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Chestnut tannin inclusion and extrusion conditions influence rumen degradability of faba bean blends

Dhumez O.[1], Chapoutot P.[1], Germain A.[2], Certenais E.[2], Chesneau G.[2]

[1] UMR MoSAR, INRA, AgroParisTech, Université Paris-Saclay, Paris, France

[2]Valorex, La Messayais, 35210 Combourtillé, France

Objectives

*The aim of this study was to compare the influence of **chestnut tannin inclusion** and of **different extrusion conditions** on the **nitrogen (N) ruminal degradation** of **faba bean/rapeseed blends**. Several technological parameters were recorded during the treatments.*

Background

Proteaginous and oilseeds present a lower crude protein content than most of the oil-meals commonly used in animal feeding. Moreover, their proteins are highly degradable in the rumen. So their protein value needs to be improved in order to enhance their utilization for ruminants.

Among technological treatments, extrusion has already been widely described as one of the most effective ways to reduce nitrogen ruminal degradation. Moreover, chestnut tannins are known to induce protein complexation and lead to a decrease in nitrogen degradation.

Material and methods

Experimental treatments

***16 treatments** on faba bean/rapeseed blends (90%/ 10%), ground on 3 mm screen at 77 ms^{-1}:*

- *2 levels of chestnut tannins (0%, **T00** vs 0.2%, **T02**) included after maturation*
- *Different technical conditions of maturation (duration of **1/4h** vs **1h**; temperature of 45°C, **T45**, vs 60°C, **T60**; 5% of added water, **W5**, vs 15%, **W15**) and of extrusion (final product temperature: 140°C; weak constraints, **WK**, vs strong, **ST**).*

Measurements & Statistical analysis

- ✓ *Crude protein (**CP**) and nitrogen in vitro enzymatic degradation (**NED1**, Aufrère et al., 1989).*
- ✓ *In sacco measurements of N degradation (Ndeg): double Latin square (3 cows and 6 replicates); degradation of a standard feed (DMdeg_stand) to account for within-cow & -day variations (Michalet-Doreau et al., 1987)*
- ✓ *Kinetics adjusted with non-linear model (Ørskov & McDonald, 1979): $Ndeg(t) = a + b\,(1- e^{-c\,t})$ (a: soluble fraction, b: degradable fraction and c: degradation rate of b fraction).*
- ✓ *Nitrogen effective degradability: **NED6** (%) = $a + b \times c / (c + kp)$ with a rumen turnover rate of particles $kp=6\%h^{-1}$ (INRA 2007), and **NED** (%) = $a \times 100/(100 + kl) + b \times c / (c + kp)$ with a turnover rate of liquid ($kl=9.71\%h^{-1}$) and of particles ($kp=4.97\%h^{-1}$) (INRA 2018).*
- ✓ *Variance-covariance analysis (GLM Procedure with Minitab) applied on kinetic parameters, with « sample » (α_i), « cow » (β_j) and « day » (γ_k) effects, and $DMdeg\_stand_{jk}$ as a covariable:*

$$Y_{ijk} = \mu + \alpha_i + \beta_j + \gamma_k + \delta\, DMdeg\_stand_{jk} + \varepsilon_{ijk}$$

- ✓ *The "sample" effect (α_i) separated into main studied factors (tannin dose, maturation duration, maturation temperature, added water and mechanical effects) and their double interactions.*
- ✓ *The 2 components, mechanical (MecaPow) & thermal (ThermPow), of the total power (TotPow) generated in the extruder (W) were calculated with the measured extrusion parameters.*

Results and discussion

- ➢ NED6 varied between 78 and 92 % (mean ± SD = 84 ± 4 %).
- ➢ No effect of maturation temperature, but N effective degradability NED6 decreased ($p<0.001$) with tannins (T02: 82.5 *vs* T00: 85.3 %), after 1/4h of maturation (1/4h: 83.6 *vs* 1h: 84.2 %), with 5% additional water (W5: 82.1 *vs* W15: 85.7 %) and, surprisingly, with weaker extrusion conditions (WK: 83.0 *vs* ST: 84.7 %) (Figure 1).
- ➢ However, all double interactions were significant ($p< 0.001$), except for tannin x mechanical one (NS) (Figure 2).
- ➢ NED6 < 80 % for 3 particular combinations of treatments (Figure 3).
- ➢ NED6 variations were not precisely related with *in vitro* enzymatic NED1 ones (NED1 = 31 ± 3 %; min-max = 28- 40 %).

