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# INFLUENCE OF PROBIOTIC ADDITION IN DIFFERENT FEED MIXTURES ON GASTROINTESTINAL TRACT DEVELOPMENT AND DRESSING PERCENTAGE OF RABBITS

# UTJECAJ DODAVANJA PROBIOTIKA U RAZLIČITE KRMNE SMJESE NA RAZVOJ GASTROINTESTINALNOG TRAKTA I POSTOTAK RANDMANA KUNIĆA

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Original scientific paper - Izvorni znanstveni članak
UDK: 636.9. i 636.087.7.8
Received - primljeno: 29. april - travanj 1994.

## ABSTRACT

Influence of energy and ADF content in feed as well as the addition of probiotic Acid-Pak 4-Way (AP4W) and the influence of their interaction on gastrointestinal (GI) tract development and dressing percentage (DP%) of weaned New Zealand White rabbits were studied. Three complete feed mixtures with different levels of digestible energy and crude protein content were tested, each with and without addition of 0,5% probiotic AP4W, Higher energy level in feed significantly ($p \leq 0,05$) improved DP%, increased carcass weight and decreased GI weight. The rate of cecum decreased due to relatively high ADF content in feed. Probiotic significantly decreased weight of GI, indicating the tendency of better DP%. The relative portion (RP%) of stomach was reduced on behalf of increased cecum RP%. Interaction between feed and probiotic was not significant.

## INTRODUCTION

Energy and crude fibre (CF) contents are the main variables when compounding feed mixtures for rabbits. High daily weight gains are the main objective during fattening period, thus the feed rich in energy is used.

High energy level in fattening feed may cause digestive disturbances as it often appears together with low content of CF i.e. acid detergent fibres (ADF) and high content of readily available carbohydrates (RAC), especially starch. Such feed may cause surplus of RAC in cecum which results in irregular microbial fermentation. Consequently, potentially pathogen microorganisms develop, leading to enteritis (Cheeke and Patton, 1980) which is one of the main reasons for mortality of fattening rabbits and causes serious economic losses.

The opinion of de Blas et al. (1986) is that when performing nutritional trials on rabbits, the weight of cecum with its content represents better index of risk due to digestive disturbances than mortality alone, since it is of highly varying nature. The correlation between higher cecum weight and mortality was noticed. Many authors reported correlation between CF (ADF) content in feed and GI tract weight: higher cecum weight when CF content in feed was very low (under recommended values) was reported by Candau et al. (1979), Dehale (1981) and de Blas et al. (1986). On the other hand Hoover and Heitmann (1972), Lebas et al. (1982) and Gidenne (1992) reported higher

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cecum weight when rabbits were fed on feed containing high level of CF (ADF). These findings agree with the results of many other authors who reported unsuitability of feed mixtures with too low as well as too high level of CF. For this reason feed mixtures with relatively high content of ADF and low, medium and high energy levels were included in our trial.

Findings in recent studies indicate that digestive process and consequently production and slaughter traits may be favorably affected by using different feed additives such as probiotics that are most common presently. Probiotics can be simple or combined products; the latter are composed of bacteria or yeast cultures, different organic acids or perhaps certain enzymes.

Such additives are especially efficient in certain stress conditions and are even more interesting in intensive rabbit breeding management systems. The use of probiotics and similar additives together with adequate composition of feed ratio might be a tool for overcoming digestion difficulties that occur due to unbalanced feed quantity and composition in relation to nutritional and physiological needs of growing rabbits.

## MATERIAL AND METHODS

A total of 75 New Zealand White rabbits, both female and male, weaned at the age of 32 days (795 g) were randomly allotted to 6 groups. After the adjustment period of one week rabbits were given the trial feed ad *libitum*. One half of the animals in each group were slaughtered at the age of 53 days and the other half at the age of 67 days. Within both groups following traits were tested: live weight at slaughter, weight of carcass (excluding lower parts of legs and head), dressing percentage (portion of carcass in % from live weight at slaughter) as well as weight of separate parts of GI tract including the content (stomach, small intestine, cecum and large intestine).

