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Effect of some probiotics on intestinal viscosity in rabbits

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ABSTRACT

The effects of three different probiotics (Toyocerin 10^{10} (spores of Bacillus toyoi), Paciflor (spores of Bacillus CIP 5832) and Yea-sacc (yeast Saccharomyces cervisiae)) on the viscosity of small intestine and caecum content of 96 young New Zealand rabbits were studied. The experiment started at the 44^th^ day of life (1363±107.9 g). The first half of the trial rabbits were slaughtered after 2 weeks of the trial, on the 57^th^ day of life, and the second half after 4 weeks, on the 71^st^ day of life. The intestinal viscosity analysis was carried out according to Bedford and Classen (1992) in the same way as in poultry. Values for viscosity were much higher in the caecum (7.07 to 7.73 mPa) than in the small intestine content (2.94 to 3.26 mPa). The addition of selected probiotics had no significant influence on viscosity in the small intestine or in the caecum content. The sex of the experimental rabbits influenced only viscosity of the small intestine content, females having higher viscosity than males (females 3.53, males 2.75 mPa, $p \leq 0.05$). The age of the experimental rabbits had no influence on intestinal viscosity.
(Keywords: animal nutrition, rabbits, probiotics, viscosity)

ZUSAMMENFASSUNG

Einfluss einer Probiotika auf die Viskosität des Darmes
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Untersucht wurde der Einfluß einiger Probiotika (Toyocerin 10^{10} (Sporen von Bacillus toyoi), Paciflor (Sporen von Bacillus CIP 5832) und Yea-sacc (Hefe Saccharomices cervisiae)) auf die Viskosität des Dünndarm- und des Blinddarminhaltes bei 96 Jungkaninchen der Rasse Weiße Neuseeländer. Mit dem Versuch wurde am 44. Lebenstag (Tiergew. 1363±107,9 g) begonnen. Die erste Hälfte der Kaninchen wurde nach 14 Tagen des Versuches (Alter 57 Tage) nach dem Zufallsprinzip aussortiert und geschlachtet. Das Gleiche geschah mit der zweiten Hälfte der Tiere nach weiteren 4 Wochen (Alter 71 Tage). Die Viskosität des Verdauungstraktinhaltes wurde nach Bedford und Classen (1992), wie bei Geflügel, durchgeführt. Die Viskositätswerte waren im Blinddarm (7,07 bis 7,73 mPa) gegenüber dem Dünndarm (2,94 bis 3,26 mPa) viel höher. Der Zusatz der Probiotika bewirkte sowohl im Dünndarm als auch im Blinddarm keine signifikante Veränderung der Viskosität. Das Geschlecht der Tiere beeinflußte die Viskosität nur im Dünndarm, wo die Viskositätswerte bei weiblichen Tieren signifikant höher waren (weibl Tiere: 3,53, männl. Tiere: 2,75 mPa, $p \leq 0,05$). Das Alter der Versuchskaninchen zeigte keinen Einfluß auf die Viskosität des Inhaltes im Verdauungstrakt.
(Schlüsselwörter: Tierernährung, Kaninchen, Probiotika, Viskosität)

INTRODUCTION

The role of different probiotic additives is to sustain digestion processes, to enable better digestibility and food conversion and to improve the health of the animal. The addition of probiotics to food for rabbits has a particularly favourable effect on microbial balance in the caecum. A stable microbial metabolism in the caecum is extremely important to prevent digestion disturbances as well as to ensure favourable production parameters and low mortality rate in intensive breedings of rabbits. Probiotics can influence gastrointestinal weight, proportions between the digestive organs (*Kermauner* and *Štruklec*, 1996) and also the microbial fermentation pattern in the caecum (*Kermauner et al.*, 1996).

Probiotics can influence the digestibility of nutrients as well. Results reported by *El-Hindawy et al.* (1993) indicate improvement in the digestibility of all nutrients when probiotic Lacto-Sacc was added. *Kamra et al.* (1996) established improved digestibility of crude proteins after the addition of the same probiotic and *Yamani et al.* (1992) found improved digestibility of crude fibre. On the contrary, *Holister et al.* (1989) and *Chaudhary et al.* (1995) found no influence of probiotic, acids or yeast cultures on the digestibility of tested nutrients. *Aderibigbe et al.* (1992) found no effect of probiotic Yea-Sacc or Lacto-Sacc on *in vitro* caecal digestibility of different substrates.