Figure 1: Effect of treatments on N effective degradability

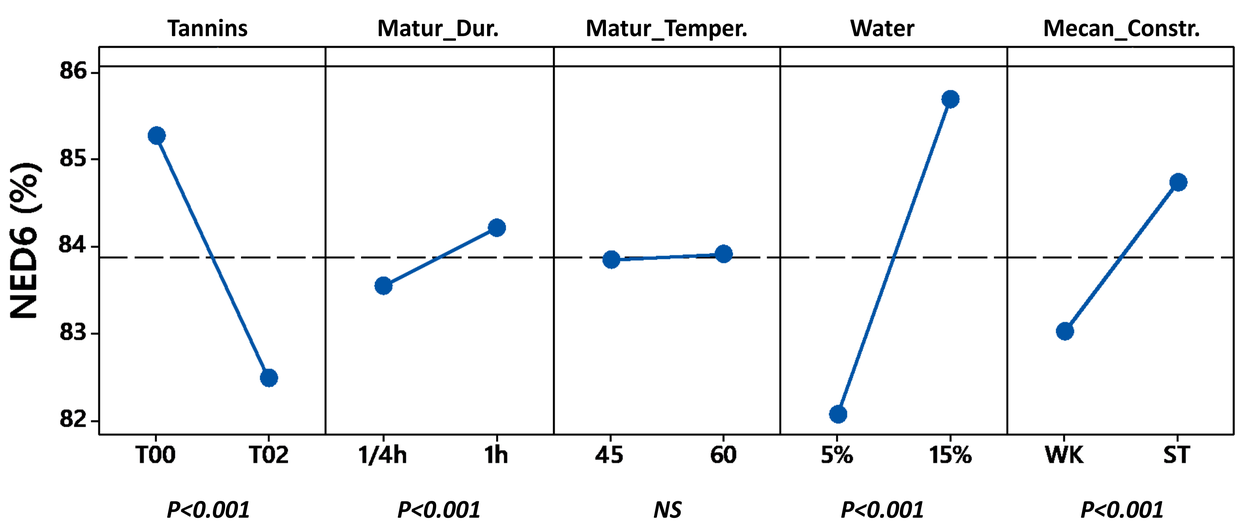


Figure 2: Double interactions between treatments on NED6 (%)

