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The effect of feed enzymes on nutrient and energy retention in young racing pigeons

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Abstract — Eight nests of two squabs were weaned at 24 days then housed in individual cages. A squab of each nest received a commercial feed for racing pigeons, the other group received the same feed but supplemented with xylanase, β-glucanase, pectinase and hemicellulase. No difference in body weight was observed between groups. Despite feed restriction, intake was higher for enzyme-supplemented diet. When related to feed intake, excreta were lower by 11% for enzyme-supplemented diet. Enzyme addition improved dry matter, organic matter, protein, energy and fibre retention. These results may show that pigeons are more sensitive to enzymes than common poultry.

pigeon / enzymes / growth / metabolizable energy

Résumé — L'effet d'enzymes alimentaires sur la rétention des nutriments et de l'énergie chez les pigeons voyageurs. Huit nids de deux pigeonneaux ont été répartis dans des cages individuelles après le sevrage à 24 jours d'âge. Un pigeonneau de chaque nid recevait une ration supplémentée avec des enzymes (xylanase, β-glucanase, pectinase et hémicellulase), tandis que l'autre recevait la même ration sans enzymes. Aucune différence de poids corporel n'a été observée entre les deux groupes. Malgré la restriction alimentaire, il y a eu une augmentation significative de l'ingestion avec la ration enrichie en enzymes. La production d'excréments exprimée par rapport à l'ingestion, a été de 11 % plus faible dans le groupe supplémenté que dans le groupe témoin. L'addition des enzymes a amélioré la rétention de la matière sèche, de la matière organique, des protéines, de l'énergie et des fibres. Cette influence positive des enzymes serait plus importante chez les pigeons que chez les poulets de chair.

pigeon / enzymes / croissance / énergie métabolisable

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1. INTRODUCTION

Pigeon fancying is spread worldwide and also the production of meat pigeons is seen as a valuable alternative to common poultry in several countries. Nutritional research on this species thus becomes relevant.

Feed enzymes have been investigated in a wide range of animal species, for instance pigs and chickens [1]. To date, data on the effects of feed enzymes in racing pigeons are very limited or non-existing. However, several arguments can be put forward to support investigations on the use of feed enzymes in racing pigeons. The use of pellets in commercial feeds for racing pigeons is still marginal. Pigeon feeds mainly consist of whole grains and seeds while minerals, vitamins and some other nutrients are provided as separate supplements. Hence, their nutrition differs greatly from other domesticated avian species like chickens or turkeys. A crude extrapolation of findings in common poultry will therefore not be possible. Nevertheless, the fact that feed enzymes are now successfully incorporated in most poultry feeds and that pigeon feed ingredients contain the same non-digestible carbohydrates as poultry feeds, give evidence for a potential of feed carbohydrases in improving nutrient retention in pigeons as well.

The present study investigated whether a cocktail of carbohydrases could improve the retention of major nutrients and growth performance in young racing pigeons after weaning.

2. MATERIALS AND METHODS

Eight nests of two pigeon (*Columba livia domestica*) squabs each were weaned at an age of 24 days and divided into two equal groups in a way that each group had a squab of each nest. All squabs were housed in individual metabolism cages on wired floor.

Water was freely accessible. A solid mineral supplement and a mixture of ground shells and stones (Dufky Ltd., Ghent, Belgium) were available ad libitum. Although these supplements made the protocol more complex, they are necessary to supply minerals and to maintain the proper functioning of the gizzard and crop.

One group (CON) received a commercial mixture of grains and seeds (Elite Jonge Duiven Super, Dufky Ltd., Ghent, Belgium). The other group (ENZ) was given the same feed but supplemented with feed enzymes (Elite EnzyMix Jonge Duiven Super, Dufky, Ghent, Belgium). The composition of the feeds is shown in Table I.

A preliminary period of two weeks served to obtain a constant ingestion of the feed and to accustom the animals to their respective feed. During this period, data on ad libitum feed intake were gathered. In the beginning and at the end of this period, all animals were weighed individually.

After the preliminary period, all pigeons were fasted until the next morning, and then a 13 d-collection period was started. In the beginning and at the end of this period, all animals were weighed and intake of ground shells and stones and mineral supplement were recorded. During this collection period, the animals received the same feed as in the preliminary period, but the amounts were restricted to about 90% of the average ad libitum intake in the preliminary period. This measure was taken to set a fixed feed intake in order to allow the calculation of retentions without having knowledge on the exact transit rate of the feeds through the digestive system.

