Effects of Wheat Stràw as A Chipper Source of Fiber in Present of Prebiotic or Probiotic on Caecal Fermentation, Digestibility and Growth Performance in Rabbits

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Abstract: Sixty three male New Zealand White rabbits, 35 days old, with an average initial weight of 678.8 ± 86.6 g were used in this experiment. Animals were divided randomly equally into seven groups (nine each) with nearly equal mean group body weights. Each group was assigned at random to one of the treatments. Four pelleted diets were used in the study. The first diet (diet C), contained 30% alfalfa hay (control-0% wheat straw). In the other three diets, wheat straw were included at levels of 10 (diet A); 20 (diet B) and 30% (diet D) to replace 33, 66 and 100% of the alfalfa hay in the control diet; with pre- (15 ml/L lactulose in drinking water) or pro-biotic (15 g/L Biogin in drinking water), respectively. The four diets contained 17.84, 17.49, 17.34 and 17.62% crude protein and were formulated to meet or exceed the essential nutrient requirements of growing rabbits. The experiment lasted for 8 weeks. The traits studied were growth performance (Daily gain in weight and Feed conversion ratio), nutrients digestibility (Dry and organic matter, crude protein, ether extract, crude fiber and NFE), neutral detergent fiber (NDF) digestibility and caecal digestion. Digestible and metabolizable energy was relatively higher in the second group (33% alfalfa hay substitution with lactulose) than other groups. Results revealed that dry and organic matter intake was a little a bit higher in the control group than other groups. On the other hand, daily gain of rabbits fed experimental diet which contained wheat straw was none significantly lower than those fed the control diet. Furthermore, the NDF digestibility was the highest in the control group. However, diet A that contained 10% wheat straw (33% alfalfa hay substitution) supplied with lactulose (prebiotic) showed a slight increase in dry and organic matter along with energy intake, than that with biogen (probiotic), On the contrary, the groups with higher alfalfa hay substitutes, B and D, benefited better from adding the biogen. Rabbit fed on the diets containing wheat straw, especially with the high level of wheat straw, in the presence of pre-biotic or pro-biotic had the best economical efficiency compared to the control diet.

Keywords: Rabbit; wheat straw; prebiotic; probiotic; growth performance; caecal fermentation; digestibility.

INTRODUCTION

Rabbits can utilize low-grain and high-roughage diets (McNitt *et al.,* 1996). The digestive system of the rabbit is characterized by the relative importance of the caecum and colon when compared with other poultry and small animals species (Portsmouth, 1977). Furthermore, coprophagy, the behaviour of ingestion of soft faeces of caecal origin, makes microbial digestion in the caecum more important for the overall utilization of nutrients by the rabbit. Because of the caecum, which contained microflora that has the ability to convert the cellulose of by-products into sugars and single cell protein, rabbit can be a semi ruminant (Cheeke *et al.,* 1986). Commercial rabbitries throughout the country normally feed a complete pelleted diet (alfalfa-based) enriched in general with various supplemental nutrients. Moreover, feeding high quality roughage sources such as alfalfa hay to animals is economically and nutritionally unjustifiable. Wheat straw a low priced roughage sources, can be utilized as a substitute source of crude fiber in rabbit diets to decreases the cost of feeding and consequently the sale price of animal products.

Dietary fiber commonly helps rabbits to maintain high rate of *ingesta* passage, avoiding the accumulation of *digesta* in the cecum that reduces feed intake causing impaired growth (De Blas *et al.,* 1999). Dietary fiber is a substrate for cecal fermentation by micro-organisms and micro-flora. Gidenne, (1996) concluded that rabbit cecal fermentation produces mainly volatile fatty acids (VFA), that a part from supplying energy to the animal, may reduce the incidence of digestive disorders (*i.e* necessary for digestive system integrity). Cecal fermentation also increases the supply of high-quality microbial protein to be ingested yet again through cecotrophy. As a consequence of the role of the caecum, the microbial activity is of a great importance for the processes of digestion and nutrient utilization.

