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Exploratory study on the utilization of different dietary methionine sources and methionine to lysine ratio for growing–finishing pigs

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ABSTRACT

The objective of this meta-analysis was to evaluate the response of growing–finishing pigs to different dietary methionine sources and to determine the ideal methionine:lysine ratio for nursery to finishing pigs. Data were obtained from peer-reviewed journals. Information were extracted from the material and methods and results sections of pre-selected articles. Forty one articles were included in the first database. Graphical and correlation analyses, multivariate exploratory analysis of factors, variance–covariance analysis, and non-linear models were applied to estimate nutritional requirements. Eighty-three percent of the articles in the database were not used for the determination of the methionine:lysine ratio because the diets did not meet the pigs' lysine requirements. Methionine sources were compared using 21 articles of the first database, and performance differences were not found ($P < 0.05$) among pigs fed diets containing L-methionine, DL-methionine, or methionine hydroxy analog. The ideal methionine:lysine ratio calculated for maximum performance of growing–finishing pigs was 26%. In this meta-analysis, studies carried out since 1964 on pig methionine requirements were reviewed, suggesting the standardization of experimental protocols to allow better comparison among the studies. On the basis of the outcome of this study, it allowed the evaluation of different methionine sources were they promoted similar performance in nursery piglets and to determine minimum methionine:lysine ratios for pigs, from nursery to finishing, that was calculated as 26% methionine as a function of lysine requirement.

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1. Introduction

One of the objectives of the supplementation of pig diets with synthetic amino acids is to minimize the environmental impact caused by nitrogen (N) excretion, in addition of enhancing performance and carcass quality (D'Mello, 2003). Methionine is an essential amino acid for all livestock species, and it is the second limiting amino acid in pig diets. However, when piglets are fed diets with protein sources with high lysine, methionine may become the first limiting amino acid (NRC, 2012).

Total amino acid requirements of non-ruminant animals depend on the chemical form with which these nutrients are supplied in the diet. The animal metabolism is only able to utilize amino acids in the L isomeric form for protein synthesis (Nelson et al., 2008). However, as most amino acids present in the D isomeric form can be converted into L-amino acids, when provided N is available (D'Mello, 2003). The dietary supplementation of synthetic DL-amino acids and DL-amino acid hydroxy analogs is based on these biochemical concepts. Several authors assert that the different chemical forms of methionine may be supplemented on equivalent basis (Chung and Baker, 1992a; Knight et al., 1998). However, a recent study demonstrated that the efficiency of the utilization of a DL-amino acid was 99% relative to its L form, whereas its DL-hydroxy analog form presented 88% efficiency (Feng et al., 2006).

Literature suggests that the lysine to sulfur amino acids ratio proposed by the NRC (2012) does not supply the requirements for maximum performance of the modern genetic lines of pigs (Kendall et al., 2002; Gaines et al., 2003, 2005). Considering that

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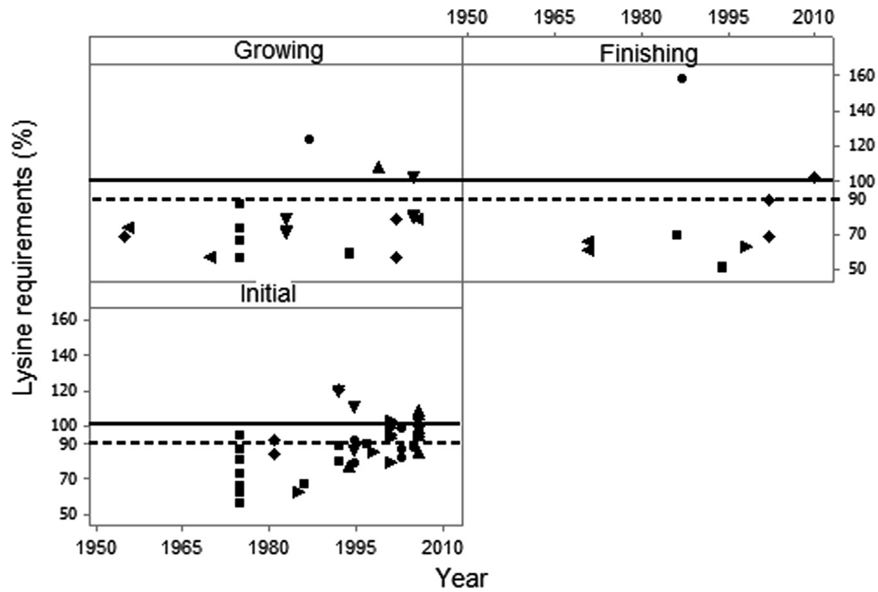

