

Protein quality evaluation in processed human foods by the digestible indispensable amino acid score methodology

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Abstract

Calculation of the digestible indispensable amino acid score (DIAAS) is recommended by the Food and Agriculture Organization of the United Nations (FAO) for evaluating protein quality in human foods. The objectives of the present studies were to determine DIAAS values for pork and beef products, and to test the hypothesis that processing increases DIAAS. In Exp. 1, 10 ileal cannulated gilts were allotted to a 10'10 Latin square. In Exp. 2, 9 ileal cannulated gilts were allotted to a 9'8 Youden square. The DIAAS was calculated using the FAO established reference patterns for children 6 mo to 3 yr and children >3 yr, adolescents, and adults. In Exp. 1, DIAAS was greater than 100 for all pork products regardless of reference pattern. For both reference patterns, the DIAAS for smoked-cooked bacon was greater than for raw belly and smoked bacon, the 2 cured hams had numerically greater DIAAS than the non-cured ham, and loin heated to 63 °C had a greater DIAAS compared with loin heated to 68 °C or 72 °C. In Exp. 2, all products had a DIAAS value greater than 100, except cooked ground beef and ribeye roast heated to 72 °C. For both reference patterns, bologna and ribeye roast heated to 64 °C had the greatest DIAAS and cooked ground beef had the least DIAAS. In conclusion, meat products generally have DIAAS values greater than 100, and curing and cooking may increase DIAAS.

Keywords: DIAAS, PDCAAS, beef, pork, amino acid digestibility

Introduction

The digestible indispensable amino acid score (DIAAS) methodology was established in 2011 as the appropriate methodology to determine protein quality in human foods (FAO, 2013). This methodology measures the digestibility of each indispensable amino acid (IAA) in a food at the end of the small intestine of humans, pigs, or rats. The pig is recognized as the preferred animal model and has been used to assign DIAAS values to cereal grains (Abelilla *et al.*, 2018; Cervantes-Pahm *et al.*, 2014; Mathai *et al.*, 2017), plant proteins (Mathai *et al.*, 2017), dairy proteins (Mathai *et al.*, 2017), and meat (Bindari *et al.*, 2018; Hodgkinson *et al.*, 2018). However, meat products usually undergo processing prior to consumption, and data are limited on how meat processing affect protein quality. Therefore, it was the objective of these studies to determine DIAAS in meat products, and to test the hypothesis that processing will increase DIAAS values.

Materials and methods

In Exp. 1, 10 gilts (initial BW: 26.63±1.62 kg) were fitted with a T-cannula in the distal ileum and allotted to a 10'10 Latin square with 10 diets and ten 7-d periods. Nine pork products were evaluated (i.e. raw belly, smoked bacon, smoked-cooked bacon, non-cured ham, alternatively cured ham, conventionally cured ham, and loin heated to 63, 68 or 72 °C). In Exp. 2, 9 ileal cannulated gilts (initial BW: 35.50±3.77) were allotted to a 9'8 Youden square with 9 diets and ten 7-d periods. Eight meat products were evaluated (i.e. salami, bologna, beef jerky, raw ground beef, cooked ground beef, and ribeye roast heated to 56, 64, or 72 °C). For both experiments, each meat product was used in one diet as the sole source of AA, and ileal digesta were collected on d 6 and 7 of each period. DIAAS values were according to FAO (2013).

Results and discussion

In experiment 1, all pork products had a DIAAS value greater than 100, regardless of the reference pattern and method of processing. This indicates that pork products are excellent quality proteins and have the potential to complement lower quality proteins, such as cereal grains and some plant proteins (FAO, 2013). For both reference patterns, smoked-cooked bacon had a greater DIAAS compared with smoked bacon and raw belly, and alternatively cured ham (cured with celery salt) and conventionally cured ham (cured with Prague powder) had greater DIAAS values than non-cured ham. Loin heated to 63 °C had a greater DIAAS value than the other 2 loins. The AA in least concentration (limiting IAA) when compared with the 2 human IAA reference patterns was Trp for smoked-cooked bacon and Val for all pork products. In experiment 2, ribeye roast heated to 72 °C and cooked ground beef had DIAAS less than 100, but all other meat products had DIAAS greater than 100. For both reference patterns, bologna had a greater DIAAS than salami and beef jerky; raw ground beef had a greater DIAAS than cooked ground beef; and the ribeye roast heated to 64 °C had a greater DIAAS value than the other 2 ribeye roasts. The limiting AA for children older than 3 yr, the limiting IAA was sulfur IAA (beef jerky), Leu (bologna, raw ground beef, and cooked ground beef), and Val (salami and the 3 ribeye roasts). In conclusion, meat products are generally excellent quality proteins with DIAAS values greater than 100. In addition, curing and moderate heating may increase DIAAS, whereas grinding meat prior to some processing methods may expose a greater surface area to heating resulting in overcooking that may reduce the DIAAS value.

References

- Abelilla, J.J., Y. Liu and H.H. Stein, 2018. Digestible indispensable amino acid score (DIAAS) and protein digestibility corrected amino acid score (PDCAAS) in oat protein concentrate measured in 20- to 30-kilogram pigs. *Journal of the Science of Food and Agriculture* 98: 410-414. <https://doi.org/10.1002/jsfa.8457>
- Bindari, Y.R., H.N. Lærke and J.V. Nørgaard, 2018. Standardized ileal digestibility and digestible indispensable amino acid score of porcine and bovine hydrolyzates in pigs. *Journal of the Science of Food and Agriculture* 98: 2131-2137. <https://doi.org/10.1002/jsfa.8697>
- Cervantes-Pahm, S.K., Y. Liu and H.H. Stein, 2014. Digestible indispensable amino acid score and digestible amino acids in eight cereal grains. *British Journal of Nutrition* 111: 1663-1672. <https://doi.org/10.1017/S0007114513004273>
- Food and Agriculture Organization of the United Nations (FAO). 2013. Dietary protein quality evaluation in human nutrition. Report of an FAO expert group. FAO food and nutrition paper 92. Food and Agriculture Organization of the United Nations. Rome, Italy. Available at: <http://www.fao.org/3/a-i3124e.pdf>.
- Hodgkinson, S.M., C.A. Montoya, P.T. Scholten, S.M. Rutherford and P.J. Moughan, 2018. Cooking conditions affect the true ileal digestible amino acid content and digestible indispensable amino acid score (DIAAS) of bovine meat as determined in pigs. *The Journal of Nutrition* 148: 1-6. <https://doi.org/10.1093/jn/nxy153>
- Mathai, J.K., Y. Liu and H.H. Stein, 2017. Values for digestible indispensable amino acid scores (DIAAS) for some dairy and plant proteins may better describe protein quality than values calculated using the concept for protein digestibility-corrected amino acid scores (PDCAAS). *British Journal of Nutrition* 117: 490-499. <https://doi.org/10.1017/S0007114517000125>