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Feeding Flaxseed to Guinea Pigs (*Cavia porcellus*) Under Northern Peruvian Condition: II. Effects on Performance and Apparent Total Tract Nutrient Digestibility

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Abstract

A study was conducted to determine the effects of graded levels of flaxseed on performance and apparent total tract nutrient digestibility (ATTD) of guinea pigs. Ninety (45 males and 45 females) one-month weaned guinea pigs were blocked (5 males or 5 females/cage) by sex and body weight and randomly allotted to three dietary concentrates (15 g/animal) containing 0, 50 and 100 g/kg flaxseed with *ad-libitum* fresh alfalfa. Results showed that flaxseed inclusion had no influence on total feed intake body weight gain and feed conversion ratio (FCR). However, males had higher total feed intake (53.6 vs. 49.5 g/day, P = 0.004), body weight gain (11.9 vs. 10.5 g/day, P < 0.001) and therefore lower FCR (4.04 vs. 4.79, P = 0.006) than females. Flaxseed supplementation had also no effects on ATTD of dry matter, organic matter, neutral detergent and gross energy. Apparent total tract digestibility of dry matter, crude protein and gross energy were higher in female than male guinea pigs while ATTD of neutral detergent fiber were not influenced by sex. Apparent total tract digestibility of fatty acids was similar for all treatments and both sexes. It was concluded that under the current study conditions (i.e. *ad-libitum* fresh alfalfa + concentrate), flaxseed inclusion up to 100 g/kg of the concentrate had no effects on guinea performance and ATTD. However, male guinea pigs exhibited better performance but lower ATTD than females.

Keywords: *Flaxseed; Guinea Pigs; Apparent Total Tract Digestibility; Fecal Fatty Acids*

Abbreviations

ATTD: Apparent Total Tract Digestibility; DM: Dry Matter; CP: Crude Protein; FCR: Feed Conversion Ratio; GE: Gross Energy; OM: Organic Matter; SAS: Statistical Analysis System

Introduction

Flaxseed (*Linum usitatissimum*) is a rich source of poly-unsaturated fatty acids particularly omega-3 fatty acids, constituting 53% of total fatty acids [1]. Flaxseed has been successfully fed to farm animals to increase concentrations of polyunsaturated fatty acids and decrease concentrations of saturated fatty acids in milk of dairy cows [2], layer eggs [3] and meat of pork [4], broilers and rabbits [5]. However, the high Anti-nutritional factors such as mucilage, cyanogenic glycosides, or trypsin inhibitors may also have detrimental impacts on nutrient digestibility [6]. Mucilage, a water-soluble non-starch polysaccharide, can interfere with nutrient absorption by increasing

intestinal digesta viscosity and thus impair nutrient utilization [7,8]. Studies with poultry indicated that feeding diets containing 8 and 16% flaxseed to broilers [9] and 15% flaxseed to layers [3] had negative effects on total tract nutrient and energy utilization. However, the adverse effects of flaxseed on nutrient digestibility may vary according to animal species. Previous studies on rabbits indicated that flaxseed can be fed to rabbits up to 16% of the diet without adverse effects on growth performance and improved total tract digestibility [10].

A recent study from our research group evaluated the effects of feeding flaxseed on carcass traits and fatty acid composition of guinea pigs under northern Peruvian conditions [11]. Our results showed that inclusion of flaxseed at 10% of the concentrated diet reduced concentrations of saturated fatty acids by 11.5% and increased concentrations of poly unsaturated fatty acids by 24.8% in guinea pig hind-legs without affecting animal carcass traits. There is currently no information on digestibility of guinea pigs fed flaxseed diets and therefore a study was designed to determine the effects of graded levels of dietary flaxseed (i.e. 0, 5 and 10% of the concentrate) on animal performance and total tract nutrient

Materials and Methods

Animals and dietary treatments

All animals were cared for in compliance with the standard regulations of animal care of the National University of Cajamarca, Peru. The study was conducted in a commercial farm in Cajabamba, Peru as described by [11]. Ninety (45 males and 45 females), one-month old weaned Peruvian line guinea pigs (514.7 ± 54.07) were blocked by weight and sex. Animals were separated according to sex and housed in 18 wire mesh cages (five separate males and five separate females/cage) with six cage replicates per treatment. All animals were fed three isonitrogenous concentrates (15 g/animal) containing 0, 5 and 10% ground flaxseed (Table 1). Concentrates were offered once daily with *ad-libitum* fresh alfalfa for 30 days. All animals consumed the concentrate diets within 15 minutes. Due to high moisture content of fresh alfalfa, water was offered once daily at 1200h. The temperature and photoperiod were 19 to 25°C and 16L:8D, respectively. Intake and weigh-back of fresh alfalfa were recorded daily by cage while animals were group weighed weekly. Feed conversion ratio (FCR) was then calculated from average collective feed intake and group body weight gain.

Total tract nutrient digestibility

Chromic oxide was added to the concentrate diet (1%) as external indigestible marker on day 22 to determine total fecal output. Grabbed fecal samples were collected three times daily on day 27, 28 and 29 from each cage, dried at 100°C for 24h and pooled by cage. Fecal dry matter output was calculated as follows:

Fecal dry matter output (g/day) = Chromic oxide consumed (g/day) ÷ fecal chromic oxide concentration (g/g).

Apparent total tract nutrient digestibility was determined by subtracting fecal nutrient concentrations from feed nutrient concentrations.

