EFFECT OF THE DIETARY RATIO BETWEEN DIGESTIBLE AND INDIGESTIBLE FIBRES ON THE DIGESTIVE HEALTH AND PERFORMANCES OF FATTENING RABBITS

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ABSTRACT

In animal nutrition, it is common to distinguish digestible fibres (DF) from indigestible fibres (ID), which both have benefits on rabbits' performances and health. DF includes a fraction of hemicellulose, pectins and soluble polysaccharides and ID are usually represented by the ADF. The aim of this study is to deepen through a meta-analysis the influence of the ratio between DF and ID (DF/ADF ratio) on the sanitary status and the performance of fattening rabbits. The database contained 28 diets from 8 trials runned in the same experimental center (3856 rabbits from Hyplus genetic), with a ratio DF/ADF ranging from 0.73 to 1.03. Within each trial, feeds were distributed in the same quantity and had a similar nutritional content (excepted for fibre). During the whole fattening period (32 to 71 days old), there was a significant decrease of the digestive sanitary risk (DSR) ($P<0.01$), the mortality and the morbidity ($P<0.05$) when the DF/ADF ratio increased. By breaking down the DSR into different types of pathologies, this beneficial effect was observed on the Rabbit Epizootic Entheropathy (REE) and on paresia ($P<0.05$), but not on diarrhea ($P=0.27$). The influence of the DF/ADF ratio on the DSR was significant throughout the first part of the fattening period (32 to 50 days old): A 2.7 point reduction of DSR was observed per 0.1 point of DF/ADF. Throughout the second part of the fattening period (51 to 71 days old), this effect was not significant but tended to decrease the DSR by 1.1 point per 0.1 point of DF/ADF ($P=0.16$). About performance, the Average Daily Gain (ADG) ($P=0.96$) and the Feed Conversion Ratio (FCR) ($P=0.98$) were not influenced by this ratio. These results suggest that the individual effect of DF and IF on health status can be optimized when their intake respects a certain balance.

Key words: rabbit, dietary fibre, ADF, digestible fibre, digestive sanitary risk

INTRODUCTION

Fibres are important components of rabbit nutrition, as they represent 32% to 51% of dietary dry matter of rabbit feed (Gidenne, 2003). They are defined as various molecules mainly composed by polyosides and lignins (Gidenne *et al.*, 2015). In rabbit nutrition, it is common to distinguish digestible fibres (DF) from indigestible fibres (ID). DF includes a fraction of hemicellulose, pectins and soluble polysaccharides, which have a fecal digestibility between 20% and 80%. IF contain the fraction of hemicellulose left, cellulose and lignin, with a low fecal digestibility (0-20%) (Trocino *et al.*, 2013; Gidenne *et al.*, 2015). Several studies showed the role of dietary fibres on rabbit health. DF is a substrate of the caecal microbiota, which fermentation activity produces volatil fatty acids (VFA). These VFA contribute to decrease the caecal pH, which helps to maintain a digestive security of animals (Gidenne, 2003; Trocino *et al.*, 2013). However Gidenne (2003) recommands a maximum level of DF of 220-240 g/kg rabbit feed if the minimum level of ADF is not obtained. IF has a beneficial effect on rabbit health as well, by regulating the digestive transit. They can decrease the retention time of feed in the digestive tract as up as 20% (De Blas *et al.*, 1999; Gidenne, 2003). This improvement of the intestine motility avoids the proliferation of potentially pathogenic bacterias and the accumulation of gas and fermentation residues, which leads to better sanitary conditions (Perez *et al.*, 1996; Kimse, 2009). Gidenne (2003) recommands a minimum level of 170 g of ADF/ kg rabbit feed, which is the usual fibrous criterion to describe the global amount of dietary IF. Thus DF and IF are relevant tools for managing the sanitary status of rabbits. However, according to Gidenne (2003), high amount of fibres can have negative impact of animal performances : for DF, increase of the digestive sanitary risk (DSR), and for IF, reduction of the digestibility and the energy level of the feed, leading to a higher feed conversion ratio. So it may be important to bring an optimum balance of dietary DF and IF. So far some works studied the ratio DF/ADF, for instance Gidenne (2003) who recommands a ratio DF/ADF<1.3 (with ADF>15%) for fattening rabbit feeds. But these works (Carraro *et al.*, 2007; Gidenne, 2003) have their limits : for the same DF/ADF range (1-1.3), the SDR doesn't evolve similarly. Moreover, nutrient intakes (excepted fibres) are different between diets used. The aim of this study is to deepen through a meta-analysis the influence of the DF/ADF ratio on the sanitary status and the performances of fattening rabbits, with different feeding plans (animals fed ad libitum or not) and the same nutrient intake (energy, proteins, amino-acids) within each trial.

