Research Article

The Effect of Different Dietary Fiber Content on the Production and Intestinal Morphology of Growing Rabbits

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Abstract | This study investigated the effect of different dietary fiber levels (17%, 19%, and 21%, groups R17, R19 and R21, respectively) on the performance of growing rabbits. Rabbits in the R21 group exhibited the highest feed intake ($P<0.05$) , while those in the R17 and R19 groups consumed nearly identical amounts of feed throughout the trial, except between 8 and 9 weeks of age. Body weight gain did not differ significantly between the R17 and R21 groups. Throughout the entire fattening period (weeks 5–11), a clear trend was observed in feed conversion ratio (FCR) among the groups, with a statistically significant difference found only between the R21 group and the R17 and R19 groups ($p<0.001$). Dietary fiber content also influenced villus length in various intestinal segments of the rabbits. However, the inconsistent trends and lack of clear differences prevent definitive conclusions. Further studies are required to better understand the impact of dietary fiber levels on the growth performance and intestinal morphology of fattening rabbits.

Keywords | *Oryctolagus cuniculus*, Crude fiber, Performance, Villi morphology

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INTRODUCTION

Fiber is a strategic pillar of modern rabbit nutrition and the driving force behind healthy intestinal function. Antibiotic-free technology and excellent health status are now unimaginable without precision formulation for fiber and fiber fractions content (Liu *et al.*, 2022; Gidenne, 2015).

Carefully selected fiber sources regulate peristalsis, protect the intestinal mucosa, and optimize digestion. The targeted use of fiber fractions is therefore the primary means of increasing yield and preventing digestive disorders (Zsédely, 2008; Mézes, 2011).

Rabbits are well adapted to fiber-rich diet (Gidenne, 2000). A significant part of their energy requirements is covered by the bacterial fermentation of fiber moreover it provides the optimal environment for the development of intestinal microflora, where a stable microbiological balance fundamentally determines the animal's performance and health (Montagne *et al.*, 2003).

Modern processing technologies and precise analytical methods allow for the targeted modification of the physical and chemical properties of fiber sources. This makes it possible to quickly and flexibly adjust the composition of diet to the feed industry and producer expectations and sustainability (Slama *et al.*, 2019; Huang *et al.*, 2024).

In the nutrition of monogastric animals, different fiber fractions have been classified for several years (Stalljohann, 2015), and the feed industry applies these in daily practice depending on its resources (Figure 1).

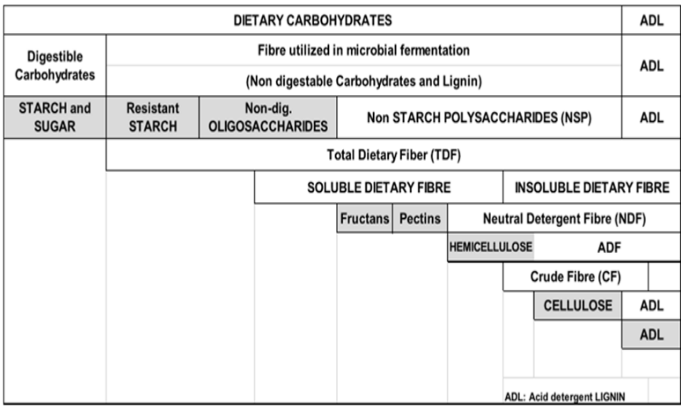

Figure 1: Classification of fiber fractions in monogastric feeding (according to Stalljohann, 2015).

Research has also been conducted on the effects of different fiber fractions in rabbit nutrition (Trocino *et al.*, 2013), but the practical application of the ratio of soluble and insoluble fibers (determination of total dietary fiber (TDF)has not yet been incorporated into rabbit feed formulation. This is mainly due to the relatively high cost of testing soluble fiber fractions. The TDF enzymatic and gravimetric method was modernized by Prosky *et al.* (1985) and today the AOAC 985.29 method is used for the separate measurement of soluble and insoluble fiber fractions.