Treatment of poor quality roughage may improve the nutritive value of diets and rabbit performance as reported by Radwan *et al.* (1983). Many processes can be done to help rabbits to digest the poor quality by-products. Many additives like probiotic and prebiotic may reduce the viscosity of intestinal contents. Probiotic have been defined as a live microbial feed supplements with beneficial effect on the host animal by improving its microbial balance (Fuller, 1989). It strengthens the animal's own non specific immune defense (Fortum and Drouet, 2000) and/or decreases the frequency of E.Coli translocation and prevents the growth of E. Coli in the intestine of rabbit (Lee, *et al.,* 2000). Prebiotic have been defined as a montage food ingredient beneficially affects the host by selectively stimulating the growth or activity of one or a limited number of bacteria in the colon and thus improves host health (Gibson and Roberfrod., 1995).

The objective of the present study is to investigate the effects of feeding growing rabbits complete pelleted diets containing wheat straw, as replacement to Alfalfa hay, with or without the presence of prebiotic or probiotic on various nutrients digestibility ((Dry and organic matter, crude protein, ether extract, crude fiber and NFE), cecum characteristics (neutral detergent fiber, NDF, digestibility and caecal digestion) and growth performance (Individual live weight, Daily gain in weight, feed consumption and Feed conversion ratio).

MATERIALS AND METHODS

The present (60 days period) experiment was conducted in the Rabbitry Research Farm, College of Agriculture, Suez Canal University, Ismailia, Egypt. Sixty three weanling male New Zealand White rabbits, 35 days old, and averaged 678.8 ± 86.6 g body weight were used. Animals were housed in individual hutches arranged in two rows. The rabbitry that has a concrete floor was designed to ensure cross ventilation and to exclude rodent and other pests. Each rabbit was provided with a metallic feeder hanged at a reasonable height in the cage to prevent feed wastage. All animals were set aside under the same managerial, hygienic and environmental conditions.

Animals were divided equally into seven experimental groups (nine animals each) with nearly equal group mean body weights. Four pelleted diets were used in this study. The first diet contained 30% alfalfa hay and served as a control diet (0% wheat straw, diet C). In the other three diets, wheat straw were included at levels of 10 (diet A); 20 (diet B) and 30% (diet D) to replace 33, 66 and 100%, respectively, of the alfalfa hay in the control diet. The four diets contained 17.84, 17.49, 17.34 and 17.62 % crude protein and were formulated to meet or exceed the essential nutrient requirements of growing rabbits, according to NRC (1977). Animals were allotted to seven experimental groups; the control group fed the diet C. The first three groups fed diets A; B or D with prebiotic (15 ml/L lactulose in water). The last three groups were fed the same A; B or D diets with probiotic (15 g/L Biogin in water). Rations were offered to the rabbits *ad libitum* and fresh water was automatically available all the time by stainless steel nipples throughout the experimental period. The chemical composition of the ingredients and experimental diets are shown in Table (1). Individual live weight, feed consumption and feed conversion were recorded weekly during the experimental period.

Table (1): Composition and proximate analysis of the experimental diets

Ingredients %	Control (C)	Level of wheat straw replacement (%)		
		33% (A)	66% (B)	100% (D)
Maize	25	24	23	23
Wheat bran	23	22	21	20
Sun flower meal	3	4	4	3
Soya bean meal	10	11	13	15
Malt	5	5	5	5
Alfalfa hay	30	20	10	0
Wheat straw	0	10	20	30
Methionine	0.3	0.3	0.3	0.3
Salt	0.5	0.5	0.5	0.5
Limestone	1	1	1	1
Molasses	1.9	1.9	1.9	1.9
Minerals and vitamin mix [a]	0.3	0.3	0.3	0.3
Proximate analysis, % of dry matter				
Crude protein	17.84	17.49	17.34	17.62
Crude fiber	12.51	12.03	12.72	12.91
Ether extract	2.15	2.1	1.75	1.96
Nitrogen free extract	57.99	58.89	58.40	56.28
Ash	9.51	9.49	9.79	11.23
Energy MJ/kg DM	10.49	10.47	10.47	10.47
Fiber fraction				
Neutral detergent fiber (NDF)	40.7	40.9	41.2	41.7
Acid detergent fiber (ADF)	21.8	22.2	22.7	22.3
Lignine	2.12	2.22	2.29	2.31