Another indicator of digestibility and absorption of nutrients is intestinal viscosity, primarily of all in the small intestine, where the majority of absorption takes place. Effects of viscosity are related to the age of animals: the viscosity of the small intestine content of adult poultry is lower than that of broiler chicks. Also, for this reason, in older animals digestibility is higher (*Almirall et al.*, 1995; *Salobir et al.*, 1995a).

Viscosity also has an important effect on intestinal motility (*McDougall et al.*, 1996). Increased viscosity of intestinal content weakens the effect of peristaltic mixing of digesta, retards the diffusion of nutrients through the intestinal wall and reduces the speed of digestion and the absorption of organic nutrients (*Hesselman* and *Aman*, 1986, cit. after *Van der Klis et al.*, 1993a).

The influence of probiotics on the digestive process is part of an extended study, conducted and partly presented by *Kermauner* and *Štruklec* (1997, 1998). The aim of this part of the study was to introduce a method of viscosity measurement in rabbits and to establish the influence of different probiotics on the viscosity of the small intestine and caecum content. Three different probiotics were used: Toyocerin 10^{10} (spores of *Bacillus toyoi*), Paciflor (spores of *Bacillus* CIP 5832) and Yea-sacc (yeast *Saccharomyces cervisiae*). Their influence on intestinal viscosity in two age groups of young rabbits was observed, in comparison with a control group.

MATERIALS AND METHODS

Animals and parameters measured

A total of 96 New Zealand White rabbits, both female and male, were allotted into 4 trial groups (24 rabbits per group). The rabbits were housed in wire cages: during the first part of the experiment two animals were housed together in each cage. During the second part of the trial the animals were housed individually. Temperature was between 17 and 18°C, humidity between 50 and 60 %, and the light period 16 hours long. The rabbits were given both feed and water *ad libitum*.

The rabbits were weaned at the age of 31 days, and individually marked (with ear tattoos) at the age of 37 days (1175±115.8 g). After an adjustment period of 1 week, the experiment started at the 44th day of life (1363±107.9 g). The first half of the trial rabbits (selected randomly) were slaughtered after 2 weeks of the trial, on the 57th day of life, and the second half after 4 weeks, on the 71st day of life. Before the trial began the rabbits were fed standard feed.

Feed

The feed was prepared according to recommendations for growing rabbits (*Maertens*, 1995) (*Table 1*).

Table 1

Composition of trial feed

Component(1)	%	Component(2)	%
Alfalfa meal(3)	23.6	Sunflower meal(9)	10.0
Barley(4)	11.0	Brewer's yeast(10)	2.0
Oats(5)	5.0	Sawdust(11)	3.0
Wheatfeed meal(6)	6.0	Molasses(12)	3.0
Sugar beet pulp(7)	18.0	Binder(13)	2.0
Soya meal(8)	11.0	Mineral-vitamin mix(14)	8.4

1. Tabelle: Zusammensetzung des Versuchsfutters

Komponente(1),(2), Luzernameh(3), Gerste(4), Hafer(5), Futterweizenschrot(6), Zuckerrübenschnitzel(7), Sojamehl(8), Mehl aus Sonnenblumenkernen(9), Bierhefe(10), Sägemehl(11), Melasse(12), Bindemittel(13), Mineral-Vitamin-Präparat(14)

The trial feeds were based on a control feed with the addition of the following probiotics:

- 0.01% Toyocerin 10^{10} (spores of *Bacillus toyoi*)
- 0.01% Paciflor (spores of *Bacillus* CIP 5832)
- 0.1% Yea-sacc (yeast culture *Saccharomyces cervisiae*)

The basic feed mixture (recipe given in *table 1*) was divided into 4 parts. The three probiotics were added to 3 parts of feed, each to one part. All mixtures were prepared and pelleted in the experimental blend unit (Biotechnical Faculty, Zootechnical Dept.) in Homec. The chemical composition of the experimental feed mixtures is shown in *Table 2*.

Viscosity measurements

The intestinal viscosity analysis was carried out according to Bedford and *Classen* (1992) in the same way as in poultry. The total contents of the small intestine and the caecum were collected, immediately homogenised and placed in microcentrifuge tubes, and then centrifuged at 9500 g for 10 minutes. The supernatant was withdrawn and the viscosity determined by a rotational cone and plate viscometer (model LVDVMPA-II+, cone MPA-40; Brookfield Engineering Laboratories Inc., Stoughton, MA), maintained at 25^{o}C and at a shear rate of 10 s^{-1}. The viscometer was labelled by means of Brookfield standard (viscosity 9.3 mPa at 25°C).