MATERIALS AND METHODS

A meta-analysis was done from a data base containing 28 diets (representing 3856 Hyplus fattening rabbits) from 8 different trials conducted in the experimental station of Saint Symphorien (France). Feeding plans were restricted (75% to 80% of *ad libitum*) for most of the trials, or partly restricted (80% of *ad libitum* then 8 to 10 days *ad libitum*), or *ad libitum*. Trials were selected so that within each trial:

- Diets had the same levels of energy, proteins and amino-acids, but not fibres, and also the same feed intakes.
- Diets had different DF/ADF ratios. Thus, the ratio was between 0.73 and 1.03, which respects Gidenne's (2003) recommendations.
- The average SDR was higher than 3%. For the whole fattening period, SDR was between 3% and 42%.

The effect of the ratio DF/ADF was measured on SDR (sum of digestive mortality and morbidity), mortality, morbidity, Rabbit Epizootic Entheropathy (REE), paresia and diarrhea. The influence of the ratio was also evaluated on performance: average daily gain (ADG) and feed conversion ratio (FCR). Measures were done at 32-50 days old (period 1), 51-71 days old (period 2) and 32-71 days old (whole period). Data was analysed by a covariance model (Sauvant *et al.*, 2005) with R software v3.5.1®.

RESULTS AND DISCUSSION

In the database, the ratio DF/ADF was between 0.73 and 1.03, with an average within each trial between 0.81 and 0.96 (Table 1). For the majority of diets, rabbits were fed restricted (18 diets i.e 64% of diets), the other diets being partly restricted (8 diets and 29% of diets) and ad libitum (2 diets and 7% of diets). Excluding these two ad-libitum diets didn't change conclusions of our study.

Sanitary digestive risk

For DF/ADF values studied, when DF/ADF ratio increased, the SDR was significantly reduced for the whole fattening period ($P<0.01$, $R^2=0.92$) and for the first period as well ($P<0.05$, $R^2=0.89$). For the second period, the SDR tended to be decreased ($P=0.16$, $R^2=0.89$). Thus, for a DF/ADF ratio from 0.73 to 1.03, we could predict that the input of 0.1 additional point of DF/ADF would allow lowering the SDR of 3.5 points for the whole fattening period (Figure 2).

We identified two articles studying the DF/ADF ratio. Gidenne (2003) showed in a meta-analysis with 16 diets that SDR was stable (about 20%) when the ratio was from 0.9 to 1.2 (2 diets), and then increased until about 65% when the ratio was from 1.2 to 1.7 (14 diets). In Carraro *et al.* (2007) study, the DF/ADF ratio between 1 and 1.3 had no significant impact on SDR, although it decreased from 41.7% to 30.6%. Thus, these two articles seemed to have contradictory conclusions for similar values of DF/ADF ratio (1-1.3). Although our values of DF/ADF ratio were different, our results were close to Carraro *et al.* (2007) conclusions: when the ratio increased, the SDR decreased without impacting performances of rabbits. The discrepancy with Gidenne (2003) could be due to the difference in feeding plan (restricted or partially restricted in the current paper, ad libitum in the Gidenne's paper).