Three different feeds were tested in the experiment (feed I, II and III) each with and without the addition of 0,5% probiotic AP4W. Feed mixtures differed regarding digestible energy (DE) levels and crude fiber (CF) i.e. neutral detergent fiber (NDF), acid detergent fibre (ADF) and acid detergent lignin (ADL). The contents of minerals, vitamins and proteins did not differ. Comparing to the NRC tables (Nutrient Requirements of Rabbits, 1977) all three trial feeds had relatively high crude protein (CP) content as well as high to very high content of CF. The NRC recommendations for CP, CF and DE content for growing rabbits are 160 g/kg, 100-120 g/kg and 10,4 MJ/kg feed, respectively. Actual trial feed composition is shown in Table 1. Probiotic AP4W (Altech. Inc., U.S.A.) is an additive composed of microencapsulated lactobacillus (*Lactobacillus acidophilus, Streptoccocus faecium*), enzymes (amylases, cellulases and proteases) fermentation extracts from dried *Aspergillus niger* and *Bacillus subtilis* electrolytes (Na, K) and acids (citric and sorbic acid).

**Table 1. Chemical analysis of feed mixtures and calculated DE content**
**Tablica 1.Kemijska analiza krmnih smjesa i izračunati sadržaj PE**

| Component (g/kg DM)<br>Sastojak (g/kg ST) | Feed mixture - Krmna smjesa | | |
|---|---|---|---|
| | Feed I and I+[a]<br>Krma I i I+[a] | Feed II and II+[a]<br>Krma II i II+[a] | Feed III and III+[a]<br>Krma III i III+[a] |
| Dry matter (g/kg) - Suha tvar | 881.47 | 903.34 | 903.36 |
| Crude protein - Sirova bjelančevina | 201.63 | 198.29 | 204.91 |
| Crude fiber - Sirova vlaknina | 262.81 | 230.52 | 155.04 |
| NDF - NDV | 426.08 | 386.97 | 328.40 |
| ADF - KDV | 299.44 | 254.01 | 186.90 |
| ADL - KDL | 91.13 | 64.94 | 51.40 |
| DE (MJ/kg DM)[b] - PE (MJ/kg ST)[b] | 10.46 | 12.84 | 14.55 |

[a] feed with + is feed with addition of 0.5% AP4W - hrana s + je krma s dodatkom 0.5% AP4W
[b] calculated from tables - izračunato iz tablica

**Table 2. The most important influences on separate tested traits of rabbits, 53 and 67 days old with statistical significance**

**Tablica 2. Najvažniji utjecaji na odvojena testirana svojstva kunića, 53 i 67 dana starih statistički značajnih**

| REGRESSION EQUATION - JEDNADŽBA REGRESIJE $y = a + b_1 (x - \bar{x}) + b_2 (x - \bar{x})^2$ | | | | | | |
|---|---|---|---|---|---|---|
| Trait - Svojstvo | Influence - Utjecaj | a | $b_1$ | p | $b_2$ | p |
| DRESSING PERCENTAGE (%) - RANDMAN (%) | | | | | | |
| 53 days - dana | Weaning weight | | | | | |
| | Težina kod odbića | 49.33 | 0.0142 | 0.003 | - | |
| 67 days - dana | Weaning weight | | | | | |
| | Težina kod odbića | 51.73 | 0.0047 | 0.183 | 0.00004 | 0.027 |
| CARCASS WEIGHT (g) - TEŽINA KARKASA (g) | | | | | | |
| 53 days - dana | Slaughter weight | | | | | |
| | Težina kod klanja | 859.03 | 0.5624 | 0.000 | -0.0003 | 0.053 |
| 67 days - dana | Slaughter weight | | | | | |
| | Težina kod klanja | 1125.97 | 0.6302 | 0.000 | - | |
| GASTROINTESTINAL TRACT WEIGHT (g) - TEŽINA GASTROINTESTINALNOG TRAKTA (g) | | | | | | |
| 53 days - dana | Slaughter weight | | | | | |
| | Težina kod klanja | 390.03 | 0.1412 | 0.017 | - | |
| 67 days - dana | Slaughter weight | | | | | |
| | Težina kod klanja | 425.02 | 0.1665 | 0.006 | - | |
| RELATIVE PORTION OF SMALL INTESTINE (%) - RELATIVNI UDIO TANKOG CRIJEVA (%) | | | | | | |
| 53 days - dana | | | | | | |
| 67 days - dana | Slaughter weight | | | | | |
| | Težina kod klanja | 21.05 | 0.0060 | 0.040 | - | |
| RELATIVE PORTION OF GROSS INTESTINE (%) - RELATIVNI UDIO DEBELOG CRIJEVA (%) | | | | | | |
| 53 days - dana | | | | | | |
| 67 days - dana | Slaughter weight | | | | | |
| | Težina kod klanja | 14.77 | -0.0073 | 0.014 | - | |
| RELATIVE PORTION OF CECUM (%) - RELATIVNI UDIO CEKUMA (%) | | | | | | |
| 53 days - dana | Slaughter weight | | | | | |
| | Težina kod klanja | 34.67 | -0.0055 | 0.228 | 0.00003 | 0.067 |
| 67 days - dana | Slaughter weight | | | | | |
| | Težina kod klanja | 34.46 | 0.0077 | 0.031 | - | |

