.5	87.3	86.2	87.3	85.5	82.6	86.0
C –120 kcal – 6 % AA	85.4	86.3	84.6	88.0	84.6	80.3	85.7
C –120 kcal – 6 % AA	85.9	86.6	82.4	80.8	86.8	85.5	84.5
C –120 kcal – 6 % AA	85.4	85.6	82.6	85.6	81.8	80.6	84.7
C –120 kcal – 6 % AA	84.1	87.8	81.8	87.0	81.8	83.1	85.5
C – 80 kcal – 3 % AA + CE	85.0	84.9	80.7	87.9	80.3	80.4	84.7
C – 80 kcal – 3 % AA + CE	81.5	81.6	81.9	86.5	82.8	78.1	82.2
C – 80 kcal – 3 % AA + CE	87.4	86.0	84.9	91.7	82.7	83.4	87.0
C – 80 kcal – 3 % AA + CE	88.5	88.2	86.9	85.8	82.0	86.9	84.8
C – 80 kcal – 3 % AA + CE	88.3	90.4	85.6	86.2	89.8	88.5	88.5
C – 80 kcal – 3 % AA + CE	84.9	85.0	79.0	83.8	86.9	87.0	85.4
C – 80 kcal – 3 % AA + CE	88.8	89.8	88.6	86.7	89.8	89.1	89.1
C – 80 kcal – 3 % AA + CE	85.9	93.2	82.3	86.4	81.9	82.7	85.8
C – 80 kcal – 6 % AA + CE	85.3	85.9	82.6	87.7	81.1	76.5	84.2
C – 80 kcal – 6 % AA + CE	88.5	89.9	86.1	87.2	81.9	81.3	86.1
C – 80 kcal – 6 % AA + CE	84.4	84.7	84.9	89.9	78.7	80.0	84.4
C – 80 kcal – 6 % AA + CE	88.2	86.9	86.1	89.9	82.0	83.1	87.1
C – 80 kcal – 6 % AA + CE	84.6	83.2	83.3	88.4	80.1	79.7	84.2
C – 80 kcal – 6 % AA + CE	85.6	83.4	82.7	82.4	88.0	85.9	85.0
C – 80 kcal – 6 % AA + CE	87.3	85.7	81.4	85.5	89.4	88.7	86.9

C – 80 kcal – 6 % AA + CE	86.1	85.1	81.6	83.1	87.1	85.1	85.4
C –120 kcal – 3 % AA + CE	87.4	92.5	80.9	88.8	84.8	86.5	87.7
C –120 kcal – 3 % AA + CE	85.9	82.5	82.2	87.5	79.8	82.7	85.3
C –120 kcal – 3 % AA + CE	85.8	88.5	86.3	87.0	85.0	84.4	86.3
C –120 kcal – 3 % AA + CE	85.8	89.3	84.4	85.7	81.4	79.5	85.6
C –120 kcal – 3 % AA + CE	85.6	84.9	80.9	85.5	81.2	73.9	82.6
C –120 kcal – 3 % AA + CE	88.8	91.3	83.4	87.5	90.4	90.7	88.9
C –120 kcal – 3 % AA + CE	85.1	83.1	84.7	84.9	85.4	84.0	85.4
C –120 kcal – 3 % AA + CE	86.7	82.5	84.8	85.7	84.8	82.4	85.3
C –120 kcal – 6 % AA + CE	85.9	84.5	79.0	88.5	81.3	82.0	85.3
C –120 kcal – 6 % AA + CE	85.5	84.0	82.8	85.4	78.6	80.3	83.5
C –120 kcal – 6 % AA + CE	87.1	85.9	84.4	92.6	81.3	82.4	85.9
C –120 kcal – 6 % AA + CE	86.8	82.3	83.7	89.1	82.8	79.1	84.0
C –120 kcal – 6 % AA + CE	84.0	85.7	84.5	84.6	82.5	77.2	83.9
C –120 kcal – 6 % AA + CE	86.8	88.1	82.5	82.0	88.4	86.4	86.1
C –120 kcal – 6 % AA + CE	85.8	87.5	85.6	83.3	86.0	82.9	86.0
C –120 kcal – 6 % AA + CE	87.5	87.4	83.8	84.4	89.3	87.9	87.2

Apêndice 12. Análise do efeito dos tratamentos sobre o consumo de ração dos frangos no período de 1 a 21 dias.

ANOVA					
Fonte	GL	SQ	QM	F	P
Tratamento	8	0,0410	0,0051	2,17	0,0423
Erro	63	0,1491	0,0024		
Total	71	0,1901			

Apêndice 13. Análise do efeito dos tratamentos sobre o ganho de peso dos frangos no período de 1 a 21 dias.

ANOVA					
Fonte	GL	SQ	QM	F	P
Tratamento	8	0,0144	0,0018	0,91	0,5142
Erro	63	0,1244	0,0020		
Total	71	0,1389			

Apêndice 14. Análise do efeito dos tratamentos sobre a conversão alimentar dos frangos no período de 1 a 21 dias.

ANOVA					
Fonte	GL	SQ	QM	F	P
Tratamento	8	0,0296	0,0037	3,81	0,0010
Erro	63	0,0611	0,0001		
Total	71	0,0908			

Apêndice 15. Análise do efeito dos tratamentos sobre o consumo de ração dos frangos no período de 22 a 35 dias.

ANOVA					
Fonte	GL	SQ	QM	F	P
Tratamento	8	0,1123	0,0140	2,44	0,0231
Erro	63	0,3630	0,0058		
Total	71	0,4752			

Apêndice 16. Análise do efeito dos tratamentos sobre o ganho de peso dos frangos no período de 22 a 35 dias.