The fermentability of insoluble fibers is limited (Stalljohann, 2015), while soluble components break down significantly, thus influencing metabolism through fermentation. It is known that a higher soluble fiber content generates higher volatile fatty acid (VFA) production in the caecum and colon, as indicated by elevated levels of non-glucogenic (NGR) intestinal content and fermentable organic matter (FOM) in the intestine (Petkova *et al.*, 2011). Chiou *et al.* (1994) came to a similar conclusion, finding that dietary fiber significantly influenced the total VFA concentration measured in the caecum ($p < 0.05$).

The structural composition of fiber determines the physical properties and viscosity of intestinal contents (Golz and Tungland, 2002), which directly affects nutrient absorption.

According to previous views, insoluble fiber had a negative effect on digestion as ballast material, and its excessive intake impaired the digestibility of nutrients, especially proteins, by diluting the feed (Schmidt, 2003). However, since the early 2000s, the use of lignocellulose-based fibers has highlighted the physiological potential of insoluble fractions.

The capillary fiber structure (Figure 2) formed during the fibrillation process (Yuan and Cheng, 2013) enabled concentrated fiber intake, meaning that significant positive changes could be achieved in the feed structure at low concentrations. Chao and Li (2008) obtained similar results when examining different types of dietary fiber fractions, where experimental feeds with increasing fiber content significantly influenced the intestinal wall morphology growth and the fibrolitic activity of the intestinal contents of growing rabbits.

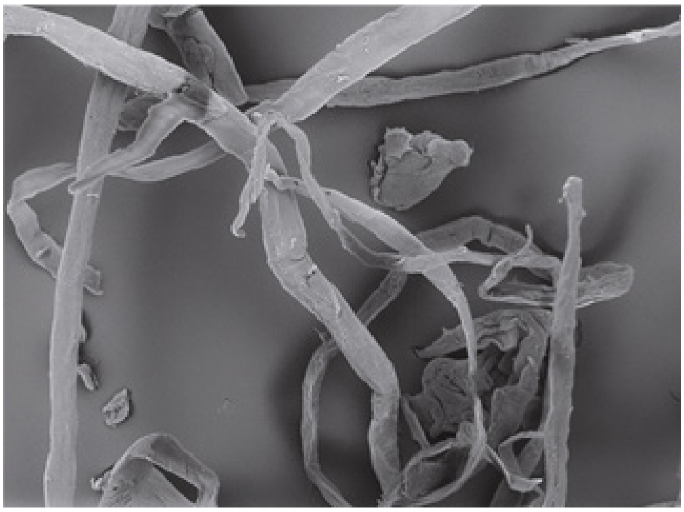

Figure 2: Capillary fiber structure (according to Englyst *et al.*, 1982).

The aim of our research was to determine the effect of different fiber contents (17, 19, and 21%) on the production and intestinal wall morphology of growing rabbits.

MATERIALS AND METHODS

The experiment was carried out at a rabbit farm in Debrecen (Hungary) with male Hycole rabbits. The ambient temperature in the building was 18-22 °C and the lighting was 8 hours per day. Weaned rabbits were placed in pairs in fattening cages made of spot-welded wire mesh (10.7 rabbits/m^2). The rabbits were allowed to eat *ad libitum* and drink *ad libitum* from nipple drinkers.

The rabbits were fed three different pelleted diets with different nutrient contents (pellet diameter: 3 mm). Based on the fiber content of the feed, three groups were formed: 17%, 19% and 21% crude fiber (groups R17, R19 and R21, respectively; Table 1).

Table 1: Chemical composition of the examined diets.

	Diets		
	R17	**R19**	**R21**
Crude protein, %	15	14	14
Crude fat, %	3.9	3	3
Crude fiber, %	17	18	21
Crude ash, %	7	6	6
NDF, %	3	39	40.
ADF, %	21	23	25
ADL, %	5	6	9
Starch, %	12	12	13
IDF, %	40	40	43
SDF, %	8	6	2
TDF, %	46	47	44.1
DIG NDF, %	19.2	22.9	23.3
Hemicellulose, %	17	17.71	16
Lignin/cellulose	0.34	0	0

NDF: neutral detergent fiber; ADF: acid detergent fiber; ADL: acid detergent lignin; IDF: insoluble dietary fiber; SDF: soluble dietary fiber; TDF: total dietary fiber; DIG NDF: digestible neutral detergent fiber.