p - level of significance – p - razina značajnosti

Data were subjected to analysis of variance using Mixed model least squares and maximum likelihood computer program PC-1 (W.R. Harvey, 1987). The influences of feed composition, probiotic addition, interaction between feed and probiotic addition and sex on tested traits were studied.

## RESULTS

Regression was used to eliminate the influence of rabbits slaughter weight on tested traits where it showed to be significant ($p \leq 0,10$) except for dressing percentage where weaning weight was considered (table 2).

At the age of 67 days the correlations were more distinctive. Animals with higher weaning weight had better dressing percentage. Except for relative portion (RP%) of stomach other traits were correlated to slaughter weight. Animals with higher weight at slaughter had higher carcass weight and weight of GI tract, RP% of small intestine and cecum was higher while RP% of large intestine was lower.

The influence of feed composition (regardless of probiotic) on tested traits is shown in Table 3.

Content of nutrients in feed had an important influence on dressing percentage in both groups. Dressing percentage appeared to be the best when high-level energy feed with medium ADF content (feed III) was fed, expecially due to increased carcass weight and decreased weight of GI tract including its content (lower feed intake). As expected, the dressing percentage in the second group was higher as, unlike younger animals, those rabbits had already reached slaughter maturity. Krajnc (1989) reported similar influence of age and feed energy level. Carcass weight and weight of GI tract were higher in older animals.

Feed obviously affects GI tract weight as well as relative portions of separate parts, especially RP% of cecum and large intestine. Feed with high energy level (III) caused decreased weight of GI tract and increased RP% of gross intestine thus on behalf of decreased RP% of cecum. Cecum adapted faster to varying energy levels in feed than stomach. Gidenne (1992b) found lower weight of GI tract at almost the same weight and age at slaughtering but he also found similar influence of feed on separate parts of GI tract. Lebas et al. (1982) reported siilar weights of GI tract while the increased CF content in feed caused increased cecum content weight only. Similar effect of feed on cecum weight was observed by Hoover and Heitmann (1972) and Gidenne (1992b) while other authors reported increased cecum weight only when feed with very low CF content - below 90 g CF/kg feed - was fed (de Blas et al., 1986) or low lignin content (Fraga et al., 1991) i.e. feed with high energy level (Dehalle, 1981).

The intake of feed I was the highest due to lower energy level, thus leading to increased weight of GI tract in the trial group. Cecum developed better as it received more substratum for microbial degradation which can improve fiber digestibility (Gidenne, 1992b).

In younger animals most of GI tract traits did not differ significantly, but with growing age these differences became more important. Rabbits require longer period to adapt to certain feed. Gidenne (1992b) found good adaptability of GI tract to feed in growing rabbits after 6 weeks of feeding.

Addition of composed probiotic (regardless of feed) influenced weight of GI tract, RP% of stomach and cecum in 67 days old rabbits (Table 4).