ANOVA					
Fonte	GL	SQ	QM	F	P
Tratamento	8	0,0200	0,0025	0,62	0,7582
Erro	63	0,2554	0,0040		
Total	71	0,2754			

Apêndice 17. Análise do efeito dos tratamentos sobre a conversão alimentar dos frangos no período de 22 a 35 dias.

ANOVA					
Fonte	GL	SQ	QM	F	P
Tratamento	8	0,0161	0,0020	1,35	0,2358
Erro	63	0,0941	0,0015		
Total	71	0,1102			

Apêndice 18. Análise do efeito dos tratamentos sobre o consumo de ração dos frangos no período de 36 a 42 dias.

ANOVA					
Fonte	GL	SQ	QM	F	P
Tratamento	8	0,0426	0,0053	1,24	0,2900
Erro	63	0,2702	0,0043		
Total	71	0,3129			

Apêndice 19. Análise do efeito dos tratamentos sobre o ganho de peso dos frangos no período de 36 a 42 dias.

ANOVA					
Fonte	GL	SQ	QM	F	P
Tratamento	8	0,0078	0,0010	0,61	0,7684
Erro	63	0,1010	0,0016		
Total	71	0,1088			

Apêndice 20. Análise do efeito dos tratamentos sobre a conversão alimentar dos frangos no período de 36 a 42 dias.

ANOVA					
Fonte	GL	SQ	QM	F	P
Tratamento	8	0,0205	0,0026	0,47	0,8726
Erro	63	0,3433	0,0054		
Total	71	0,3639			

Apêndice 21. Análise do efeito dos tratamentos sobre o consumo de ração dos frangos no período de 1 a 42 dias.

ANOVA					
Fonte	GL	SQ	QM	F	P
Tratamento	8	0,3692	0,0461	2,85	0,0092
Erro	63	1,0214	0,0162		
Total	71	1,3906			

Apêndice 22. Análise do efeito dos tratamentos sobre o ganho de peso dos frangos no período de 1 a 42 dias.

ANOVA					
Fonte	GL	SQ	QM	F	P
Tratamento	8	0,0679	0,0085	1,72	0,1106
Erro	63	0,3103	0,0049		
Total	71	0,3781			

Apêndice 23. Análise do efeito dos tratamentos sobre a conversão alimentar dos frangos no período de 1 a 42 dias.

ANOVA					
Fonte	GL	SQ	QM	F	P
Tratamento	8	0,0314	0,0039	4,77	0,0001
Erro	63	0,0518	0,0008		
Total	71	0,0831			

Apêndice 24. Análise do efeito dos tratamentos sobre a energia digestível ileal nos frangos aos 21 dias.

ANOVA					
Fonte	GL	SQ	QM	F	P
Tratamento	8	430461,9991	53807,7499	6,05	<0,0001
Erro	63	560172,0265	8891,6195		
Total	71	990634,0255			

Apêndice 25. Análise do efeito dos tratamentos sobre a digestibilidade ileal da matéria seca em frangos nos 21 dias.

ANOVA					
Fonte	GL	SQ	QM	F	P
Tratamento	8	320,3643	40,0455	6,24	<0,0001
Erro	63	404,6203	6,4225		
Total	71	724,9846			

Apêndice 26. Análise do efeito dos tratamentos sobre a energia digestível ileal em frangos aos 42 dias.

ANOVA					
Fonte	GL	SQ	QM	F	P
Tratamento	8	302948,883	37868,610	3,31	0,0032
Erro	63	721328,343	11449,656		
Total	71	1024277,226			

Apêndice 27. Análise do efeito dos tratamentos sobre a digestibilidade ileal da matéria seca em frangos aos 42 dias.

ANOVA					
Fonte	GL	SQ	QM	F	P
Tratamento	8	41,9804	5,2475	2,14	0,0450
Erro	63	154,7001	2,4556		
Total	71	196,6805			

Apêndice 28. Análise do efeito dos tratamentos sobre a digestibilidade ileal da arginina em frangos aos 21 dias.

ANOVA					
Fonte	GL	SQ	QM	F	P
Tratamento	8	45,7504	5,7188	3,95	0,0008
Erro	63	91,2004	1,4476		
Total	71	136,9508			

Apêndice 29. Análise do efeito dos tratamentos sobre a digestibilidade ileal da histidina em frangos aos 21 dias.

ANOVA					
Fonte	GL	SQ	QM	F	P
Tratamento	8	142,8866	17,8608	1,70	0,1163
Erro	63	662,5751	10,5171		
Total	71	805,4617			

Apêndice 30. Análise do efeito dos tratamentos sobre a digestibilidade ileal da isoleucina em frangos aos 21 dias

ANOVA					
Fonte	GL	SQ	QM	F	P
Tratamento	8	87,0075	10,8759	4,91	<0,0001
Erro	63	139,4114	2,2129		
Total	71	226,4190			

Apêndice 31. Análise do efeito dos tratamentos sobre a digestibilidade ileal da leucina em frangos aos 21 dias

ANOVA					
Fonte	GL	SQ	QM	F	P
Tratamento	8	76,0309	9,5039	4,20	0,0004
Erro	63	142,6620	2,2645		
Total	71	218,6928			

Apêndice 32. Análise do efeito dos tratamentos sobre a digestibilidade ileal da lisina em frangos aos 21 dias

ANOVA					
Fonte	GL	SQ	QM	F	P
Tratamento	8	112,6584	14,0823	7,34	<0,0001
Erro	63	120,8828	1,9188		
Total	71	233,5412			

Apêndice 33. Análise do efeito dos tratamentos sobre a digestibilidade ileal da metionina em frangos aos 21 dias.