Individual feed and water intakes were measured daily. From the second day of the collection period, excreta were collected daily for each pigeon and were immediately stored at –20 °C after weighing. The excreta samples were pooled per pigeon in order to get sufficient sample volume for all analyses. Each day, the excreta were also visually checked for their consistency.

The excreta were filtered for contamination with spoilage from the mineral

Table I. Composition of the experimental diets and enzyme concentration in the enzyme supplemented feed.

Chemical composition	$g \cdot kg^{-1}$	*Ingredients*[4]	$g \cdot kg^{-1}$
Moisture(1)	124	Peas	600
Crude ash(1)	22	Wheat	240
Ether-extract(1)	35	Milocorn	120
Crude protein(1)	174	Safflowerseed	40
Crude fibre(1)	60		
Organic matter(1)	854	*Enzymes*(5)	
Starch(2)	505		
Free sugars(2)	32	Fungal xylanase	$0.55\ F.X.U \cdot kg^{-1}$
Nitrogen-free extract	585	Fungal β-glucanase	$0.41\ F.B.G \cdot kg^{-1}$
Apparent metabolizable energy ($MJ \cdot kg^{-1}$)(3)	12.7	Pectinase	$36\ P.S.U \cdot kg^{-1}$
		Hemicellulase	$0.9\ kV.H.C.U \cdot ml^{-1}$

(1) Obtained by Weende analysis.
(2) Calculated from CVB [2].
(3) Calculated according to Larbier and Leclercq [6].
(4) As formulated.
(5) As formulated; Novo Nordisk (Bagsvaerd, Denmark).

supplement, ground shells and stones or feathers. Then, the samples of the two feeds and excreta samples were lyophylised and subjected to proximate analysis to determine their contents of dry matter (DM), crude protein (CP = 6.25 × nitrogen), crude fibre (CF), ether-extract (EE) , starch (St.), free sugars (Su.), nitrogen-free extract (NFE) and organic matter (OM). The gross energy content (GE) was calculated according to Schiemann et al. [9]:

$$GE\ (kJ \cdot kg^{-1}) = 23.3\ CP + 39.5\ EE + 20.0\ CF + 17.4\ NFE$$

with CP, EE, CF and NFE being expressed in $g \cdot kg^{-1}$. For all of these components, the retentions were calculated by dividing the amount in the excreta by the amount in the feed of each component. An a priori estimate of the apparent metabolizable energy content (AME) was calculated according to an accepted formula for poultry [6]:

$$AME\ (kJ \cdot kg^{-1}) = 15.5\ CP + 34.3\ EE + 16.7\ St. + 13.0\ Su.$$

with CP, EE, St. and Su. expressed in $g \cdot kg^{-1}$. The intake of mineral supplements and ground shells and stones was neglected in these calculations.

Analyses of variance, paired t-tests and calculation of means and standard errors were performed by SPSS 7.5 (SPSS Inc., Chicago, IL, U.S.A.). Data are presented as means ± standard deviation.

3. RESULTS

3.1. Body weight

During the preliminary period, the animals grew from 432 ± 37 g to 448 ± 50 g ($P = 0.049$). All animals lost weight to 419 ± 47 g immediately after the preliminary period due to fasting ($P < 0.001$), but also in the collection period, body weight decreased slightly towards 412 ± 43 g ($P < 0.001$). At no point, significant differences were seen between the groups.

3.2. Feed and water intake

The calculated gross energy content of the feed was 16.9 MJ·kg^{-1}. Despite restriction to about 90% of the ad libitum feed intake, i.e. 30.0 ± 0.5 g per pigeon per day, the feed was not always consumed completely. In the CON group, feed consumption was significantly less than in the ENZ group (Tab. II). The incomplete ingestion was not considered to be a drawback on the trial as the individual feed intakes were still fairly constant over the days (data not shown). Water intake was not significantly different between groups.

3.3. Excreta

No significant differences were seen on the daily excreta production, but when related to the feed intake, the ENZ group produced 11% less excreta than the CON group (Tab. II). When also water intake was taken into account, the decrease was 10%.

The moisture contents in the excreta of CON and ENZ were 702 ± 15 g·kg^{-1} and 687 ± 28 g·kg^{-1}, respectively. This non-significant difference could neither be noticed.

3.4. Retention

Table II indicates that, although not significant for each parameter, each component's retention was increased due to carbohydrase supplementation. Significant improvements were noted on the retention of dry matter (+ 3%), crude protein (+ 27%), organic matter (+ 3%) and energy (4%). An improvement of 39% on the retention of crude fibre almost reached the level of significance.