Table 2

Chemical composition of trial feeds (g/kg DM)

Component (g/kg DM)(1)	Control	Toyocerin(2)	Paciflor(3)	Yea-sacc(4)
Crude protein(5)	199.26	208.66	205.87	206.40
Crude fat(6)	25.23	21.61	20.82	20.71
Crude fibre(7)	153.14	175.50	176.60	174.36
NDF	331.87	339.76	346.97	350.04
ADF	184.51	217.51	219.66	220.41
ADL	33.15	41.39	40.57	38.96
Crude ash(8)	79.84	74.26	73.91	73.87
N-free extract(9)	542.53	519.97	522.80	524.65
Phosphorus	7.26	5.79	5.72	5.76
Calcium	13.81	11.01	10.68	10.84
Potassium	11.47	14.54	14.17	14.43
Sodium	2.61	2.30	2.24	2.30
Zinc (mg/kg DM)	183.92	264.76	251.28	273.33
Manganese (mg/kg DM)	237.05	315.73	295.64	309.81
Total sugars(10)	60.09	66.92	64.48	56.15
Dry matter (DM)(11)	862.83	909.61	893.44	897.18
Gross energy (MJ/kg DM)(12)	17.88	17.86	17.88	17.78
Digestible energy (MJ/kg)(13)*	10.0	10.0	10.0	10.0

* Calculated from tables *(Errechnet nach den Tabellen von)* (*Schlolaut, 1982*; *Maertens et al., 1990*)

2. Tabelle: Chemische Zusammensetzung des Versuchsfutters

Komponente(1), Futter mitToyocerin(2), Futter mit Paciflor(3), Futter mit Hefekultur(4), Rohprotein(5), Rohfett(6), Rohfaser(7), Rohasche(8), Nitrogenfreier Extrakt(9), Gesamte Kohlenhydrate(10), Trockensubstanz(11), Bruttogenergie(12), Verdauliche Energie(13)

Statistics

The data were subjected to statistical analysis using the GLM procedure in the SAS statistical program (SAS/STAT, 1990). The model was as follows:

$$Y_{ijk} = \mu + P_i + S_j + A_k + P.S_{ij} + P.A_{ik} + S.A_{jk} + e_{ijk}$$

Y_{ijk}	- measured value
μ	- population mean
P_i	- effect of probiotic (i=1,2,3,4)
S_j	- effect of sex (j=1,2)
A_k	- effect of age (k=1,2)
$P.S_{ij}$, $P.A_{ik}$, $S.A_{jk}$	- interactions between main effects
e_{ijk}	- error

RESULTS

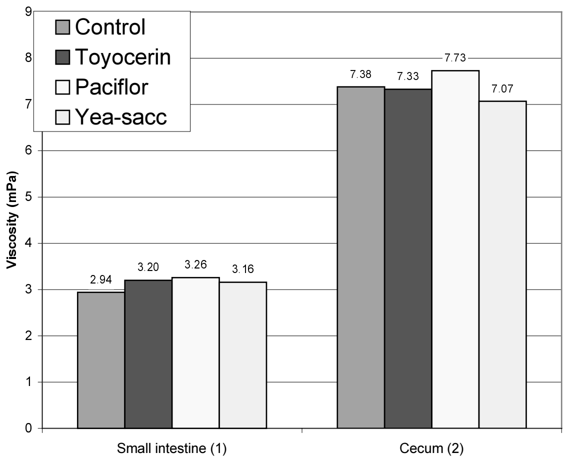
The viscosity of the small intestine content was highly influenced by the sex of the trial animals, while the viscosity of the caecum content was found to be independent of probiotic, sex or age of trial rabbits. Interactions were not expressed anywhere.

Influence of probiotics

Values for viscosity were much higher in the caecum than in the small intestine (*Figure 1*). In rabbits a special separation mechanism takes place in the colon and caecum. Due to this separation of large particles in the colon only small particles and solubles remain in the caecum. This part of the digesta probably has higher viscosity.

Figure 1

The effect of probiotic on viscosity of small intestine and caecum content in rabbits



1. Abbildung: Einfluss der Probiotika auf die Viskosität des Inhalts von Dünndarm und Blinddarm bei Kaninchen

Dünndarm(1), Blinddarm(2)

These results cannot be compared with others, since no data on viscosity measurements in rabbits are to be found in the literature available. Only data for viscosity in the small intestine of poultry exist: in experiments performed by *Salobir et al.* (1995a, 1995b) viscosity values in the small intestine content in broiler chickens were similar, but *Liebert* (1995) and *Salobir et al.* (1997) reported slightly higher values (from 3.30 to 8.14 mPa) than in the small intestine content of rabbits in the present experiment.