Table 1: Average (Av) and standard deviation (SD) of nutritional values (DF, ADF, DF/ADF) of diets used for trials in the database for the meta-analysis. 1: value calculated by formulation

	DF[1] (% raw)	ADF (% raw)	DF/ADF		
Trials	Av ± SD	Av ± SD	Av	Min	Max
Trial 1	19.3 ± 1.8	22.0 ± 0.2	0.88	0.79	0.96
Trial 2	19.0 ± 3.0	21.3 ± 0.4	0.89	0.80	0.98
Trial 3	17.6 ± 0.5	21.6 ±0.1	0.82	0.80	0.84
Trial 4	21.3 ± 0.1	23.5 ± 1.0	0.91	0.88	0.94
Trial 5	21.2 ± 0.9	22.0 ± 0.2	0.96	0.90	1.02
Trial 6	18.0 ± 2.4	20.8 ± 1.4	0.87	0.73	1.03
Trial 7	17.1 ± 1.1	21.2 ± 0.0	0.81	0.75	0.87
Trial 8	21.1 ± 1.4	22.3 ± 0.2	0.95	0.90	1.0

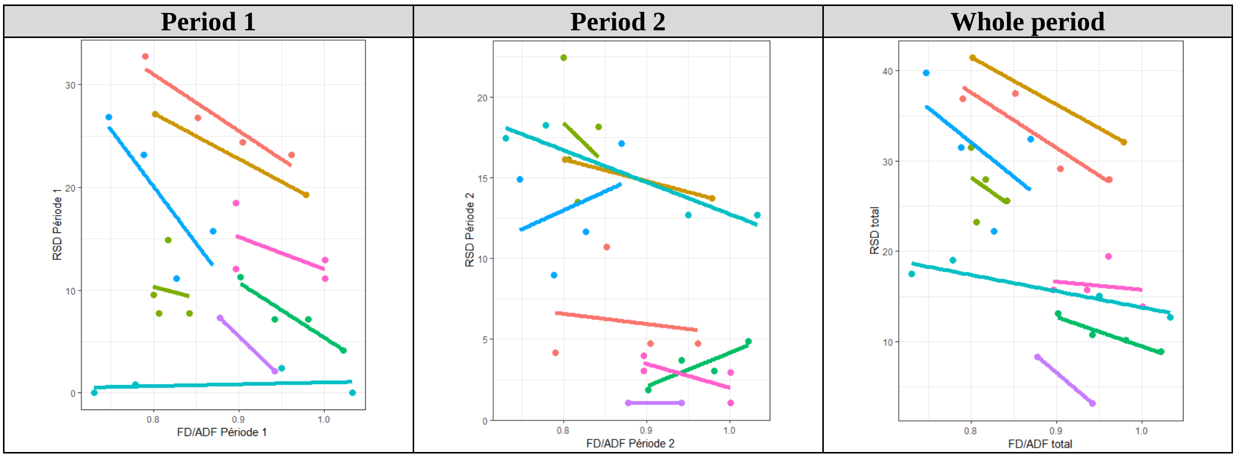

Figure 2: Effect of DF/ADF on SDR for period 1, period 2 and whole fattening period.

Mortality and morbidity

Regarding the mortality, we observed a decrease for the whole period ($P<0.05$, $R^2=0.88$), and for the first period as well ($P<0.05$, $R^2=0.89$). However, for the second period, the mortality was not reduced ($P=0.55$, $R^2=0.73$). Thus, the input of 0.1 additional point of DF/ADF would allow lowering the mortality of 1.7 points for the whole fattening period.

The morbidity was significantly lowered for the whole period ($P<0.05$, $R^2=0.84$), and tended to be reduced for the first period ($P=0.09$, $R^2=0.84$). For the second period, the effect of the ratio differed according to the different trials. Thus, the input of 0.1 additional point of DF/ADF would allow lowering the morbidity of 1.9 points for the whole fattening period.

In Carraro *et al.* (2007) study, the DF/ADF ratio had no significant impact on mortality and morbidity. However, it decreased respectively from 25% to 17.6%, and from 16.7% to 13%.

Typologies of sanitary digestive risk

Regarding the REE, when the DF/ADF ratio increased, the REE was significantly lowered for the whole period ($P<0.05$, $R^2=0.87$), and tended to be reduced for the first period ($P=0.17$, $R^2=0.86$) and the second period ($P=0.11$, $R^2=0.89$). The input of 0.1 additional point of DF/ADF would allow lowering the REE of 2.0 points for the whole fattening period.