The chemical composition of the examined diets is shown in Table 1. Fifty males from each group were included in the study (25 cages/group). The basic ingredients used in the feed formula were alfalfa, olive pomace, grape seed pellets, Arbocel, sugar beet pellets, sunflower meal, oats, barley, wheat, bran, DDGS, CGF, corn germ, molasses, soybean oil, NaCl, and Ca carbonate.

When compiling the formulas, we took into account not only the individual fiber fractions in the feed but also the lignin content and the lignin-cellulose ratio. The crude fiber, NDF, ADF, and ADL analyses (Englyst *et al*., 1982) were performed at the feed laboratory of the University of Pannonia (Hungary). The insoluble and soluble fiber content was measured, and the total dietary fiber content was also determined (AOAC, 985.29, 2001.03, 991.43; AACC 32.07.01; AOAC 2009.01, 2011.25; 2017.16 (RINTDF)).

The chemical composition of the feed ingredients is shown in Table 2. Fattening took place between 35 and 77 days of age. During the study, the individual body weight of the rabbits was measured weekly, from which the daily weight gain was calculated. The amount of feed consumed was measured per cage and the feed conversion ratio per cage was calculated. Mortality was recorded daily.

At the end of the fattening period, the rabbits were slaughtered at the Tetrabbit Ltd. slaughterhouse in Baja (Hungary). The rabbits were not fed from the evening before slaughter. Slaughter took place in the early morning hours, in accordance with applicable animal welfare regulations, after stunning.

Table 2: Chemical composition of feed ingredients.

Ingredients	Ash	Moisture	Crude protein	Crude fat	Crude fiber	NDF	ADF	IDF	SDF	TDF
Arbocel	0.3	7.4	1.5	0	64	84	60	81.4	0.56	81.96
Barley	2	11.5	9.4	1.65	4.5	16.8	5.6	19.46	1.57	21.03
CGF	5.2	10.9	18.15	3	8	33	9	30.89	0.93	31.82
Sugar beet pellets	7	12	8.5	0	17	37	21	49.62	17.15	66.77
DDGS	5	12	29	8	7	29.5	9	27.41	0.81	28.22
Bran (high fiber content)	5	13	1	2	10.1	41.2	13	41.2	4.52	45.78
Bran (standard)	5	12.9	15	3	10.05	38	12	37.71	3.49	41
Corn germ	2	1	2	2	8	40	1	42.75	5.34	48.09
Lucerne	9	8.8	1	1	29	48	35	57.48	1.33	58.8
High oil content corn germ	1	7	14	45	6.	23	23	32	2.46	34.46
Sunflower husk	2.5	9	4	5	51	73	5	37.04	6.88	43.92
Sunpro 20	5	9.4	21.5	1	35	5	36			
Olive scones	7	11	11	2	3	57	43	30.02	2	32.8
Soybean meal	6	11	35.9	1.4	19.3	30	21	20.28	4.1	24.46
Soybean hulls	4	12.5	10	2	3	57	42	69.71	6.27	7
Grape seed scones	2	1	1	0	4	61	54	68.93	4.79	73.72
Feed flour	3	12.5	15.5	3	5	24	7	30.43	2	33.23
Oat	2	9	11	3	12	3	14	36.69	2.42	39.11

NDF, ADF, IDF, SDF, TDF: see in Table 1.

For the evaluation of intestinal morphology, tissue samples were taken from the different part of the digestive tract (duodenum, jejunum, ileum and caecum) of 10-10 randomly selected rabbit per group, rinsed in physiological saline solution (Salsol), and then fixed in 8% buffered formalin at room temperature.

Sections were prepared from the specimens, and the epithelial tissues were examined microscopically at the Department of Pathology, University of Veterinary Medicine (Hungary).

Based on the section photos (10-10 per groups) we measured the villi length and the crypt size using CaseViewer (3DHISTECH) software. Most of intact and measurable villi were measured. This reason the number of measurements per group in case of different part of the digestive tract was different: duodenum (n=170, 230, and 200); jejunum (n=218, 240, and 252); ileum (n=220, 250 and 220), and caecum (n=200, 270 and 300) in groups R17, R19 and R21, respectively. In case of crypt 30-30 measurements were performed per intestinal segment.