[a]Composition of the mineral and vitamin premix (per 1 kg): Vitamin A, 4,000,000 IU; Vitamin D3, 50,000 IU; Vitamin E, 16.79 g; Vitamin K, 0.67 g; Vitamin B1, 0.67 g: Vitamin B2, 2.0 g; Vitamin B6, 0.67 g; Vitamin B12, 0.004 g; Pantothenic acid, 6.67 g; Biotin 0.07g; Folic acid, 1.67 g; Choline chloride, 400g; Mn, 10 g; Zn, 23.3 g; Fe, 25 g; Ca, 1.67 g; I, 0.25 g; Se, 0.033 g; and Mg 133.4mg.

Digestibility trails were carried out at the last week of the feeding experiment. During the collection period of 5 days, total faeces voided were daily weighed, wrapped in aluminum foil and dried in an oven at 60°C until constant weight. The dried faecal samples were ground and stored for analysis. Proximate analysis of the diets and faeces were carried out according to the methods of AOAC (1990). Composite samples of daily urine (containing 10% H_2SO_4 solution to fix the nitrogen) were collected for each animal over the collection period for nitrogen determination.

Cecotrophy trial:

All the experimental rabbits were used in a digestibility trials, a wooden collar (150 g and 25 cm diameter) was put on each animal to prevent the ingestion of soft feces (cecotrophy). The collar was put on at 6:00, half an hour after the light was switched on and was removed 24 h later. The collected soft feces were stored at -20 °C. Feed intake was recorded for 3 day before the collar was placed, and the animals were weighed just before the collar was placed. Seven days later the same procedure was repeated to determine more precisely an average soft feces excretion. Soft feces were then freeze-dried till being analyzed.

Cecal trial:

Seven days after the last cecotrophy control, the animals were slaughtered by cervical dislocation at the time of 18:30, to avoid the cecotrophy period. The gastrointestinal tract was removed and weighed. The stomach and cecum were weighed separately with and without their contents. The pH was measured in the cecal contents. Cecal content was immediately divided into two samples; one was dried at 80 °C and used to determine buffer capacity. The other sample was centrifuged at 2500 rpm for 10 min. The supernatant fluid was used to determine ammonia nitrogen (NH_3-N) and total VFA's concentration. A solution of 5% orthophosphoric acid plus 1% mercury chloride was added (0.1 mL/mL) to the samples for total VFA's determination. Samples for ammonia nitrogen determination were acidified with a solution of 0.2 *M* hydrochloric acid. The fluid pH values were immediately determined by a digital pH-meter. NH_3-N concentration was determined according to *Conway (1957).* Total volatile fatty acids (VFA's) were determined by the steam distillation method as described by Warner (1964). Fibre fractions were determined following Van Soest method (Van Soest, *et al.*, 1991).

Economical efficiency (Y):

At 13 weeks of age was calculated according to the following equation; [Y= {(A- B) / B} x 100], where A is the selling price of the obtained gain and B is the feeding cost of this gain.

Statistical analysis:

for all studied parameters were analysed statistically using the Statistical Analysis Systems (SAS, 1999). The linear mathematical model for the analysis comprised the effect of treatment as the sole source of variation (One-way analysis of variance). Significant differences among means were evaluated using Duncan's Multiple Range Test (Duncan, 1955).

RESULTS AND DISCUSSIONS

Nutrients digestibility:

The digestibility coefficients, digestible energy and metabolizable energy of the experimental diets fed to rabbits are presented in Table (2). Dry and organic matter intake levels were somewhat higher in the control group (C) than that of the other groups fed diets contained wheat straw A; B or D. However, levels of digestible and metabolizable energy were slightly elevated in the second group (A) than other groups. These results can be attributed to the effect of pro- or pre-biotic which may alter the bacterial population in the cecum of rabbits, which in turn may affect the digestibility of dietary components and consequently alter the end products of the ongoing fermentation (Lowery *et al.*, 1969). On the other hand, Rabbits in group A consuming the diet contained 10% wheat straw in presence of lactulose showed slightly higher dry matter, organic matter and energy intake, than the same diet in presence of biogen, As for the other two with higher replacements, B and D, Adding the pro-biotic was the most beneficial. These results may be due to lactulose got more of its effect with low diet content of wheat straw because it only supplies the microorganism with energy. However, it is intended from a pre-biotic to increase the number and/or activity of microorganism. However, in diets with high content of wheat straw (B and D) it is necessary to have a great number of microorganism to deal with this large amount of harsh fibers using part of dietary energy for the process of fiber decomposing. In general, all digestibility coefficient values were not significantly changed with rabbits fed the other three diets contained wheat straw, compared to control group except for crude protein which was significantly higher ($P< 0.05$) in diets B and D, compared to other two diets (i.e. A and C). The later result may be due to the presence of higher microbial population in the caecum together with the copropagy permits rabbits to recycle the resultant energy and amino acids. These results are in agreement with those of Gouet and Fonty, (1973); Forsythe and Parker (1985); and Marounek *et al.* (1995).

Digestibility of NDF and caecal digestion:

The NDF digestibility, pH, total volatile fatty acid and ammonia nitrogen (NH_3-N) concentration in caecum subject matter of rabbit fed the experimental diets are presented in Table (3). Neutral detergent fiber (NDF) digestibility showed slight increase in the second group (A) than that in the other groups apart from pre and pro-biotic remedy. These results are mainly related to the effect of pre- or pro-biotic therapy which may alter the bacterial population in the cecum of rabbits, especially, the capacity of the caecum is approximately 0.49 of the total capacity of the digestive tract, Which in turn may affect the digestibility of dietary components and consequently alter the end products of fermentation (Lowery *et al.*, 1969). The NDF digestibility ranged between 23.12 and 25.93%. However, all experimental diets showed similar values of caecal pH (5.3, on average). These results are in agree with those reported by Carabaño *et al.* (1988) who found that pH value of the caecal contents was slightly acidic (5.6 – 6.2).

Growth Performance:

Data of Table (4) showed that the dry matter intake and weight gain of rabbits fed the experimental diets contained wheat straw were not significant lower than that of rabbits fed the control diet. In addition, feed conversion ratio of rabbits received diets including wheat straw with pre- or pro-biotic resulted in increased feed conversion ratio by about 7- 14 % than that of diet C. These results may be attributed to the higher microbial activity in rabbits' cecum with the increased content of wheat straw reconcile with pre- or pro-biotic additions which affect the cecal acidity and contents' weight. The later situation may reduce feed intake and cause performance to be impaired. These results reported herein are in harmony with those reported by McNitt *et al.* (1996).

Economical efficiency:

Data of Table (5) revealed that the cost of total consumed feed decreased with increasing the level of wheat straw in rabbit diets up to 20% (diet B). However, rabbit fed on diets containing wheat straw with pre- or pro-biotic had the best economical efficiency compared to diet C, the situation that is more pronounced with the level of wheat straw getting higher.

Table (2): Effect of treatments on nutrients digestibility.

	Control	33% Substitution (A)		66% Substitution (B)		100% Substitution (D)	
	(C)	Lactulose	Biogen	Lactulose	Biogen	Lactulose	Biogen
Daily intake (g/head/day)							
Dry matter	81.74	80.71	77.85	72.71	74.24	72.56	75.22
Organic matter	73.97	73.05	70.46	65.59	66.97	64.41	66.77
Digestibility coefficients							
Dry Matter	62.41±1.6	63.62±0.6	62.96±0.6	64.85±0.7	63.47±0.7	62.72±0.8	61.99±0.8
Organic matter	64.22±1.7	65.53±1.7	64.84±1.7	65.61±0.8	64.91±0.8	64.32±0.9	63.72±0.9
Crude protein	67.14^b±1.1	68.45^b±1.1	68.23^b±1.1	70.75^a±0.9	71.22^a±0.9	72.66^a±0.7	71.96^a±0.7
Ether extract	66.55±0.9	67.95±1.9	66.95±1.9	67.75±0.9	65.82±0.9	65.45±0.8	64.81±0.8
Crude fiber	27.30±1.7	28.71±1.7	29.69±1.7	28.95±0.8	29.69±0.8	28.26±0.9	29.59±0.9
Nitrogen free extract	71.61±1.8	72.62±1.8	73.82±1.8	74.04±0.9	73.94±0.9	74.35±0.1	73.84±0.10
DOMD	47.50	47.87	45.69	43.03	43.47	41.43	42.55
DE (MJ/kg DM)*	9.03	9.10	8.68	8.18	8.26	7.87	8.08
ME (MJ /kg DM)**	7.13	7.18	6.85	6.45	6.52	6.21	6.38