4. DISCUSSION

The incomplete ingestion of the feed in the collection period was probably a consequence of a diminished nutritional requirement as the animals were reaching the end of the sigmoid growth curve. Experiments have demonstrated the fast initial growth of pigeon squabs due to crop-milk feeding [12].

Table II. The water and feed intakes, the production of excreta in relation to water and feed intakes and the retentions during the collection period (mean ± standard deviation; $N = 8$).

Collection period	*CON*	*ENZ*	*P-value*
Feed intake (g per day per pigeon)	27.4 ± 1.0	29.1 ± 1.2	0.015
Water intake (g per day per pigeon)	32 ± 6	33 ± 4	N.S.
Excreta (g per day per pigeon)	24.6 ± 2.0	23.3 ± 2.4	N.S.
Excreta (g per g feed)	0.90 ± 0.05	0.80 ± 0.05	0.010
Excreta (g per g feed+water)	0.41 ± 0.04	0.37 ± 0.03	0.005
Retention of dry matter (%)	69.6 ± 1.0	71.8 ± 1.1	0.009
Retention of crude protein (%)	22.0 ± 1.6	27.9 ± 3.5	0.002
Retention of ether-extract (%)	86.5 ± 1.8	87.7 ± 0.8	N.S.
Retention of crude fibre (%)	18 ± 4	25 ± 5	(0.058)
Retention of organic matter (%)	72.1 ± 0.9	74.3 ± 0.8	0.002
Retention of nitrogen-free extract (%)	91.7 ± 1.2	92.2 ± 0.9	N.S.
Retention of energy (%)	69.4 ± 0.9	71.8 ± 0.9	< 0.001

[1] CON = group without enzyme supplements;
[2] ENZ = enzyme supplemented group; N.S. = not significant (P ≥ 0.05).

The fact that the birds were reaching their adult weight rapidly, would have contributed to the lack of growth differences between the groups. The slight weight loss during the collection period could give a minor misestimation of retention figures, but as no significant differences in weight loss were seen between the groups, the differences in retention found between the groups is still valid.

It is interesting to compare the content of AME (12.7 $MJ \cdot kg^{-1}$) as calculated by a formula for common poultry with the figure that can be derived from this experiment: when the retention of the energy for the control group (69.4%) is taken as a measure for apparent retention of the energy, and combined with the level of gross energy (16.9 $MJ \cdot kg^{-1}$), the AME content obtained is 11.7 $MJ \cdot kg^{-1}$. Taking into account that the AME formula of Larbier and Leclercq [6] was probably based on meal feed and that the developmental stages of the pigeons were relatively more towards adult weight than in chickens, the formula of Larbier and Leclerq gave a reasonably close estimation of the apparent metabolizable energy content.

Several studies have shown that non-starch-polysaccharide degrading enzymes, like xylanase and β-glucanase, in a wheat-based diet can have a considerable reducing effect on the intestinal viscosity and a subsequent improvement of the consistency of the excreta [8, 11]. That is considered to be a beneficial action in the prevention of infection, because it keeps the litter dryer [10]. In the present study, the consistency of the excreta was not visibly altered, and the moisture content of the excreta was not significantly decreased. The absence of an effect on water intake also indicates that the water balance was not altered. In the above mentioned publications, the increase in nutrient utilisation is in most cases linked to a decrease in intestinal viscosity. Based on crude parameters, being the moisture content and the subjective consistency of the excreta, no evidence was provided for this action in the present study. A possible explanation for the absence of such an effect could be that poultry feeds usually contain about twice as much wheat as in the present pigeon feed.

The trend towards a large improvement of the crude fibre fraction is evidently a consequence of the direct action of the added enzymes on the cell wall components. In agreement with the theory that cell wall degradation will make other nutrients more available for digestive processes, the enzyme supplementation significantly increased the retention of crude protein, organic matter, energy and the total dry matter.

In broiler trials, where similar enzyme blends to the present study were used in a soybean-rich diet, no beneficial effects of enzyme addition were shown [3, 7]. Other studies with diets based on barley or wheat found increased values for the excreta/feed ratio, N-retention, metabolizable energy and overall growth performance in broilers when using xylanase and β-glucanase [4, 5]. This indicates that the usefulness of feed enzymes will depend on several factors, including diet composition and genotype. Nevertheless, this study demonstrated that feed enzymes in pigeon nutrition can induce very clear improvements on the retention of nutrients and energy.

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