ANOVA					
Fonte	GL	SQ	QM	F	P
Tratamento	8	1,3074	0,1634	0,32	0,9572
Erro	63	32,5932	0,5174		
Total	71	33,9006			

Apêndice 34. Análise do efeito dos tratamentos sobre a digestibilidade ileal da fenilalanina em frangos aos 21 dias.

ANOVA					
Fonte	GL	SQ	QM	F	P
Tratamento	8	62,3256	7,7907	3,89	0,0009
Erro	63	126,2932	2,0046		
Total	71	188,6188			

Apêndice 35. Análise do efeito dos tratamentos sobre a digestibilidade ileal da treonina em frangos aos 21 dias.

ANOVA					
Fonte	GL	SQ	QM	F	P
Tratamento	8	213,5638	26,6955	4,62	0,0002
Erro	63	364,0752	5,7790		
Total	71	577,6390			

Apêndice 36. Análise do efeito dos tratamentos sobre a digestibilidade ileal da valina em frangos aos 21 dias.

ANOVA					
Fonte	GL	SQ	QM	F	P
Tratamento	8	140,2182	17,5273	5,81	<0,0001
Erro	63	190,0415	3,0165		
Total	71	3330,2597			

Apêndice 37. Análise do efeito dos tratamentos sobre a digestibilidade ileal da alanina em frangos aos 21 dias.

ANOVA					
Fonte	GL	SQ	QM	F	P
Tratamento	8	65,8232	8,2279	3,04	0,0060
Erro	63	170,7421	2,7102		
Total	71	236,5652			

Apêndice 38. Análise do efeito dos tratamentos sobre a digestibilidade ileal do aspartato em frangos aos 21 dias.

ANOVA					
Fonte	GL	SQ	QM	F	P
Tratamento	8	51,8967	6,4871	1,52	0,1689
Erro	63	269,1520	4,2722		
Total	71	321,0477			

Apêndice 39. Análise do efeito dos tratamentos sobre a digestibilidade ileal da cistina em frangos aos 21 dias.

ANOVA					
Fonte	GL	SQ	QM	F	P
Tratamento	8	55,7945	6,9743	0,52	0,8359
Erro	63	842,5362	13,3736		
Total	71	898,3308			

Apêndice 40. Análise do efeito dos tratamentos sobre a digestibilidade ileal da glutamina em frangos aos 21 dias.

ANOVA					
Fonte	GL	SQ	QM	F	P
Tratamento	8	24,5160	3,0645	1,41	0,2100
Erro	63	136,9418	2,1737		
Total	71	161,4578			

Apêndice 41. Análise do efeito dos tratamentos sobre a digestibilidade ileal da glicina em frangos aos 21 dias.

ANOVA					
Fonte	GL	SQ	QM	F	P
Tratamento	8	78,5876	9,8234	3,90	0,0009
Erro	63	158,6527	2,5183		
Total	71	237,2403			

Apêndice 42. Análise do efeito dos tratamentos sobre a digestibilidade ileal da serina em frangos aos 21 dias.

ANOVA					
Fonte	GL	SQ	QM	F	P
Tratamento	8	45,1542	5,6443	2,20	0,0394
Erro	63	161,8693	2,5694		
Total	71	207,0236			

Apêndice 43. Análise do efeito dos tratamentos sobre a digestibilidade ileal do total de aminoácidos em frangos aos 21 dias.

ANOVA					
Fonte	GL	SQ	QM	F	P
Tratamento	8	45,8775	5,7347	4,55	0,0002
Erro	63	79,3833	1,2600		
Total	71	125,2608			

Apêndice 44. Análise do efeito dos tratamentos sobre a digestibilidade ileal da arginina em frangos aos 42 dias.

ANOVA					
Fonte	GL	SQ	QM	F	P
Tratamento	8	129,8448	16,2306	3,00	0,0065
Erro	63	340,8464	5,4103		
Total	71	470,6912			

Apêndice 45. Análise do efeito dos tratamentos sobre a digestibilidade ileal da histidina em frangos aos 42 dias.

ANOVA					
Fonte	GL	SQ	QM	F	P
Tratamento	8	452,6219	56,5777	1,62	0,1369
Erro	63	2199,5807	34,9140		
Total	71	2652,2026			

Apêndice 46. Análise do efeito dos tratamentos sobre a digestibilidade ileal da isoleucina em frangos aos 42 dias.

ANOVA					
Fonte	GL	SQ	QM	F	P
Tratamento	8	110,4493	13,8062	2,94	0,0074
Erro	63	295,4772	4,6901		
Total	71	405,9265			

Apêndice 47. Análise do efeito dos tratamentos sobre a digestibilidade ileal da leucina em frangos aos 42 dias.

ANOVA					
Fonte	GL	SQ	QM	F	P
Tratamento	8	23,7167	2,9646	1,13	0,3559
Erro	63	165,2672	2,6233		
Total	71	188,9839			

Apêndice 48. Análise do efeito dos tratamentos sobre a digestibilidade ileal da lisina em frangos aos 42 dias.

ANOVA					
Fonte	GL	SQ	QM	F	P
Tratamento	8	109,3218	13,6652	1,51	0,1732
Erro	63	571,7334	9,0751		
Total	71	681,0552			

Apêndice 49. Análise do efeito dos tratamentos sobre a digestibilidade ileal da metionina em frangos aos 42 dias.

ANOVA					
Fonte	GL	SQ	QM	F	P
Tratamento	8	1,8611	0,2326	0,24	0,9806
Erro	63	60,0222	0,9527		
Total	71	61,8834			

Apêndice 50. Análise do efeito dos tratamentos sobre a digestibilidade ileal da fenilalanina em frangos aos 42 dias.