The statistical analyses of the production and intestinal villi data was evaluated with R software package using one-way ANOVA. The normality of the data was checked with Shapiro-Wilk test. For the pairwise comparisons Tukey-test was used. The mortality rate in the groups was evaluated using a chi-square test.

All procedures were carried out on a commercial farm in accordance with the routine production practices. The animals were maintained and fed following national and European animal welfare guidelines. Since the study followed everyday management practices without additional experimental interventions, formal ethical approval was not required. Rabbits were handled according to the principles stated in the European Directive 2010/63/EU and according to the Hungarian legal requirements (32/1999. /III. 31./ and 178/2009. /XII. 29./).

RESULTS

The production results of the growing rabbits are summarized in Table 3. The rabbits in the R21 group consumed the highest amount of feed (P<0.01), while the rabbits in the R17 and R19 groups consumed almost the same amount throughout the entire period, except for the 8-9 weeks period (P>0.05). Over the entire fattening period, the R21 group consumed 6.2-8.5% more feed than the R17 and R19 groups (P<0.001).

In terms of body weight, a trend can be observed whereby rabbits in the R19 group had lower body weight than those in the other two groups from week 8 onwards (P<0.05; Table 3). Until week 9, the rabbits in group R21, which consumed feed with a high fiber content, were slightly larger than those in group R17, but from week 10 onwards, the trend reversed, and the rabbits in group R17 were larger than those in group R21.

Table 3: Production performance of growing rabbits depending on the fiber content of the diet.

	Diets				
Age, day	**R17**	**R19**	**R21**	**SEM**	**Prob**
Feed intake, g/day					
35-43	96.0[a]	95.4[a]	102[b]	0.85	<0.001
43-50	135[a]	133[a]	144[b]	0.89	<0.001
50-57	152[a]	144[a]	160[b]	1.63	<0.001
57-64	161[b]	153[a]	168[b]	1.41	<0.001
64-71	162[a]	160[a]	172[b]	1.70	0.002
71-78	159	159	167	1.98	0.088
35-78	145[a]	142[a]	154[b]	0.99	<0.001
Body weight, g					
35	858	858	858	5.70	0.998
43	1177	1178	1193	7.45	0.257
50	1559	1556	1586	9.97	0.065
57	1927[ab]	1883[a]	1946[b]	13.1	0.003
64	2249[b]	2172[a]	2251[b]	17.7	0.002
71	2522[b]	2450[a]	2519[ab]	21.2	0.027
78	2781[b]	2701[a]	2774[ab]	24.5	0.043
Weight gain (BWg), g/day					
35-43	45.6	45.6	47.7	0.74	0.472
43-50	54.6	54.0	56.2	0.78	0.121
50-57	52.5[b]	46.7[a]	51.4[b]	1.03	<0.001
57-64	45.9[b]	41.3[a]	43.6	1.11	0.018
64-71	39.0	39.0	38,2	1.12	0.654
71-78	37.0	35.9	36.4	1.38	0.871
35-78	45.8[b]	43.9[a]	45.6[ab]	0.57	0.036
Feed conversion ratio, g/g					
35-43	2.11	2.10	2.15	0.017	0.242
43-50	2.49	2.46	2.57	0.027	0.078
50-57	2.90[a]	3.13[b]	3.13[b]	0.030	<0.001
57-64	3.56[a]	3.83[ab]	3.90[b]	0.071	0.043
64-71	4.25[ab]	4.09[a]	4.56[b]	0.078	0.012
71-78	4.45	4.69	4.91	0.199	0.511
35-78	3.17[a]	3.24[a]	3.38[b]	0.018	<0.001

[a,b]: means with different superscripts differ significantly (P<0.05).

According to our results, this decrease was greater in group R21 than in group R17. The rabbits in the R17 and R21 groups did not differ significantly in this trait (P>0.05; Table 3). The rabbits in the R19 group also did not differ from either group, except for the period between 7 and 9 weeks of age, but during this period there was a significant decline in body weight gain in this group. Due to the significantly lower body weight gain observed between 7 and 9 weeks of age, the weight gain of rabbits in group R19 differed significantly from that of group R17 for the entire growing period (5-11 weeks) (P<0.05).