Fig. 1. Lysine concentration (%) in the diets. The line shows the requirement (NRC, 2012) for each weight group and sex calculated for each experiment. Items below 10% of the requirement were excluded from further analysis.

the levels of dietary amino acids are based on lysine requirements, further knowledge on the sources and levels of methionine supplements typically added to pig diets to maximize performance is essential, as well as the determination of optimal methionine:lysine ratios.

Individual literature studies do not provide a robust scientific foundation to determine if the performance differences obtained in pigs supplemented with different methionine sources are effectively sound, as some reports present contradictory and inconclusive results. Therefore, exploratory analyses and a meta-analysis were performed to quantify and to summarize that information. Meta-analysis fits data to experimental diversity, increasing sample number, thereby detecting differences that cannot be demonstrated in small populations. The objective of this meta-analysis was to evaluate the response of growing–finishing pigs to different methionine sources and to determine the ideal methionine:lysine ratio for nursery to finishing pigs.

2. Material and methods

2.1. Information systematization and selection of articles

Data were extracted from the material and methods and results sections of the selected articles all published in peer-reviewed journals. Papers were critically evaluated as to their quality and relevance considering the meta-analysis objectives. The information contained in each selected study was analyzed according to experimental design, treatments, evaluated parameters, and statistical analysis. The selected articles were then checked for their compliance with different criteria in order to determine their inclusion or not in the meta-analysis. The main criteria used for including the articles were: (a) addition of different methionine levels in the diets; (b) all other amino acids (AA) fixed at 100% of their optimal levels; and (c) presentation of the nutritional composition of the experimental diets. Only data reported in articles published in peer-reviewed journals were selected, and their acceptance for publication was considered as a subjective indication of their methodological quality. Studies evaluating the supplemental L-methionine, DL-methionine, methionine hydroxy analog (MHA) methionine sinthentic sources, and methionine naturally present in the feedstuffs of the basal diet were also included in our analyses. Negative or positive effects were not used as selection criteria for the inclusion of the studies in the database.

2.2. Building the database and data coding and filtering

Data were entered in an spreadsheet, where each row represented a treatment and each column represented an exploratory parameter. Information relative to the objective of the study (animal performance) and other variables (genetic strain, sex, dietary nutritional composition, production parameters, and rearing phase) were used to provide a descriptive analysis of the studies included in the database. Each dietary methionine source was coded. In addition to this categorical coding, three other moderating codes were applied: (a) general code (study effect), where each study and dose-response received a sequential number; (b) inter code, consisting of the general code number plus a sequential number representing the treatment (e.g., article 1, treatment 01 = 1 + 01 = 101); and (c) intra code, similar to the inter code, but when measurements were repeated (in time or doses series). Dependent and independent variables were determined according to criteria described in literature (Lovatto et al., 2007; Sauvant et al., 2008).

2.3. Description of the database

2.3.1. Methionine:lysine ratio

The database of the meta-analysis applied to determine the ideal methionine:lysine ratio included seven articles describing 13 dose-response trials and published between 1981 and 2006 (median: 1995), totaling 1232 pigs. The following variable means were calculated: 11 kg (5–32 kg) of initial body weight, 64 kg (6–105 kg) of final body weight, 2848 kcal of metabolizable energy/kg diet (2733–3370 kcal/kg), 19.56% (14.5–23.8%) of dietary crude protein level, 1.18% (0.96–1.44%) of calculated digestible lysine level, 0.37% (0.14–0.76%) of calculated digestible methionine level, 0.80% (0.52–1.04%) of digestible threonine level, 0.24% (0.18–0.33%) of digestible tryptophan level, 1.01% (0.71–1.20%) of calcium level, and 0.75% (0.69–0.82%) of total phosphorus level. The database consisted of 141 rows (treatment) and 183 columns (variables).

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