ANOVA					
Fonte	GL	SQ	QM	F	P
Tratamento	8	43,4573	5,4322	1,64	0,1302
Erro	63	208,1022	3,3032		
Total	71	251,5596			

Apêndice 51. Análise do efeito dos tratamentos sobre a digestibilidade ileal da treonina em frangos aos 42 dias.

ANOVA					
Fonte	GL	SQ	QM	F	P
Tratamento	8	176,0666	22,0083	0,69	0,7018
Erro	63	2019,9401	32,0626		
Total	71	2196,0074			

Apêndice 52. Análise do efeito dos tratamentos sobre a digestibilidade ileal da valina em frangos aos 42 dias.

ANOVA					
Fonte	GL	SQ	QM	F	P
Tratamento	8	184,5979	23,0747	5,78	<0,0001
Erro	63	251,4155	3,9907		
Total	71	436,0134			

Apêndice 53. Análise do efeito dos tratamentos sobre a digestibilidade ileal da alanina em frangos aos 42 dias.

ANOVA					
Fonte	GL	SQ	QM	F	P
Tratamento	8	13,0268	1,6284	0,54	0,8185
Erro	63	188,4168	2,9907		
Total	71	201,4436			

Apêndice 54. Análise do efeito dos tratamentos sobre a digestibilidade ileal do aspartato em frangos aos 42 dias.

ANOVA					
Fonte	GL	SQ	QM	F	P
Tratamento	8	36,0740	4,5093	0,28	0,9711
Erro	63	1024,6177	16,2638		
Total	71	1060,6917			

Apêndice 55. Análise do efeito dos tratamentos sobre a digestibilidade ileal da cistina em frangos aos 42 dias.

ANOVA					
Fonte	GL	SQ	QM	F	P
Tratamento	8	17,9787	2,2473	0,34	0,9480
Erro	63	419,3448	6,6563		
Total	71	437,3235			

Apêndice 56. Análise do efeito dos tratamentos sobre a digestibilidade ileal da glutamina em frangos aos 42 dias.

ANOVA					
Fonte	GL	SQ	QM	F	P
Tratamento	8	71,6129	8,9516	0,84	0,5718
Erro	63	671,9269	10,6655		
Total	71	743,5398			

Apêndice 57. Análise do efeito dos tratamentos sobre a digestibilidade ileal da glicina em frangos aos 42 dias.

ANOVA					
Fonte	GL	SQ	QM	F	P
Tratamento	8	31,8519	3,9815	0,32	0,9540
Erro	63	775,0134	12,3018		
Total	71	806,8652			

Apêndice 58. Análise do efeito dos tratamentos sobre a digestibilidade ileal da serina em frangos aos 42 dias.

ANOVA					
Fonte	GL	SQ	QM	F	P
Tratamento	8	80,7432	10,0929	0,89	0,5331
Erro	63	717,3587	11,3866		
Total	71	798,1019			

Apêndice 59. Análise do efeito dos tratamentos sobre a digestibilidade ileal do total de aminoácidos em frangos aos 42 dias.

ANOVA					
Fonte	GL	SQ	QM	F	P
Tratamento	8	40,9163	5,1145	2,12	0,0471
Erro	63	152,2681	2,4170		
Total	71	193,1844			

Apêndice 60. Análise de contrastes do consumo de ração dos frangos no período de 1 a 21 dias.

Contrastes					
Fonte	GL	Contraste	QM	F	P
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,00157176	0,00157176	0,49	0,8617
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,00115685	0,00115685	0,03	0,9611
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,00007243	0,00007243	0,00	0,4225
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,00000568	0,00000568	0,65	0,4181
Com CE vs Sem CE	1	0,00115685	0,00115685	0,66	0,4870

Apêndice 61. Análise de contrastes do ganho de peso dos frangos no período de 1 a 21 dias.

Contrastes					
Fonte	GL	Contraste	QM	F	P
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,00128536	0,00128536	0,65	0,4230
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,00003177	0,00003177	0,02	0,4225
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,00227046	0,00227046	1,15	0,4181
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,00309912	0,00309912	1,57	0,2151
Com CE vs Sem CE	1	0,00523843	0,00523843	2,65	0,1085

Apêndice 62. Análise de contrastes da conversão alimentar dos frangos no período de 1 a 21 dias.

Contrastes					
Fonte	GL	Contraste	QM	F	P
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,00354060	0,00354060	3,65	0,0607
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,00011673	0,00011673	0,12	0,7299
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,00080633	0,00080633	0,83	0,3656
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,00188844	0,00188844	1,94	0,1680
Com CE vs Sem CE	1	0,00505230	0,00505230	5,20	0,2590

Apêndice 63. Análise de contrastes do consumo de ração dos frangos no período de 22 a 35 dias.

Contrastes					
Fonte	GL	Contraste	QM	F	P
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,00746789	0,00746789	1,30	0,2592
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,00128931	0,00128931	0,22	0,6378
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,00002442	0,00002442	0,00	0,9483
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,00448872	0,00448872	0,78	0,3808
Com CE vs Sem CE	1	0,00849904	0,00849904	1,48	0,2291

Apêndice 64. Análise de contrastes do ganho de peso dos frangos no período de 22 a 35 dias.

Contrastes					
Fonte	GL	Contraste	QM	F	P
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,00002546	0,00002546	0,01	0,9371
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,00000300	0,00000300	0,00	0,9784
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,00126404	0,00126404	0,31	0,5785
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,00010416	0,00010416	0,03	0,8732
Com CE vs Sem CE	1	0,00025804	0,00025804	0,06	0,8016

Apêndice 65. Análise de contrastes da conversão alimentar dos frangos no período de 22 a 35 dias.