In general, rabbits consuming feed with a higher fiber content consumed more feed per unit of body weight than their counterparts consuming feed with a lower fiber content. According to our results, feed conversion was the worst in group R21, but we only found significant differences between weeks 7 and 9 compared to group R17, and between weeks 9 and 10 compared to group R19 (P<0.05; Table 3). However, for the entire fattening period (5-11 weeks), a clear order emerged between the groups, but a significant difference (P<0.001) was only found between the R21 group and the other two groups (R17 and R19).

During the entire fattening period, only one rabbit died (from group R17), which indicates that all three feeds tested were suitable for the healthy rabbit population included in the study and did not cause any problems that would have led to mortality.

The results of the intestinal mucosa examination are summarized in Table 4. In the case of the duodenum, we found a significant difference between the groups consuming feed with different fiber content: the shortest average villus length was found in group R19, which differed significantly from the results of the other two groups (P<0.001; Table 4). The R17 and R21 groups did not differ from each other.

Table 4: The development of the intestinal villi size of individual intestinal segments of growing rabbits depending on the fiber content of the diet.

	Diets				
Intestinal segment	**R17**	**R19**	**R21**	**SEM**	**Prob**
Duodenum	411.7^{b}	345.7^{a}	419.5^{b}	134.6	<0.001
Jejunum	500.9^{c}	386.0^{a}	420.7^{b}	118.0	<0.001
Ileum	389.9^{b}	356.6^{a}	379.0^{b}	85.0	<0.001
Caecum	115.6^{a}	124.1^{b}	123.5^{b}	4.94	0.017

^{a,b,c}: means with different superscripts differ significantly (P<0.05)

We obtained similar results for the ileum, although the differences were smaller. In the case of the jejunum, all three groups differed significantly from each other: the shortest average intestinal villus length was found in group R19, and the longest in group R17. The R21 group was between the two groups. The values measured in the caecum differed from that observed in other intestinal segments. The lowest value for this trait was achieved by group R17 (P=0.016). There was no difference in this trait between the other two groups.

DISCUSSION

The results of the present study confirm previous findings in the literature indicating that dietary fiber content has a significant impact on the production performance and intestinal morphology of growing rabbits (Gidenne, 2000, 2015) and also the trend in feed consumption consistent with the literature (Farias-Kovac *et al*., 2020). Feeding the highest fiber diet (21%) increased feed intake; however, it impaired feed conversion ratio (FCR), which is consistent with the findings of Trocino *et al*. (2013), who also reported a negative effect of increasing ADF levels on feed efficiency. The highest feed intake in R21 may be due to the fact that although there is a difference in ADF content between the three diets, only the R21 group differed significantly from the other two groups in terms of SDF content. The decline in feed intake between 8 and 9 weeks may have been due to health problems, but the exact cause is unknown.

In the case of the medium fiber diet (19%), the observed temporary decline in growth performance was most likely related to health issues rather than directly to fiber content. Similar phenomena were also described in other studies, where environmental and health-related factors exerted a stronger impact on growth performance than fiber fractions per se (Farias-Kovac *et al*., 2020).

It is well known that the intensity of weight gain decreases steadily with age (Saliu *et al*., 2022). Moreover, it is important to note that although the body weights of the two outer groups (R17 and R21) did not differ significantly from each other during the entire study period, there was still an interesting trend in the trait examined between the two groups, which is presumably due to the different nutritional requirements at the different ages (Farias-Kovac *et al*., 2020).

This result confirms what is already known in the literature (Gidenne, 2015) namely that at the beginning of the fattening period, mainly to avoid digestive disorders, it is advisable to feed young rabbits with a diet with higher fiber content, while in the last 2-3 weeks of the fattening period it is advisable to switch to a lower fiber content.

Feed conversion was also in line with the literature (Gidenne *et al*., 2001). In the trial of Chao and Li (2008), similar results were found, namely the daily feed intake of growig rabbits increased with rising ADF levels and similarly, with regard to body weight gain, it was found that daily gain deteriorated with increasing fiber levels, and a moderate level (190 g/kg ADF) was found to be optimal. At this ADF level, significant quadratic and/or cubic effects were observed on villus height, crypt depth, and villus height/crypt depth across the duodenum, jejunum, and ileum, with the 190 g/kg ADF group generally showing the most favourable intestinal morphology.