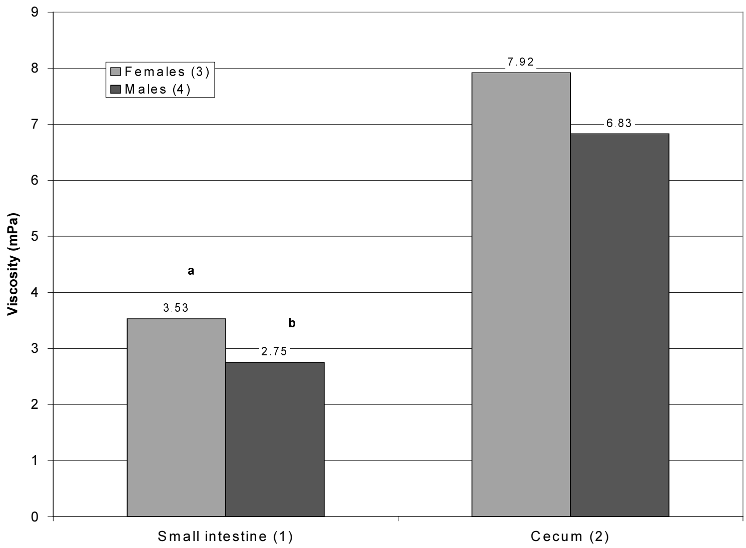
With respect to the influence of probiotics on the viscosity of the small intestine content no data are available, even relating to poultry. Only the effect of enzymes in poultry has been investigated: *Salobir et al*. (1995b) established lower viscosity in the small intestine of chickens when different enzymes were used (xylanase and β-glucanase).

Influence of sex

Analysis of variance (*Table 3*) showed that the sex of the trial animals influenced only the viscosity of the small intestine content. This influence is shown in *Figure 2*.

Figure 2

The effect of sex on viscosity of small intestine and caecum content in rabbits



2. Abbildung: Einfluss des Geschlechts auf die Viskosität des Inhaltes von Dünndarm und Blinddarm bei Kaninchen

Dünndarm(1), Blinddarm(2), Weiblich(3), Männlich(4)

Females had higher viscosity in the small intestine and caecum content, but only in the small intestine were the differences significant. In the literature all the experimental animals (in poultry) were of male sex, so no data on the influence of sex on viscosity in digesta are available.

Differences between sexes in rabbits have been established only by some authors and for some parameters: in growth, in weights of digestive organs and in some parameters of microbial fermentation in the caecum. *Kermauner* and *Štruklec* (1993, 1994) established decreased daily weight gain in females in the last trial week. *Štruklec et al.* (1994) found differences between sexes in stomach and caecum weight (with its content) and in percentage of acetic acid in the caecum content. *Kermauner* and *Štruklec* (1996) reported higher weight and proportion of the caecum and lower proportion of the small intestine in females than in males. *Kermauner et al.* (1996) found an interaction between sex and age of trial rabbits. At 67 days mol% of acetic acid in the caecum content was lower and mol% of propionic acid was higher in females than in males. *Lopez et al.* (1988) found faster growth of the digestive organs (particularly the caecum) in females than in males.

Influence of age

Age of rabbits had no effect on viscosity in the small intestine (57^{th} d.: 3.02, 71^{st} d. 3.26 mPa) or the caecum (57^{th} d.: 7.56, 71^{st} d. 7.19 mPa) content. This is not in accordance with *Almirall et al.* (1995) or *Salobir et al.* (1995a), who reported decreased viscosity in the small intestine of older chickens. This decrease can be expected, due to the more developed digestive tract in older animals. In the rabbits the small intestine reached its final weight in the 7^{th} week (at 49 days), while growth of the caecum stopped after 9 weeks (at 63 days) (*Laplace* and *Lebas*, 1972; *Vicente et al.*, 1989).

If younger rabbits (before the 7^{th} week of age) were compared with rabbits of 71 days of age (used in this experiment) differences in viscosity would probably be expressed more clearly.

CONCLUSIONS

Values for viscosity were much higher in the caecum than in the small intestine content.

The addition of the selected probiotics Toyocerin 10^{10}, Paciflor and Yea-sacc had no significant influence on viscosity in the small intestine or the caecum content.

The sex of the experimental rabbits influenced only the viscosity of the small intestine content, females having higher viscosity.

The age of the experimental rabbits had no influence on intestinal viscosity.

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