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

Huart François[a,b], Bera François[a], Blecker Christophe[c], Malumba Paul[c], Beckers Yves[b]

[a]University of Liège, Gembloux Agro-Bio Tech, Food Engineering Laboratory, Avenue de la faculté 2B, B-5030 Gembloux, Belgium
[b]University of Liège, Gembloux Agro-Bio Tech, Precision Livestock and Nutrition, Passage des Déportés, 2, B-5030 Gembloux, Belgium
[c]Care FoodIsLife, Terra Teaching and Research Center. University of Liège, Gembloux Agro-Bio Tech, Avenue de la Faculté 2B, B-5030 Gembloux, Belgium

1 Introduction

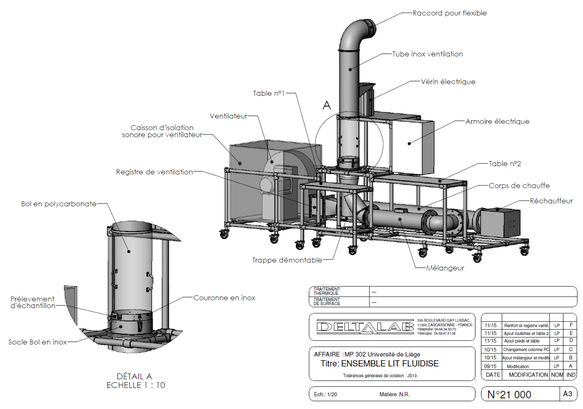
In vitro protocols are currently used to assess the effect of high temperature drying on food and feed digestibility. The results from such protocols have shown some discrepencies with in vivo performance when material processed differently are used.

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 → (Fecal Energy) → Digestible 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 2-3 2 ml pespin (2,5g/100ml) 45 min at 40°C in a **shaking water bath**
Intestine	15 ml sodium monohydrogenocarbonate pH 6,8, 1 ml (**156U/ml**) pancreatin solution (10g/100ml) 2 h at 40°C in a **shaking water bath**

Centrifugation 3220g
Washing with 10ml éthanol and acétone
Drying at 60°C during 72h

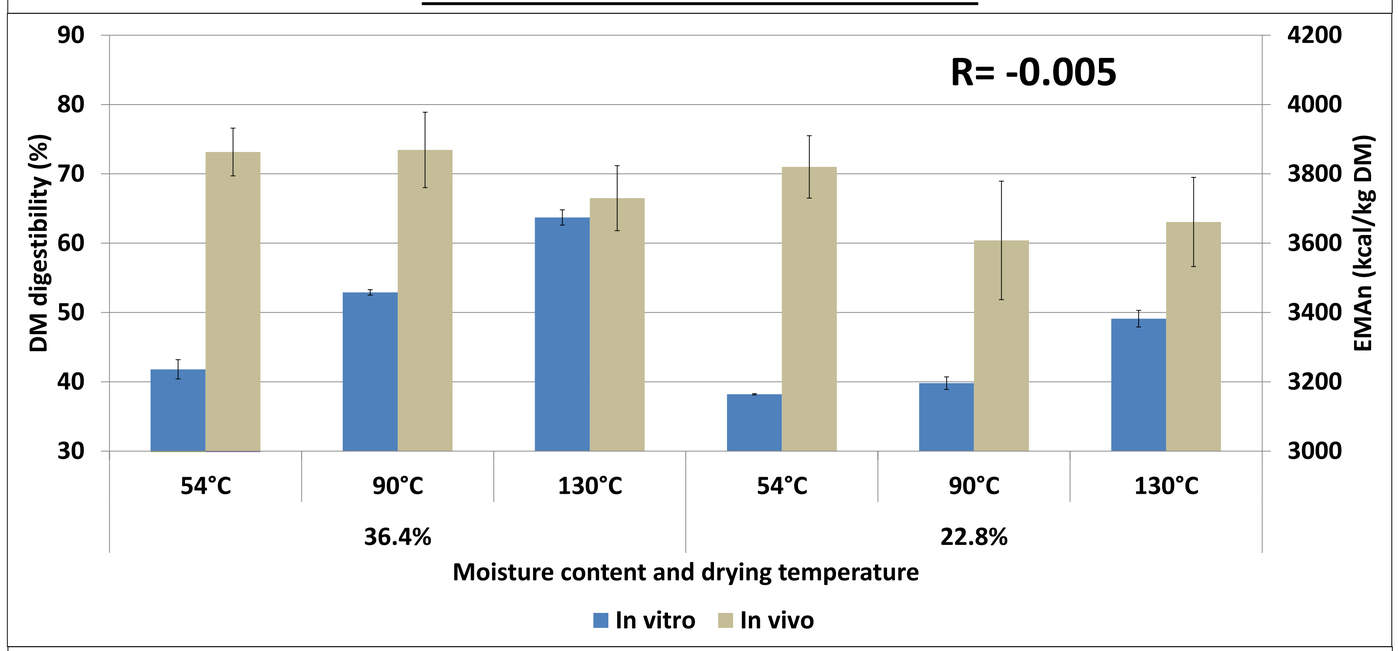
$$In\ vitro\ digestibility\ \% = \frac{dry\ weight\ of\ sample\ - dry\ weight\ of\ residue}{dry\ weight\ of\ sample} * 100$$