Contrastes					
Fonte	GL	Contraste	QM	F	P
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,00380187	0,00380187	3,96	0,1156
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,00063914	0,00063914	2,55	0,5153
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,00115954	0,00115954	0,43	0,3815
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,00106992	0,00106992	0,78	0,4005
Com CE vs Sem CE	1	0,00590609	0,00590609	0,72	0,0511

Apêndice 66. Análise de contrastes do consumo de ração dos frangos no período de 36 a 42 dias.

Contrastes					
Fonte	GL	Contraste	QM	F	P
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,00297666	0,00297666	0,69	0,4080
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,00200675	0,00200675	0,47	0,4965
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,01139607	0,01139607	2,66	0,1081
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,00313090	0,00313090	0,73	0,3962
Com CE vs Sem CE	1	0,01716917	0,01716917	4,00	0,0497

Apêndice 67. Análise de contrastes do ganho de peso dos frangos no período de 36 a 42 dias.

Contrastes					
Fonte	GL	Contraste	QM	F	P
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,00017926	0,00017926	0,11	0,7939
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,00067484	0,00067484	0,42	0,5189
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,00266192	0,00266192	1,66	0,2024
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,00047473	0,00047473	0,30	0,5883
Com CE vs Sem CE	1	0,00317806	0,00317806	1,98	0,1642

Apêndice 68. Análise de contrastes da conversão alimentar dos frangos no período de 36 a 42 dias.

Contrastes					
Fonte	GL	Contraste	QM	F	P
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,00228695	0,00228695	0,42	0,5195
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,00014532	0,00014532	0,03	0,8708
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,00017093	0,00017093	0,03	0,8600
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,00075548	0,00075548	0,14	0,7109
Com CE vs Sem CE	1	0,00145646	0,00145646	0,27	0,6070

Apêndice 69. Análise de contrastes do consumo de ração dos frangos no período de 1 a 42 dias.

Contrastes					
Fonte	GL	Contraste	QM	F	P
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,02234611	0,02234611	1,38	0,2448
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,00690340	0,00690340	0,43	0,5164
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,00391101	0,00391101	0,24	0,6250
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,00694005	0,00694005	0,43	0,5153
Com CE vs Sem CE	1	0,03580002	0,03580002	2,21	0,1423

Apêndice 70. Análise de contrastes do ganho de peso dos frangos no período de 1 a 42 dias.

Contrastes					
Fonte	GL	Contraste	QM	F	P
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,00015559	0,00015559	0,03	0,8595
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,00002027	0,00002027	0,00	0,9490
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,02036532	0,02036532	4,14	0,0462
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,00997956	0,00997956	2,03	0,1595
Com CE vs Sem CE	1	0,01569709	0,01569709	3,19	0,0790

Apêndice 71. Análise de contrastes da conversão alimentar dos frangos no período de 1 a 42 dias.

Contrastes					
Fonte	GL	Contraste	QM	F	P
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,00294189	0,00294189	3,58	0,0630
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,00059715	0,00059715	0,73	0,3971
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,00856614	0,00856614	10,43	0,0020
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,00594606	0,00594606	7,24	0,0091
Com CE vs Sem CE	1	0,01541819	0,01541819	18,77	<0,0001

Apêndice 72. Análise de contrastes da energia digestível ileal dos frangos no período aos 21 dias.

Contrastes					
Fonte	GL	Contraste	QM	F	P
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	20888,4610	20888,4610	2,35	0,1304
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	43478,2816	43478,2816	4,89	0,0307
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	122449,6155	122449,6155	13,77	0,0004
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	122017,4359	122017,4359	13,72	0,0004
Com CE vs Sem CE	1	276823,7363	276823,7363	31,13	<0,0001

Apêndice 73. Análise de contrastes da digestibilidade ileal da matéria seca nos frangos aos 21 dias.

Contrastes					
Fonte	GL	Contraste	QM	F	P
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,35236923	0,35236923	0,05	0,8156
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	29,28898140	29,28898140	4,56	0,0366
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	41,23312917	41,23312917	6,42	0,0138
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	40,46292104	40,46292104	6,30	0,0147
Com CE vs Sem CE	1	88,24616917	88,24616917	13,74	0,0004

Apêndice 74. Análise de contrastes da energia digestível ileal dos frangos no período aos 42 dias.

Contrastes					
Fonte	GL	Contraste	QM	F	P
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	10534,3285	10534,3285	0,92	0,3411
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	14130,4642	14130,4642	1,23	0,2708
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	48066,9784	48066,9784	4,20	0,0446
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	64011,3504	64011,3504	5,59	0,0212
Com CE vs Sem CE	1	120323,9921	120323,9921	10,51	0,0019

Apêndice 75. Análise de contrastes da digestibilidade ileal da matéria seca nos frangos aos 42 dias.

Contrastes					
Fonte	GL	Contraste	QM	F	P
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	5,72441094	5,72441094	2,33	0,1318
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	3,71125080	3,71125080	1,51	0,2235
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	2,64266560	2,64266560	1,08	0,3035
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	9,89458411	9,89458411	4,03	0,0490
Com CE vs Sem CE	1	20,65806290	20,65806290	8,41	0,0051

Apêndice 76. Análise de contrastes da digestibilidade ileal da arginina nos frangos aos 21 dias.