The addition of AP4W decreased GI tract weight despite equal feed intake, which was the reason for slightly improved dressing percentage (52,26% compared to 51,21% with no addition of AP4W). Fausch (1981) established higher digesta passage through GI tract due to higher lactic acid concentration. Probiotic addition inhibits effect of pathogen microorganisms, hence it lowers the pressure on immunity mechanisms in intestine wall. This may cause thinner intestine mucous membrane and consequently better absorption of nutrients and better digestibility of feed. Decreased weight of intestine mucous membrane also means fewer proteins and other nutrients for regeneration since it is one of the most active tissues in the organism. Cheeke et al. (1989) found that addition of probiotics and acidifiers improves protein utilization in rabbits. Thinner intestine mucous membrane (and consequently faster absorption of nutrients) as well as faster digesta passage might be a reason for lower weight of GI tract where AP4W was added.

**Tablica 3. Utjecaj krmnih smjesa na testirane osobine kunića s eliminiranim utjecajima najvažnijih svojstava**

**Table 3. Influence of feed mixtures on tested traits of rabbits with eliminated influences of the most important traits**

| | FEED - HRANA | | | Signif. of differences (p) | | |
|---|---|---|---|---|---|---|
| Trait - Svojstvo | I | II | III | I-II | II-III | I-III |
| DRESSING PERCENTAGE (%) - RANDMAN (%) | | | | | | |
| 53 days - dana | 48.45 | 48.55 | 51.00 | 0.892 | 0.004 | 0.003 |
| 67 days - dana | 51.55 | 50.79 | 52.86 | 0.214 | 0.004 | 0.030 |
| CARCASS WEIGHT (g) - TEŽINA KARKASA (g) | | | | | | |
| 53 days - dana | 840 | 850 | 887 | 0.474 | 0.019 | 0.013 |
| 67 days - dana | 1129 | 1110 | 1138 | 0.179 | 0.067 | 0.582 |
| GASTROINTESTINAL TRACT WEIGHT (g) - TEŽINA GASTROINTESTINALNOG TRAKTA (g) | | | | | | |
| 53 days - dana | 398.2 | 392.9 | 378.9 | 0.726 | 0.365 | 0.275 |
| 67 days - dana | 426.5 | 453.7 | 394.9 | 0.095 | 0.002 | 0.075 |
| RELATIVE PORTION OF STOMACH (%) - RELATIVNI UDIO ŽELUCA (%) | | | | | | |
| 53 days - dana | 26.5 | 28.9 | 31.4 | 0.172 | 0.178 | 0.012 |
| 67 days - dana | 29.5 | 30.9 | 28.4 | 0.214 | 0.047 | 0.339 |
| RELATIVE PORTION OF SMALL INTESTINE (%) - RELATIVNI UDIO TANKOG CRIJEVA (%) | | | | | | |
| 53 days - dana | 20.9 | 21.8 | 21.6 | 0.378 | 0.827 | 0.529 |
| 67 days - dana | 21.0 | 20.1 | 22.0 | 0.208 | 0.022 | 0.268 |
| RELATIVE PORTION OF GROSS INTESTINE (%) - RELATIVNI UDIO DEBELOG CRIJEVA (%) | | | | | | |
| 53 days - dana | 14.4 | 13.8 | 14.1 | 0.269 | 0.530 | 0.663 |
| 67 days - dana | 13.7 | 14.2 | 16.4 | 0.481 | 0.006 | 0.003 |
| RELATIVE PORTION OF CECUM (%) - RELATIVNI UDIO CECUMA (%) | | | | | | |
| 53 days - dana | 37.1 | 34.7 | 32.1 | 0.057 | 0.050 | 0.003 |
| 67 days - dana | 36.3 | 34.6 | 32.5 | 0.067 | 0.029 | 0.001 |

p - level of significance
p - razina značajnosti

**Table 4. Influence of probiotic addition in feed on tested traits of 67 days old rabbits, balanced regarding traits with the most important influence**