Parameters adjustment of in vitro model

- Amount of sample: 1g and 0.5g
- Amylase activity : 156, 400 and 800 U/ml
- Flour granulometry (d0.5): 125-226 µm (**G1**) and 30-72µm (**G2**)
- Method of agitation: shaking bath (**SB**) VS continuous magnetic stirring (**CS**)

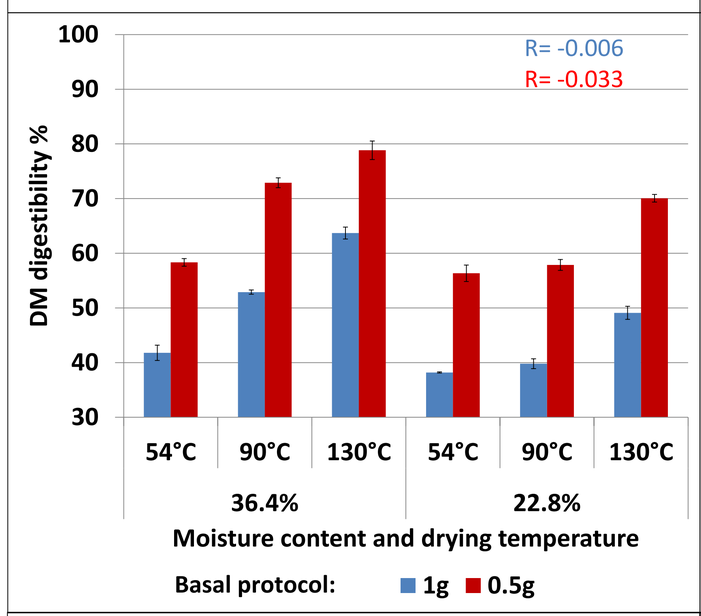
3 Results

Basal In vitro Model VS In vivo

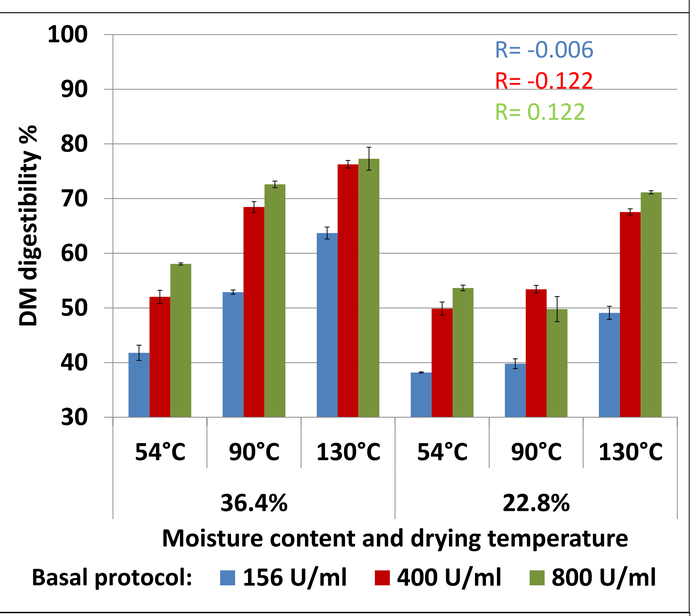


In vitro DM digestibility of corn grain increased with increasing drying temperature and this increase was more pronounced at high moisture content. The ME decreased at high drying temperature in poultry and at low moisture content. The low correlation (-0.0115) showed that the in vitro model is not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