Contrastes					
Fonte	GL	Contraste	QM	F	P
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	5,20980625	5,20980625	3,60	0,0624
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	10,00140625	10,00140625	6,91	0,0108
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,63202500	0,63202500	4,66	0,0347
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,63202500	0,63202500	0,44	0,5112
Com CE vs Sem CE	1	19,52535156	19,52535156	13,49	0,0005

Apêndice 77. Análise de contrastes da digestibilidade ileal da histidina nos frangos aos 21 dias.

Contrastes					
Fonte	GL	Contraste	QM	F	P
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,95550625	0,95550625	0,09	0,7641
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	5,16425625	5,16425625	0,49	0,4860
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,05175625	0,05175625	0,00	0,9443
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,05405625	0,05405625	0,01	0,9431
Com CE vs Sem CE	1	0,42250000	0,42250000	0,04	0,8418

Apêndice 78. Análise de contrastes da digestibilidade ileal da isoleucina nos frangos aos 21 dias.

Contrastes					
Fonte	GL	Contraste	QM	F	P
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	16,54455625	16,54455625	7,48	0,0081
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	20,02562500	20,02562500	9,05	0,0038
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	1,08160000	1,08160000	0,49	0,4870
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	3,23100625	3,23100625	1,46	0,2314
Com CE vs Sem CE	1	32,37610000	32,37610000	14,63	0,0003

Apêndice 79. Análise de contrastes da digestibilidade ileal da leucina nos frangos aos 21 dias.

Contrastes					
Fonte	GL	Contraste	QM	F	P
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	7,99475625	7,99475625	3,53	0,0649
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	12,97800625	12,97800625	5,73	0,0197
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	4,85100625	4,85100625	2,14	0,1483
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,61622500	0,61622500	0,27	0,6037
Com CE vs Sem CE	1	22,17232656	22,17232656	9,79	0,0027

Apêndice 80. Análise de contrastes da digestibilidade ileal da lisina nos frangos aos 21 dias.

Contrastes					
Fonte	GL	Contraste	QM	F	P
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	3,73455625	3,73455625	1,95	0,1679
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	7,24955625	7,24955625	3,78	0,0564
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	4,62250000	4,62250000	2,41	0,1256
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	8,32322500	8,32322500	4,34	0,0413
Com CE vs Sem CE	1	23,32890000	23,32890000	12,16	0,0009

Apêndice 81. Análise de contrastes da digestibilidade ileal da metionina nos frangos aos 21 dias.

Contrastes					
Fonte	GL	Contraste	QM	F	P
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,34810000	0,34810000	0,67	0,4152
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,47265625	0,47265625	0,91	0,3428
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,00600625	0,00600625	0,01	0,9145
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,28622500	0,28622500	0,55	0,4598
Com CE vs Sem CE	1	0,89302500	0,89302500	1,73	0,1937

Apêndice 82. Análise de contrastes da digestibilidade ileal da fenilalanina nos frangos aos 21 dias.

Contrastes					
Fonte	GL	Contraste	QM	F	P
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	2,92410000	2,92410000	1,46	0,2317
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	15,32722500	15,32722500	7,65	0,0075
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	4,97290000	4,97290000	2,48	0,1203
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	5,25555625	5,25555625	2,62	0,1104
Com CE vs Sem CE	1	25,74293906	25,74293906	12,84	0,0007

Apêndice 83. Análise de contrastes da digestibilidade ileal da treonina nos frangos aos 21 dias.

Contrastes					
Fonte	GL	Contraste	QM	F	P
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	10,44905625	10,44905625	1,81	0,1836
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	23,83880625	23,83880625	4,13	0,0465
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	14,59240000	14,59240000	2,53	0,1171
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	15,34680625	15,34680625	2,66	0,1082
Com CE vs Sem CE	1	62,82543906	62,82543906	10,87	0,0016

Apêndice 84. Análise de contrastes da digestibilidade ileal da valina nos frangos aos 21 dias.

Contrastes					
Fonte	GL	Contraste	QM	F	P
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	22,46760000	22,46760000	7,45	0,0082
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	18,72725625	18,72725625	6,21	0,0154
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	2,56800625	2,56800625	0,85	0,3597
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	12,69140625	12,69140625	4,21	0,0444
Com CE vs Sem CE	1	50,61401406	50,61401406	16,79	0,0001

Apêndice 85. Análise de contrastes da digestibilidade ileal da alanina nos frangos aos 21 dias.

Contrastes					
Fonte	GL	Contraste	QM	F	P
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	11,62810000	11,62810000	4,29	0,0424
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	4,39950625	4,39950625	1,62	0,2073
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	13,39560000	13,39560000	4,94	0,0298
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	1,61290000	1,61290000	0,60	0,4433
Com CE vs Sem CE	1	27,23535156	27,23535156	10,05	0,0024

Apêndice 86. Análise de contrastes da digestibilidade ileal do aspartato nos frangos aos 21 dias.

Contrastes					
Fonte	GL	Contraste	QM	F	P
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,02560000	0,02560000	0,01	0,9385
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	4,14122500	4,14122500	0,97	0,3286
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	6,86440000	6,86440000	1,61	0,2096
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	3,02276000	3,0276000	0,71	0,4031
Com CE vs Sem CE	1	9,71880625	9,71880625	2,27	0,1365

Apêndice 87. Análise de contrastes da digestibilidade ileal da cistina nos frangos aos 21 dias.

Contrastes					
Fonte	GL	Contraste	QM	F	P
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	25,75562500	25,75562500	1,93	0,1701
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	7,31702500	7,31702500	0,55	0,4622
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,85100625	0,85100625	0,06	0,8017
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	3,10640625	3,10640625	0,23	0,6315
Com CE vs Sem CE	1	18,57610000	18,57610000	1,39	0,2430

Apêndice 88. Análise de contrastes da digestibilidade ileal da glutamina nos frangos aos 21 dias.