Based on intestinal villi analysis, it was evident that fiber composition affected gut morphology, although the differences were not consistent across all intestinal segments or parameters. This partially aligns with the findings of Álvarez *et al*. (2007), who demonstrated that increasing fiber and NDF levels reduced villus length. Although we observed the opposite trend in the R19 and R21 groups, we also obtained the longest intestinal villi when feeding the rabbits with the lowest NDF content (R17) (Table 4).

In contrast, our results suggest that the effect is not strictly linear but rather influenced by the specific fiber fractions and their physicochemical properties, in accordance with the review by Gidenne (2015).

Chiou *et al*. (1994) came to a similar conclusion in their research, which showed that the quality (source) of fiber is also crucial: the group supplemented with lignin ate significantly less than those who consumed alfalfa, cellulose or pectin. Different sources of dietary fiber significantly influenced feed intake, weight gain, feed conversion rate and VFA production of the rabbits. Rabbits on the diet with the lignin supplement gained significantly less body weight ($P < 0.05$) than did the other treatment groups of rabbits fed the cellulose or pectin supplemental diet. It has been shown that purified fiber sources (lignin, cellulose, pectin) significantly shorten intestinal villi compared to alfalfa, and lignin specifically damaged the surface of the villi in the duodenum and jejunum.

CONCLUSIONS

The study demonstrates that dietary fiber content significantly influences the production performance and intestinal morphology of growing rabbits. Overall, it can be concluded that although higher fiber content promotes feed intake, it does not necessarily provide a growth advantage. Although fiber composition modified villus morphology, the effects were not consistent or statistically significant across all intestinal segments. These findings highlight the importance of optimizing fiber fractions - particularly the ratio of soluble to insoluble fiber and warrant further targeted research into the digestibility of specific fiber sources in growing rabbit nutrition.

NOVELTY STATEMENT

This study aimed to explore how different fiber contents in rabbit feed affect both productivity and intestinal morphology. The results show clear trends in feed intake, feed conversion ratio, and intestinal structure, although not all differences were statistically significant. This research contributes to better understanding optimal dietary fiber compositions in growing rabbits.

AUTHORS CONTRIBUTION

AM conceptualization, investigation, data curation, writing original draft preparation. ADJ investigation, project administration. CD investigation, data curation, formal analysis, methodology, writing review and editing. MS investigation. ZG supervision, writing review and editing, data curation, validation. RJ investigation, project administration. ZM formal analysis, writing review and editing. ZN supervision, writing review and editing.

Generative AI and AI assisted technology statement

The authors declare that no generative AI and AI assisted technology was used in the creation of this manuscript.

Conflict of interest

The authors have declared no conflict of interest.

REFERENCES

Álvarez JL, Marguenda I, Rebollar PG, Carabaño R, De Blas C, Corujo A, Ruiz AIG (2007). Effects of type and level of fiber on digestive physiology and performance in reproducing and growing rabbits. World Rabbit Sci., 15(1): 9–17. https://doi.org/10.4995/wrs.2007.610

AOAC 985.29 (2016). Official methods of analysis of the association of American Organization of Analytical Chemists International. 20th Ed., Arlington

Chao HY, Li FC (2008). Effect of level of fibre on performance and digestion traits in growing rabbits. Anim. Feed Sci. Technol., 144(208): 279-291. https://doi.org/10.1016/j.anifeedsci.2007.10.007

Chiou PW, Yu B, Lin C (1994). Effect of different components of dietary fiber on the intestinal morphology of domestic rabbits. Comp. Biochem. Physiol. Comp. Physiol., 108(4): 629-638. https://doi.org/10.1016/0300-9629(94)90349-2

Englyst HN, Wiggins HS, Cummings JH (1982). Determination of non-starch polysaccharides in plant foods by gas-liquid chromatography of constituent sugars as alditol acetates. Analyst, 107(1272): 307-318. https://doi.org/10.1039/an9820700307

Farías-Kovac C, Nicodemus N, Delgado R, Ocasio-Vega C, Noboa T, Abdelrasoul RAS, Carabaño R, García J (2020). Effect of dietary insoluble and soluble fibre on growth performance, digestibility, and nitrogen, energy, and mineral retention efficiency in growing rabbits. Animals, 10: 1346. https://doi.org/10.3390/ani10081346