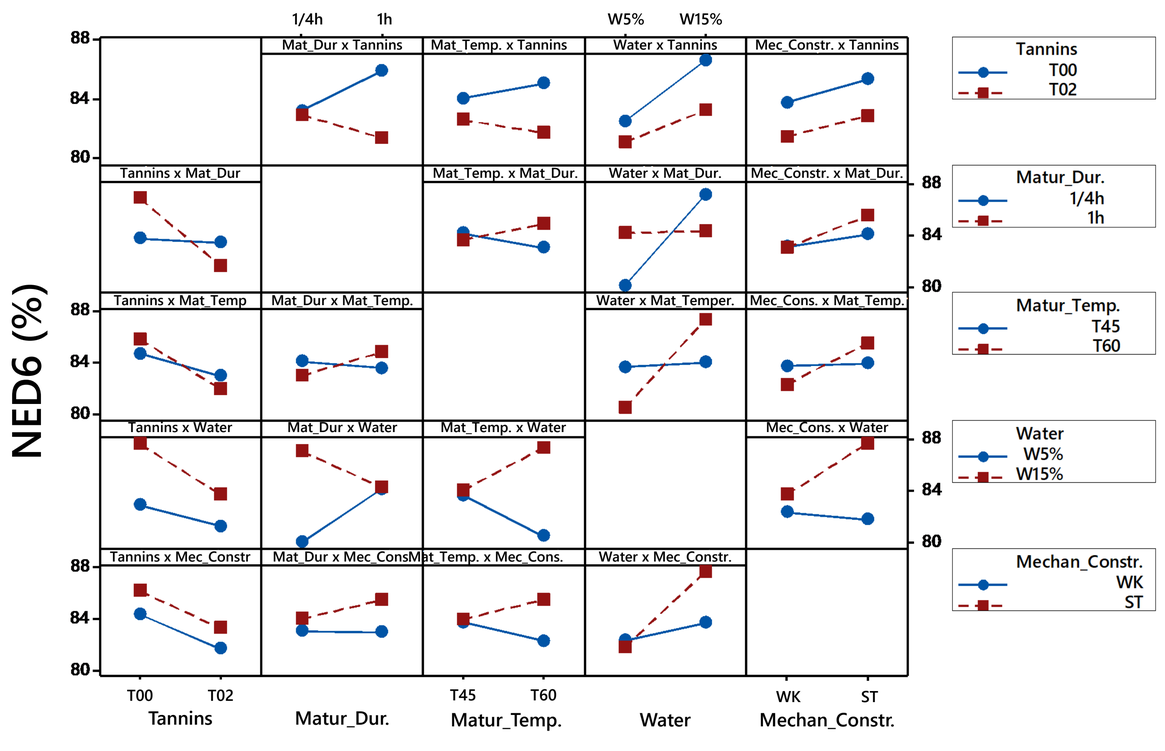
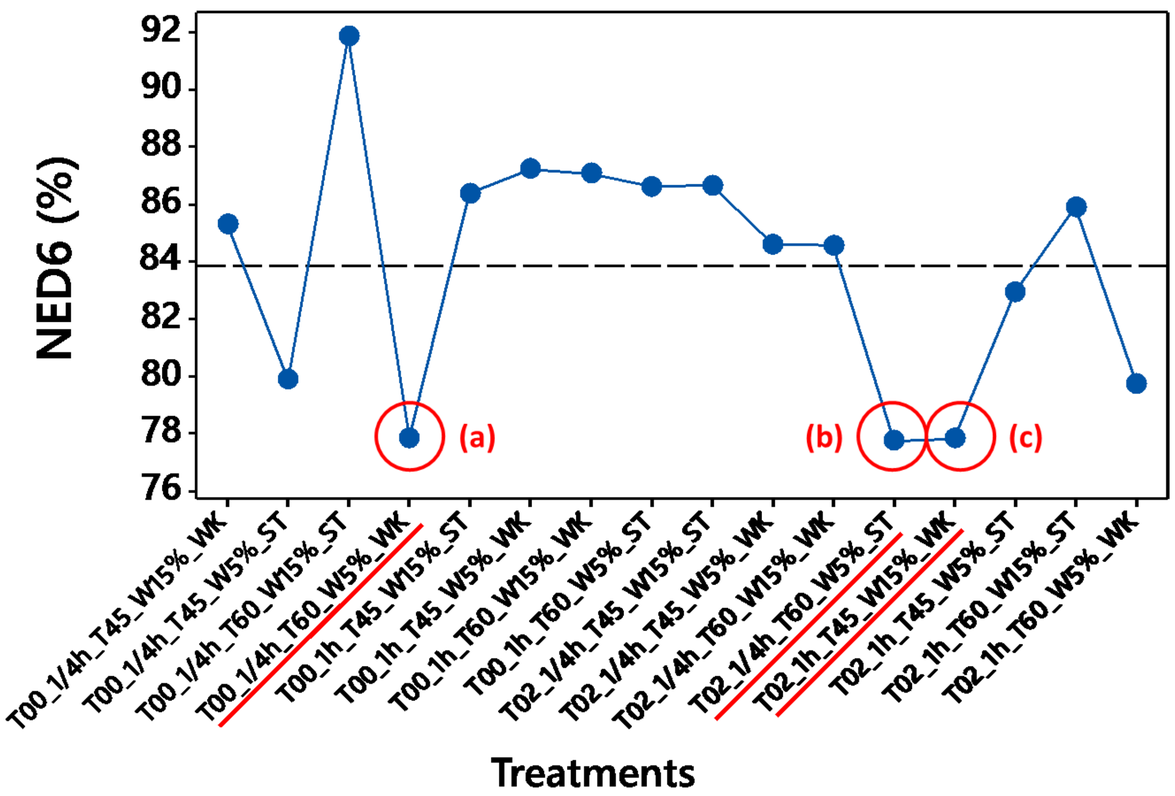


Figure 3: N effective degradability according to treatments



- ➢ In contrast to Chapoutot *et al.,* (2018), on this data set, NED6 was not statistically linked to the total power inside the extruder (5561 ± 806 W, min-max = 4116-7077 W), nor to its two components, MecaPow (5076 ± 1111 W, min-max = 3370-7077 W) and ThermPow (484 ± 518 W, min-max = 0-1208 W).
- ➢ Calculated in the new INRA 2018 system, NED values of the 3 best treatments (a), (b) and (c) (figure 2) were about 76 %, higher than INRA 2018 Table value for a similar extruded faba bean/rapeseed blend (65%).

  Then, according to their chemical composition, the protein values of these 3 best products varied between 115 and 120 g/kg DM for PDI & from 110 to 125 g/kg DM for RPB, respectively compared to PDI = 150 and RPB = 85 g/kg DM for a similar simply extruded blend in INRA 2018 Tables.

Conclusion

- ❖ ***Inclusion of chestnut tannins before extrusion associated with different technological conditions decreased nitrogen ruminal degradation and, thus, improved the protein values of oilseeds and proteaginous.***
- ❖ ***Effects on rumen N degradability were not connected to the various treatment conditions and not precisely related with in vitro results.***
- ❖ ***For these treatments, total power generated in the extruder did not permit to predict the reduction of N degradability.***
- ❖ ***The tested products had lower PDI/RPB ratios compared to INRA 2018 Table.***

References

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