Does in vitro protocol predict the nutritional value of thermally treated cereals?

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1 Introduction

In vitro protocols are currently used to assess the effect of high temperature drying on food and feed digestibility. The results from such protocols have shown some discrepancies with in vivo performance when material processed differently are used.

To improve the prediction value of in vitro protocols, several parameters have to be optimised, including substrate concentration and particle sizes, buffer characteristics, enzymes activity and agitation.

The aim of this study was to compare and improve a three steps in vitro digestion model in comparison with in vivo performances of broilers.

2 Material and Methods

Corn grains and drying conditions

One variety harvested at two moisture contents (36.4% and 22.8%) after black layer appearance.

Dried in a fluidised bed drier at 54°C, 90°C and 130°C.

Animal experimentation

Metabolism cages

72 broilers Ross 308
Force feeding technic
Excreta collection and chemical analyses
Measure of metabolisable energy (EM)

Gross Energy ↓ Digestible Energy ↓ Fecal Energy ↓ Urinary Energy ↓ Metabolisable Energy ↓

Basal In vitro Model

1g of sample (d0.5: 125-226 μm)

Crop
10 ml Sodium acetate, 0.05M pH 5.4
30 min at 40°C in a shaking water bath

Proventriculus and Gizzard
100 μl chloramphenicol (0.5g/100 ml ethanol)
4ml HCl 0.2 M, pH 2.1
2 ml peptin (2.5g/100ml)
45 min at 40°C in a shaking water bath

Intestine
15 ml sodium monohydrogen carbonate pH 6.8, 1 ml (156U/ml) pancreatin solution (10g/100ml)
2 h at 40°C in a shaking water bath

Centrifugation 3200g
Washing with 10ml ethanol and acetic acid
Drying at 60°C during 72h

Effect of substrate concentration

Effect of Granulometry

Effect of agitation

Effect of amylase activity

In vitro DM digestibility of corn grain increased with increasing drying temperature and this increase was more pronounced at high moisture content. The ME decreased at high drying temperature in poultry and at low moisture content. The low correlation [-0.0115] showed that the in vitro model is not able to predict the feeding value of corn grain for poultry.

In vivo

90°C
90°C
90°C
800 U/ml

Basal in vitro Model VS In vivo

Moisture content and drying temperature

In vitro

36.4% Moisture content and drying temperature

1g

0.5g

Low substrate concentration and high amylase activity of pancreatin improved DM digestibility while reduction of corn flour particle size didn’t affect its final DM digestibility. Correlation coefficient remained low. Agitation greatly improved DM digestibility. This increase in DM digestibility reached 20%. It is believed that the improvement in DM digestibility is mainly due to the increase in starch digestibility which is the most important component of corn grain. In a shaking water bath, particle flour dispersed in the solution rapidly sediment into the tubes limiting the contact between enzymes and substrate. Continuous agitation promotes heat and mass transfer within the reaction increasing random interactions between substrate and enzymes.

4 Conclusion

A good adjustment of the substrate concentration, amylase activity and agitation would improve the ability of in vitro digestion simulation to accurately predict nutritional value of thermally treated cereals. They have to be taken into account on the implementation of in vitro digestion simulation aiming to predict in vivo performances of consumers.