a,b Means with different superscripts in the same raw differ significantly ($P < 0.05$).

* Digestible Energy (DE) = 0.19 x Digestible organic matter digestibility (DOMD) in g/100g.

** Metabolisable energy (ME) = 0.15 x DOMD (MAFF, 1975).

Table (3): Effect of various wheat straw substitution treatments on Neutral detergent fiber (NDF) digestibility and caecal digestion traits

	Control	33% Substitution (A)		66% Substitution (B)		100% Substitution (D)	
	(C)	Lactulose	Biogen	Lactulose	Biogen	Lactulose	Biogen
NDFD, (%)	24.39	25.67	25.93	24.76	24.87	23.12	23.87
Soft feaces (g/d)	23.25	17.54	16.13	22.69	23.05	24.18	19.09
Body weight (BW g)	2289.0	2054.4	2073.4	2147.0	1898.2	1978.6	2022.5
Soft feaces/BW (g/100g)	1.02	0.85	0.78	1.06	1.21	1.22	0.94
Cecal DM (g)	93.00	70.17	90.27	92.20	99.53	64.33	68.50
DM (%)	32.29	38.38	38.63	46.14	40.31	38.18	34.69
pH	5.72	5.33	5.45	5.15	5.24	5.32	5.13
TVFA's (mmol/l)	62.2	63.4	64.6	64.9	65.5	65.7	66.2
$N\text{-}NH_3$, (mmol/l)	18.2	17.9	18.4	19.3	18.9	18.4	18.8

DM = dry matter

Table (4): Effect of treatments on growth performance

Trait (g/head/day)	Control (C)	33% Substitution (A)		66% Substitution (B)		100% Substitution (D)	
		Lactulose	Biogen	Lactulose	Biogen	Lactulose	Biogen
DM intake	81.74	80.71	77.85	72.71	74.24	72.56	75.22
Weight gain	26.2	22.61	22.83	21.76	21.77	20.97	22.06
Feed conversion	3.12	3.57	3.41	3.34	3.41	3.46	3.41

Table (5): Economic evaluation of the experimental diets.

	Control	33% Substitution (A)		66% Substitution (B)		100% Substitution (D)	
		Lactulose	Biogen	Lactulose	Biogen	Lactulose	Biogen
Price diet/kg	1.35	1.22	1.26	1.12	1.16	1.06	1.1
BW (kg)	2.289	2.054	2.073	2.147	1.898	1.978	2.022
Feed consumption (1-8 weeks)	4.577	4.519	4.359	4.071	4.157	4.063	4.212
Total feed cost (PT)	6.179	5.514	5.493	4.560	4.822	4.307	4.633
Average gain in weight (g)	1.467	1.266	1.278	1.218	1.219	1.174	1.235
Price/kg WG (PT)	16	16	16	16	16	16	16
Total revenue (PT)	23.475	20.258	20.455	19.496	19.505	18.789	19.765
Net revenue (PT)	17.295	14.744	14.962	14.936	14.683	14.481	15.132
Economic efficiency (E.E.)*	2.80	2.67	2.72	3.28	3.04	3.36	3.27
Relative economic efficiency	100.00	95.54	97.32	117.02	108.78	120.13	116.68

CONCLUSION

Diets contained wheat straw and reconcile with pre- (i.e. *lactulose*) or pro-biotic (i.e. *Biogen*) additions plays an imperative role in improving digestibility and productive performance as well as economic and relative economic efficiencies of the growing rabbits.

