Effects of toasting during the production of rapeseed meal on protein hydrolysis

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Thermal treatments are involved during the production process of the most common protein sources used in animal feeds (e.g. soybean and rapeseed meal) and influence their nutritional value. The largest decrease in the nutritional value of oilseed proteins occurs during the toasting step, a source of heat that involves steam. Toasting is used as a fast resource to remove the remaining solvent and for denaturation of antinutritional factors. The aim was to analyse the effects of toasting on protein modifications that influence accessibility of enzymes for protein hydrolysis. Protein hydrolysis is used in this experiment as a reflection of protein digestibility. A batch of 00-rapeseeds was cold pressed, solvent extracted and desolventized without the use of steam, in order to limit protein denaturation. The un-denatured meal was divided in 2 batches for replication and toasted with the use of steam for 120 minutes. Samples were taken every 20 minutes during this period and analysed for degree of denaturation using differential scanning calorimetry, content and type of glucosinolates, protein dispersibility index (PDI) in water, and degree and rate of hydrolysis after 2 hours using the in vitro pH-STAT method with trypsin, chymotrypsin, and peptidase as enzymes. Statistical analysis was performed by analysis of variance using the GLM procedure of SAS, with toasting as fixed effect. Analysis of correlations was performed with the CORR procedure of SAS.

Enthalpy of denaturation decreased ($p<0.001$) with the increasing toasting time, which means that proteins in rapeseed meals with longer toasting time were more denatured compared to rapeseed meals with shorter toasting time. The concentration of indolyl- and alkenyl-glucosinolates were linearly reduced, with indolyl-glucosinolates disappearing completely after toasting for 100 minutes. The PDI linearly decreases from 16% after 20 minutes toasting to 6% after 120 minutes. The effect of toasting time on the degree of hydrolysis after 2 hours was not significant ($p>0.05$). However, the hydrolysis rate was linearly reduced ($p=0.001$) with increasing toasting time. The hydrolysis rate of the rapeseed meal toasted for 120°C was 75% lower than the degree of hydrolysis of the sample toasted for 20 minutes. Differences on the rate of hydrolysis could possibly be related to protein solubility, as there is a significant correlation ($r=0.95$, $p<0.001$) between the PDI and the hydrolysis rate. The decrease in protein solubility with increasing toasting time is possibly related to aggregation of proteins and could be the limiting factor for the rate of hydrolysis. The rate of hydrolysis could be lower for insoluble proteins as compared to soluble proteins. A lower rate of hydrolysis in thermally processed samples could impact on the size of the peptides that are produced during digestion.

In conclusion, increasing toasting time induces protein modifications that are related to decreased solubility and impaired enzyme accessibility, which affect the rate of protein hydrolysis.