Gidenne T (2000). Recent Advances in rabbit nutrition: Emphasis on fibre requirements. A review. World Rabbit Sci., 8(1): 23-32. https://doi.org/10.4995/wrs.2000.414

Gidenne T (2015). Dietary fibres in the nutrition of the growing rabbit and recommendations to preserve digestive health: A review. Animal, 9(2): 227-242. https://doi.org/10.1017/S1751731114002729

Gidenne T, Arveux P, Madec O (2001). The effect of the quality of dietary lignocellulose on digestion, zootechnical performance and health of the growing rabbit. Anim. Sci., 73(1): 97-104. https://doi.org/10.1017/S1357729800058094

Golz D, Tungland B (2002). Fermentable fiber provides added value to pet foods. Feedstuffs, 74(53): 14-15.

Liu B, Cui Y, Ali Q, Zhu X, Li D, Ma S, Wang Z, Wang C, Shi Y (2022). Gut microbiota modulate rabbit meat quality in response to dietary fiber. Front Nutr., 9: 849429. https://doi.org/10.3389/fnut.2022.849429

Mézes M (2011). Takarmányozástan "Animal Nutrition." University of Kaposvár. Available at: Digital Textbook Library.

Montagne L, Puske JM, Hampson DJ (2003). A review of interactions between dietary fiber and the intestinal mucosa, and their consequences on digestive health in young non-ruminant animals. Anim. Feed Sci. Technol., 108(1-4): 95-117. https://doi.org/10.1016/S0377-8401(03)00163-9

Petkova M, Grigorova S, Abadjieva D (2011). Biochemical and physiological changes in growing rabbits fed different sources of crude fiber. Biotechnol. Anim. Husb., 27(3): 1367-1378. https://doi.org/10.2298/BAH1103367P

Prosky L, Asp NG, Furda I, DeVries JW, Schweizer TF, Harland BF (1985). Determination of total dietary fiber in foods and food products: Collaborative study. J. Assoc. Off. Anal. Chem., 68(4): 677-679. https://doi.org/10.1093/jaoac/68.4.677

Saliu E M, Krieg R, Martínez-Vallespín B, Simon A, Zentek J (2022). Performance, health, bacterial metabolites and intestinal histomorphology in does and growing rabbits fed diets with increasing lignocellulose-to-cellulose proportions. Arch. Anim. Nutr., 76(2): 125-144. https://doi.org/10.1080/1745039X.2022.2074204

Schmidt J (2003). Nyers rost, In: A takarmányozás alapjai. (Crude Fiber, In: Nutrition, in Hung.) Schmidt, J. Ed.; Mezőgazda Kiadó, Budapest, Hungary, pp. 38-45.

Slama J, Schedle K, Wurzer GK, Gierus M (2019). Physicochemical properties to support fibre characterization in monogastric animal nutrition. J Sci Food Agric., 99(8): 3895-3902. https://doi.org/10.1002/jsfa.9612

Stalljohann G (2015). Raufutter in der schweinefütterung, proteinmarkt.de fachartikel, 1-7. https://www.proteinmarkt.de/fileadmin/bilder/fachartikel/2015/Fachartikel_Raufutter_in_der_Schweinefuetterung-WEB.pdf

Trocino A, García J, Carabano R, Xiccato G (2013). A meta-analysis on the role of soluble fiber in diets for growing rabbits. World Rabbit Sci., 21(1): 1-15. https://doi.org/10.4995/wrs.2013.1285

Yuan X, Cheng G (2013). From cellulose fibrils to single chains: Understanding cellulose dissolution in ionic liquids. PCCP-Phys. Chem. Chem. Phys. R. Soc. Chem., 1: 6-7.

Huang Y, Li C, Zheng S, Fu X, Huang Q, Liu G, Chen Q (2024). Influence of three modification methods on the structure, physicochemical, and functional properties of insoluble dietary fiber from *Rosa roxburghi* Tratt Pomace. Molecules, 29(9): 2111. https://doi.org/10.3390/molecules29092111

Zsédely E (2008). The effect of feed fiber composition and physical form on the digestive biology and production of meat rabbits (Doctoral thesis). University of Debrecen, Available at: DEA Repository.