**Tablica 4. Utjecaj dodatka probiotika u krmu na testirana svojstva 67 dana starih kunića, uravnoteženih s obzirom na svojstva s najvažnijim utjecajem**

| | PROBIOTIC ADDITION - DODAVANJE PROBIOTIKA | | p of |
|---|---|---|---|
| Trait - Svojstvo | – | + | difference |
| DRESSING PERC. (%) - RANDMAN (%) | 51.21 | 52.26 | 0.103 |
| GASTROINTESTINAL TRACT WEIGHT (g) TEŽINA GASTROINTESTINALNOG TRAKTA (g) | 441.1 | 409.0 | 0.053 |
| RP% OF STOMACH (%) RELATIVNI UDIO ŽELUCA (%) | 31.0 | 28.2 | 0.021 |
| RP% OF CECUM (%) RELATIVNI UDIO CEKUMA (%) | 33.3 | 35.6 | 0.009 |

p - level of significance – p - razina značajnosti

The RP% of stomach in the second group significantly decreased where AP4W was added while cecum portion increased. As the result of probiotic addition the environment in cecum seems to be more favorable for development of wanted microorganisms, hence the amount of fermentation increases together with RP% of cecum on behalf of stomach RP%. Cheeke et al. (1989) reported decreased intake of cecotrops when either probiotics or acidifiers were added thus lower RP% of stomach in our trial might be that low due to decreased quantity of consumed cecotrops in stomach.

Addition of AP4W in separate feed significantly influenced dressing percentage, carcass weight and weight of GI tract. Interaction between feed and probiotics was proved as significant only in feed II, where the influence of AP4W addition was negative: it decreased both dressing percentage and carcass weight and increased weight of GI tract. In both marginal feeds (I and III) interaction had opposite (positive) influence, but nonsignificant.

Regardless of feed type, the addition of probiotics lowered the weight of GI tract (Table 4); obviously positive, although nonsignificant effects of AP4W in marginal feeds prevailed over negative influence in feed II.

Sex of trial animals influenced only stomach and cecum RP% at the age of 53 days (Table 5). RP% of cecum in females was higher mostly on behalf of the decreased RP% of stomach. Cecum in females develops sooner and has higher weight (Lopez et al., 1988). Considering equal feed intakes and equal live weight of females and males in trial, it would be interesting to study whether females start to consume feed mixtures sooner (in the period till weaning), this being the reason for faster cecum development.

## CONCLUSIONS

Feed composition had a significant influence on tested traits of growing rabbits. The most favorable influences were obtained when feed with high energy level and medium ADF content (feed III) was fed: the best dressing percentage and carcass weight and the lowest weight of GI tract including its content. Feed III increased RP% of large

intestine of behalf of decreased RP% of stomach and cecum. Feed III had the most favorable influences despite the high energy level which can be explained with adequate ADF content.

Addition of composed probiotic AP4W (regardless of feed) decreased weight of GI tract, which indicates better dressing percentage. RP% of stomach was lower on behalf of increased RP% of cecum. This may lead to better digestibility of feed with addition of probiotic.

Interaction between feed composition and probiotic addition appeared when dressing percentage as well as weight of carcass and weight of GI tract were tested. These interactions were significant only in feed II (medium DE and medium ADF content) and had a negative effect.

Considering established differences between sexes we would suggest standardization of sex for nutritional trials on growing rabbits.

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## SAŽETAK

Istraživan je utjecaj sadržaja energije i kiselih deterdžentnih vlakana (KDV) u hrani kao i dodavanje probiotika Acid-Pak 4-Way (AP4W) i njegov utjecaj interakcije na razvoj gastrointestinalnog trakta (GI) i randman (RP%) odbitih bijelih New Zealand kunića. Testirane su tri kompletne krmne smjese s različitom količinom probavljive energije i sirovih bjelančevina, svaka s ili bez dodatka probiotika AP4W. Visoka količina energije u hrani signifikantno ($P \leq 0,05$) povećava RP% i težinu karkasa a smanjuje težinu GI. Stupanj udjela smanjenja težine cekuma rezultat je visokog sadržaja KDV u hrani. Probiotik signifikantno smanjuje težinu GI što ukazuje na tendenciju boljeg RP%. Relativni udio želuca (RUŽ) bio je smanjen u korist povećanja relativnog udjela cekuma (RUC). Interakcija između hrane i probiotika nije bila signifikantna.