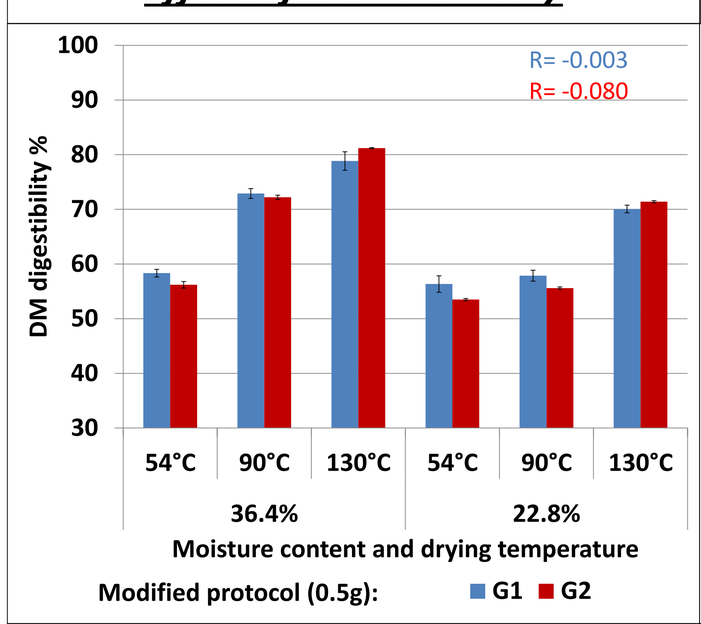
Effect of substrate concentration



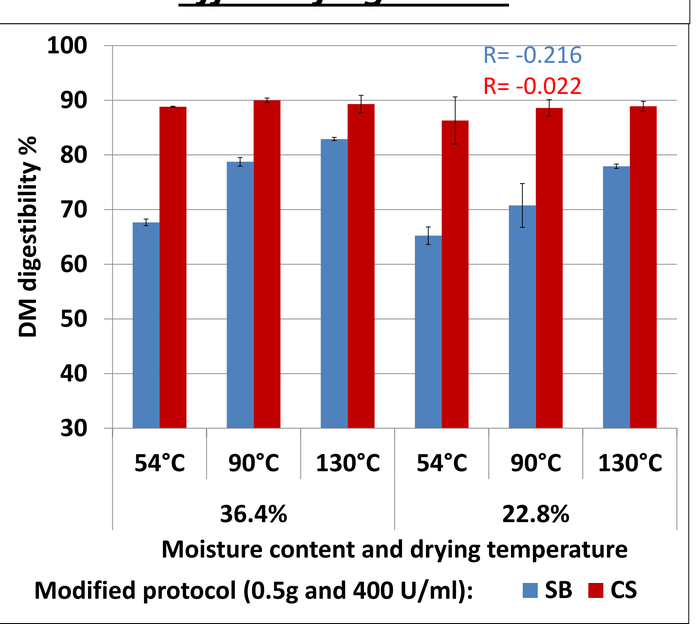
Effect of amylase activity



Effect of Granulometry



Effect of agitation



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 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.

Acknowledgement:
This research was funded by the « Direction Générale Opérationnelle de l'Agriculture, des Ressources Naturelles et de l'Environnement » of Walloon government through the project MAISECVOL. The authors are grateful to Nathalie Peclers.