Paresia were significantly reduced for the whole period ($P<0.05$, $R^2=0.49$), and tended to be lowered for the first period ($P=0.07$, $R^2=0.50$). For the second period, the effect of the ratio differed according to the different trials. Thus, the input of 0.1 additional point of DF/ADF would allow lowering paresia of 0.5 points for the whole fattening period. It should be noted that in the experimental station's conditions animals developed few paresia symptoms (0% to 3.2%), which limited the evaluation of this criterion.

Then, for diarrhea, there was no influence of the DF/ADF ratio neither for the whole period (P=0.27, R^2=0.81), nor for the second period (P=0.93, R^2=0.74). However, diarrheas tended to be reduced for the first period (P=0.06, R^2=0.85).
To our knowledge, there was no study about the impact of the DF/ADF ratio on different SDR pathologies (REE, paresia, diarrheas), and even less according to fattening periods.
It is important to say that, for economical and time reasons, DF is usually calculated instead of measured, because their analysis is complex. This is the explanation why in the literature there are several ways for calculating DF (Gidenne, 2003; Alvarez *et al.*, 2007; Carraro *et al.*, 2007). Thus, it would be interesting to use a standardized DF calculation method for all studies.
This meta-analysis could be deepen with diets having a DF/ADF ratio higher than 1.03. Thus we could identify if the SDR has a linear or a parabolic response.

Performance
In our study, average ADG and FCR were respectively 42.7 g/day and 2.92. When the DF/ADF ratio increased, the ADG was not significantly modified whether for the whole fattening period (P=0.96, R^2=0.99), the first period (P=0.21, R^2=0.97) or the second period (P=0.51, R^2=0.98).
The DF/ADF ratio also didn't influence the FCR whether for the whole fattening period (P=0.74, R^2=0.98), the first period (P=0.27, R^2=0.68) or the second period (P=0.78, R^2=0.93).

CONCLUSIONS

This study shows that, from trials conducted in the same farm context, the increase of the ratio DF/ADF in the range 0.73 to 1.03 has a beneficial impact on sanitary status of rabbit without impairing performance. This effect is greater for the DSR and the mortality for the first fattening period in comparison with the second period. These results suggest that the beneficial effect of DF and IF can be optimized when their levels in feed are well balanced.

REFERENCES

Alvarez JL., Marguenda I., Garcia-Rebollar P., Carabano R., De Blas C., Corujo A., Garcia-Ruiz A.I.,2007. Effects of type and level of fibre on digestive physiology and performance in reproducing and growing rabbits. World Rabbit Sci., 15, 9-17.

Carraro L., Trocino A., Fragkiadakis M., XiccatoG., Radaelli G., 2007. Digestible fibre to ADF ratio and starch level in diets for growing rabbits. Italian Journal of Animal Science, 6, 752-754.

De Blas C., Garcia J, Carabano R, Role of fibre in rabbit diets, a review, 1999. INRA/EDP Sciences, 48(1), 3-13.

Gidenne T., 2003. Fibres in rabbit feeding for digestive troubles prevention : respective role of low digested and digestible fibre. Rev Livestock Production Science 81, 105-117.

Gidenne T, Lebas F., Savietto D., Dorchies P., Duperray J., Davoust C., Fortun-Lamothe L., 2015, Nutrition et alimentation, Le lapin : de la biologie à l'élevage, 137-182

Kimse M., Caractérisation de l'écosystème caecal et santé digestive du lapin : contrôle nutritionnel et interaction avec la levure probiotique saccharomyces cerevisae, 2009.Thèse, Université de Toulouse.

Perez JM., Gidenne T., Bouvarel I., Arveux P., Bourdillon A., Briens C., Le Naour J., Messager B., Mirabito L., Lamboley B.,1996. Apports de cellulose dans l'alimentation du lapin en croissance : conséquences sur les performances et la mortalité, INRA/EDP Sciences, 45 (4), 299-309.

Sauvant D., Schmidely P., Daudin J.J., 2005, Les méta-analyses des données expérimentales : applications en nutrition animale, INRA Prod. Anim. 18, 63-73

Trocino A., Garcia J., Carabano R., Xiccato G., 2013. A Meta-analysis on the role of soluble fibre in diets for growing rabbits, World Rabbit Sci. 2013, 21: 1-15.