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تأثير استخدام تبن القمح مصدر رخيص للالياف فى وجود البروبيوتيك او البريبيوتيك على الاداء الانتاجى و الهضم و التخمر فى منطقة الاعور فى الارانب

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استخدم فى هذة الدراسة ٦٣ ذكر نيوزيلندى ابيض عمر ٣٥ يوم بمتوسط وزن ابتدائى ٦٧٨,٨± ٨٦,٦ جرامتم تقسيم هذة الارانب الى سبع مجاميع متساوية فى الوزن تحتوى كل مجموعة على سبع ارانب. تم تكوين اربع علائق مصبعة العليقة الاولى تحتوى على ٣٠% دريس برسيم و استخدمت عليقة كنترول. فى الثلاث علائق الاخرى تم ادخال تبن القمح بنسب ١٠، ٢٠، ٣٠% ليحل محل دريس البرسيم فى العليقة الكنترول بنسب احلال ٣٣، ٦٦، ١٠٠% على التوالى. و كانت العلائق مكونة لتفى بالاحتياجات الغذائية الارانب النامية و تحتوى على ١٧,٤٩، ١٧,٨٤، ١٧,٣٤ و ١٧,٦٢ % بروتين خام. تم تقسيم الحيوانات الى سبع مجاميع المجموعة الاولى تغذت على العليقة الكنترول تحتوى على (٠%من تبن القمح & ٣٠% دريس برسيم) و ثلاث مجاميع الثانية و الثالثة و الرابعة غذيت على ثلاثة علائق تحتوى الاولى على (١٠% تبن قمح &٢٠% دريس برسيم بنسبة احلال ٣٣%) و الثانية على (٢٠% تبن قمح &١٠% دريس برسيم بنسبة احلال ٦٦%) و الثالثة على (٣٠% تبن قمح &٠% دريس برسيم بنسبة احلال ١٠٠%) على التوالى فى وجود مصدر للبريبيوتيك و هو لاكتلوز مضاف الى الماء بمعدل ١٥ مللى لكل لتر ماء شرب. و فى المجاميع الثلاثة المتبقية الخامسة و السادسة و السابعة تم تقديم نفس الثلاث علائق السابقة و لكن فى وجود مصدر للبروبيوتيك و هو البيوجين مضاف الى ماء الشرب بمعدل ١٥ جرام فى اللتر.

و فى هذة الدراسة التى استمرت الى ثمانية اسابيع تم دراسة الاداء الانتاجى و معاملات هضم المركبات الغذائية و معاملات هضم الالياف الذائبة فى المحلول المتعادل و الهضم و التخمر فى منطقة الاعور. و اشارت النتائج ارتفاع بسيط فى و غير معنوى فى المادة الجافة و المادة العضوية الماكولة فى المجموعة الكنترول عن باقى المجاميع المحتوية على تبن القمح سواء فى وجود البريبيوتك او البروبيوتيك. بينما كانت الطاقة المهضومة و الطاقة الممثلة اعلى فى مجموعة ٣٣ % احلال فى وجود اللاكتلوز عن باقى المجاميع.بالاضافة الى انخفاض غير معنوى فى معدل النمو اليومى.

معامل هضم الالياف الذائبة فى المحلول المتعادل كانت اعلى فى المجموعة الثانية التى تغذت على عليقة تحتوى على ١٠% تبن قمح (٣٣% احلال) سواء فى وجود الاكتلوز او البيوجين و لكن داخل نفس العليقة تفوق الاكتلوز على البيوجين فى المادة الجافة الماكولة و الطاقة المهضومة و الممثلة.

وقد خلصت النتائج إلى أن الأرانب التى غذيت على علائق تحتوى على تبن القمح بدلا من دريس البرسيم فى وجود البريبيوتيك أو البروبيوتيك كانت أعلى فى كفائتها الإقتصادية ولم يكن لها أى تأثير ضار على الصفات الإنتاجية وهضم الألياف والتخمرات فى الأعور.