Contrastes					
Fonte	GL	Contraste	QM	F	P
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	1,61925625	1,61925625	0,74	0,3914
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	10,95610000	10,95610000	5,04	0,0283
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	7,08890625	7,08890625	3,26	0,0757
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	3,53440000	3,53440000	1,63	0,2069
Com CE vs Sem CE	1	20,81640625	20,81640625	9,58	0,0029

Apêndice 89. Análise de contrastes da digestibilidade ileal da glicina nos frangos aos 21 dias.

Contrastes					
Fonte	GL	Contraste	QM	F	P
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,87422500	0,87422500	0,35	0,5578
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,19140625	0,19140625	0,08	0,7837
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,02175625	0,02175625	0,01	0,9262
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,71825625	0,71825625	0,29	0,5952
Com CE vs Sem CE	1	1,40126406	1,40126406	0,56	0,4585

Apêndice 90. Análise de contrastes da digestibilidade ileal da serina nos frangos aos 21 dias.

Contrastes					
Fonte	GL	Contraste	QM	F	P
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	9,40955625	9,40955625	3,66	0,0602
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	11,18902500	11,18902500	4,35	0,0410
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	4,26422500	4,26422500	1,66	0,2024
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	14,08125625	14,08125625	5,48	0,0224
Com CE vs Sem CE	1	37,39322500	37,39322500	14,55	0,0003

Apêndice 91. Análise de contrastes da digestibilidade ileal do total de aminoácidos nos frangos aos 21 dias.

Contrastes					
Fonte	GL	Contraste	QM	F	P
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	3,39480625	3,39480625	2,69	0,1057
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	8,38102500	8,38102500	6,65	0,0123
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	3,68640000	3,68640000	2,93	0,0921
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	3,74422500	3,74422500	2,97	0,0896
Com CE vs Sem CE	1	18,45776406	18,45776406	14,65	0,0003

Apêndice 92. Análise de contrastes da digestibilidade ileal da arginina nos frangos aos 42 dias.

Contrastes					
Fonte	GL	Contraste	QM	F	P
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	1,05575625	1,05575625	0,20	0,6602
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	7,24955625	7,24955625	1,34	0,2514
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	1,03530625	1,03530625	0,19	0,6633
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,31922500	0,31922500	0,06	0,8089
Com CE vs Sem CE	1	7,02912656	7,02912656	1,30	0,2587

Apêndice 93. Análise de contrastes da digestibilidade ileal da histidina nos frangos aos 42 dias.

Contrastes					
Fonte	GL	Contraste	QM	F	P
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,00525625	0,00525625	0,00	0,9902
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	5,89275625	5,89275625	0,17	0,6826
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,22090000	0,22090000	0,01	0,9369
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,15210000	0,15210000	0,00	0,9476
Com CE vs Sem CE	1	2,58405625	2,58405625	0,07	0,7865

Apêndice 94. Análise de contrastes da digestibilidade ileal da isoleucina nos frangos aos 42 dias.

Contrastes					
Fonte	GL	Contraste	QM	F	P
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	3,28515625	3,28515625	0,70	0,4058
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,91725625	0,91725625	0,19	0,6616
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,64400625	0,64400625	0,14	0,7122
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,81450625	0,81450625	0,17	0,6783
Com CE vs Sem CE	1	4,99522500	4,99522500	1,07	0,3060

Apêndice 95. Análise de contrastes da digestibilidade ileal da leucina nos frangos aos 42 dias.

Contrastes					
Fonte	GL	Contraste	QM	F	P
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,64400625	0,64400625	0,25	0,6220
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	2,89850625	2,89850625	1,10	0,2972
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,19802500	0,19802500	0,08	0,7844
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	1,65122500	1,65122500	0,63	0,4305
Com CE vs Sem CE	1	4,48380625	4,48380625	1,71	0,1958

Apêndice 96. Análise de contrastes da digestibilidade ileal da lisina nos frangos aos 42 dias.

Contrastes					
Fonte	GL	Contraste	QM	F	P
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,02250000	0,02250000	0,00	0,9604
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	11,64515625	11,64515625	1,28	0,2616
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	1,22655625	1,22655625	0,14	0,7144
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	1,55002500	1,55002500	0,17	0,6808
Com CE vs Sem CE	1	8,74680625	8,74680625	0,96	0,3300

Apêndice 97. Análise de contrastes da digestibilidade ileal da metionina nos frangos aos 42 dias.

Contrastes					
Fonte	GL	Contraste	QM	F	P
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,15602500	0,15602500	0,16	0,6871
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,02975625	0,02975625	0,03	0,8603
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,39375625	0,39375625	0,41	0,5226
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,20930625	0,20930625	0,22	0,6409
Com CE vs Sem CE	1	0,03851406	0,03851406	0,04	0,8413

Apêndice 98. Análise de contrastes da digestibilidade ileal da fenilalanina nos frangos aos 42 dias.

Contrastes					
Fonte	GL	Contraste	QM	F	P
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,00075625	0,00075625	0,00	0,9880
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	1,47015625	1,47015625	0,45	0,5071
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,44890000	0,44890000	0,14	0,7136
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	1,70302500	1,70302500	0,52	0,4754
Com CE vs Sem CE	1	2,58405625	2,58405625	0,78	0,3798

Apêndice 99. Análise de contrastes da digestibilidade ileal da treonina nos frangos aos 42 dias.

Contrastes					
Fonte	GL	Contraste	QM	F	P
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	3,20410000	3,20410000	0,10	0,7530
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	33,98890000	33,98890000	1,06	0,3071
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	6,26250625	6,26250625	0,20	0,6600
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,96530625	0,96530625	0,03	0,8628
Com CE vs Sem CE	1	30,83025625	30,83025625	0,96	0,3305

Apêndice 100. Análise de contrastes da digestibilidade ileal da valina nos frangos aos 42 dias.

Contrastes					
Fonte	GL	Contraste	QM	F	P
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	5,77200625	5,77200625	1,45	0,2336
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,00105625	0,00105625	0,00	0,9871
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,06890625	0,06890625	0,02	0,8959
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,11222500	0,11222500	0,03	0,8674
Com CE vs Sem CE	1	2,29901406	2,29901406	0,58	0,4507

Apêndice 101. Análise de contrastes da digestibilidade ileal da alanina nos frangos aos 42 dias.

Contrastes					
Fonte	GL	Contraste	QM	F	P
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,34515625	0,34515625	0,12	0,7352
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	3,17730625	3,17730625	1,06	0,3066
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	4,31600625	4,31600625	1,44	0,2341
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	2,48850625	2,48850625	0,83	0,3652
Com CE vs Sem CE	1	9,07515625	9,07515625	3,03	0,0864

Apêndice 102. Análise de contrastes da digestibilidade ileal do aspartato nos frangos aos 42 dias.

Contrastes					
Fonte	GL	Contraste	QM	F	P
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	3,01022500	3,01022500	0,19	0,6685
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,00680625	0,00680625	0,00	0,9837
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,39375625	0,39375625	0,02	0,8768
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,01890625	0,01890625	0,00	0,9729
Com CE vs Sem CE	1	1,66732656	1,66732656	0,10	0,7499

Apêndice 103. Análise de contrastes da digestibilidade ileal da cistina nos frangos aos 42 dias.

Contrastes					
Fonte	GL	Contraste	QM	F	P
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	1,42802500	1,42802500	0,21	0,6448
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,77440000	0,77440000	0,12	0,7342
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,05760000	0,05760000	0,01	0,9262
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,10562500	0,10562500	0,02	0,9002
Com CE vs Sem CE	1	1,74240000	1,74240000	0,26	0,6107

Apêndice 104. Análise de contrastes da digestibilidade ileal da glutamina nos frangos aos 42 dias.

Contrastes					
Fonte	GL	Contraste	QM	F	P
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	3,61950625	3,61950625	0,34	0,5623
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	22,04302500	22,04302500	2,07	0,1555
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,13322500	0,13322500	0,01	0,9114
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	2,72250000	2,72250000	0,26	0,6152
Com CE vs Sem CE	1	4,15650156	4,15650156	0,39	0,5347

Apêndice 105. Análise de contrastes da digestibilidade ileal da glicina nos frangos aos 42 dias.

Contrastes					
Fonte	GL	Contraste	QM	F	P
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	8,95505625	8,95505625	0,73	0,3968
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	1,34560000	1,34560000	0,11	0,7419
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	3,85140625	3,85140625	0,31	0,5778
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	1,64480625	1,64480625	0,13	0,7158
Com CE vs Sem CE	1	13,68075156	13,68075156	1,11	0,2957

Apêndice 106. Análise de contrastes da digestibilidade ileal da serina nos frangos aos 42 dias.

Contrastes					
Fonte	GL	Contraste	QM	F	P
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	6,00250000	6,00250000	0,53	0,4705
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,09455625	0,09455625	0,01	0,9277
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,00140625	0,00140625	0,00	0,9912
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,00490000	0,00490000	0,00	0,9835
Com CE vs Sem CE	1	1,85640625	1,85640625	0,16	0,6877

Apêndice 107. Análise de contrastes da digestibilidade ileal do total de aminoácidos nos frangos aos 42 dias.

Contrastes					
Fonte	GL	Contraste	QM	F	P
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,04950625	0,04950625	0,02	0,8867
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	3,96010000	3,96010000	1,64	0,2052
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,33930625	0,33930625	0,14	0,7092
C – 80 kcal – 3 % AA vs C – 80 kcal – 3 % AA + CE	1	0,63600625	0,63600625	0,26	0,6098
Com CE vs Sem CE	1	3,22651406	3,22651406	1,33	0,2523

VITA

Heitor Vieira Rios, filho de Jayme Oliveira Rios e Luiza Helena Bergallo Vieira Rios, nascido em 17 de dezembro de 1990, em Porto Alegre – RS. Completou o ensino fundamental e o ensino médio no Colégio Anchieta localizado na cidade de Porto Alegre - RS em 2007. Em 2008 ingressou no curso de Medicina Veterinária na Universidade Federal do Rio Grande do Sul. Em 2011 trancou a faculdade para realizar curso de inglês na Austrália. No último semestre da faculdade foi Estagiário Nível Superior na BRF, em Lajeado, na área de avicultura sob supervisão de Débora Leal. Formou-se Médico Veterinário em dezembro de 2014. No primeiro semestre de 2015 ingressou em primeiro lugar na seleção no Programa de Pós Graduação em Zootecnia da UFRGS, sob orientação do professor PhD. Sergio Luiz Vieira. Recebeu o prêmio de Menção Honrosa na área de Nutrição na Conferência Facta 2015 com o trabalho entitulado “Aproveitamento da energia em frangos de corte alimentados com dietas suplementadas com níveis crescentes de amilase e formuladas com fitase”. Em 2016, recebeu o prêmio José Maria Lamas na Conferência Facta, também na área de nutrição, com o trabalho entitulado “Desempenho e utilização da energia de frangos alimentados com dietas suplementadas com um complexo enzimático”. Foi submetido à banca de defesa de Dissertação em fevereiro de 2017.