Chemical analysis

Feed (concentrates and alfalfa) and fecal samples were analyzed for dry matter (DM) and ash using standard procedures [13]. Neutral detergent fiber (NDF) of feed and fecal samples was determined according to [12] in an Ankom fiber Analyzer (Ankom Technology, Macedon, NY. USA) using heat stable α-amylase and without the addition of sodium sulfite. A Leco Nitrogen Analyzer (FP-428 Nitrogen Determinator, Leco Corp., St. Joseph, MI, USA) was used for determination of crude protein (N × 6.25). Gross energy (GE) was determined using an adiabatic bomb calorimeter. Chromic oxide of concentrates and fecal samples was determined as described by [14].

Fatty acid methyl esters of flaxseed, alfalfa, concentrates and fecal samples were directly determined according to [15]. Tridecanoic acid (C13:0) was used as internal standard. The fatty acid methyl esters were analyzed by gas chromatography as described by [11].

	Flaxseed inclusion in concentrate (%)				
	0	**5**	**10**	**Alfalfa**	**Flaxseed**
Concentrate ingredients (%)					
Corn	50.0	45.0	39.0		
Wheat bran	20.0	20.5	21.5		
Soybean meal	12.0	12.0	13.0		
Soybean integral	12.0	8.0	5.5		
Rice bran	5.0	7.5	10.0		
Flaxseed	0	5.0	10.0		
Vit-mineral premix[1]	0.5	0.5	0.5		
Salt	0.5	0.5	0.5		
Chemical composition (%)					
Ash	4.3 ± 0.27	4.6 ± 0.82	4.7 ± 0.24	9.4 ± 0.51	3.2 ± 0.14
Crude protein	21.4 ± 0.30	21.6 ± 0.72	21.5 ± 1.10	23.4 ± 0.14	22.9 ± 0.81
Neutral detergent fiber	26.0 ± 0.42	25.9 ± 0.58	26.7 ± 0.15	46.4 ± 1.12	35.7 ± 1.30
Gross energy, kJ/g	19.3 ± 0.50	20.5 ± 0.25	21.3 ± 0.21	18.0 ± 0.96	27.2 ± 0.29
Fatty acids (% of fatty acids)					
C14:0	1.0 ± 0.03	1.0 ± 0.05	1.0 ± 0.04	2.3 ± 0.11	ND[2]
C16:0	13.1 ± 1.3	12.5 ± 4.6	11.4 ± 1.9	2.1 ± 0.02	5.9 ± 0.01
C16:1	1.2 ± 0.06	1.2 ± 0.02	1.1 ± 0.04	2.0 ± 0.13	0.6 ± 0.07
C18:0	2.2 ± 0.43	2.4 ± 0.90	2.6 ± 0.49	2.4 ± 0.16	4.2 ± 0.01
C18:1-n9c	27.5 ± 0.48	27.7 ± 0.69	27.0 ± 0.28	13.2 ± 0.02	19.6 ± .0.30
C18:2-n6c	49.9 ± 0.69	42.9 ± 0.98	34.8 ± 0.82	11.5 ± 2.04	13.7 ± .0.20
C18:3-n3	4.0 ± 0.76	12.0 ± 1.80	21.7 ± 0.70	59.6 ± 0.50	56.4 ± 0.82
Total fatty acids	8.4 ± 0.75	9.4 ± 0.20	11.2 ± 0.66	3.3 ± 0.04	47.8 ± 0.52

Table 1: *Ingredients and chemical composition of dietary concentrates, alfalfa and flaxseed.*

[1]Contained/kg 9,000,000 IU vit. A, 2,000,000 IU vit. D_3, 8000 IU vit E, 2g vit. K_3, 1.5g vit. B_1, 5g vit. B_2, 1.5g vit. B_6, 9 mg vit. B_{12}, 200 mg Pantothenic acid, 25g Folic acid, 60g Niacin, 30g Mn, 30 g Zn, 1.5g Fe, 1g I, 100 mg Se, 100 mg Co.

[2]Not detected.

Statistical analysis

Data were analyzed using the MIXED procedure of SAS [16] with a 2 x 2 factorial arrangement of treatments with pens (blocks) as a random effect. Mean effects of treatment (0, 5 and 10% flaxseed), sex (males and females) and their interactions were tested. The least squares mean method was used to detect differences among treatment means, and statistical significance was declared at $P < 0.05$ level.

Results

Animal performance

Animal performance data are depicted in table 2. Flaxseed supplementation had no influence on total feed intake (average 51.4 g/day), daily gain (average 11.9g) and FCR (average 4.42). However, guinea pig males had higher ($P = 0.004$) total feed intake, weight gain ($P < 0.001$) and lower ($P = 0.006$) FCR than females.

	Flaxseed (F) inclusion (%)			SEM[1]	Sex (S)		SEM[1]	P-value		
	0	5	10		Male	Female		F	S	F x S
Initial body weight (g)	510.8	525.3	518.5	12.42	523.3	513.1	10.14	0.718	0.492	0.893
Final body weight (g)	844.7	856.1	853.5	18.01	816.6	886.3	14.70	0.897	0.007	0.459
Alfalfa intake (g/d)	38.5	36.8	35.9	0.89	39.8	35.9	0.73	0.412	0.004	0.786
Total feed intake (g/d)	52.1	50.4	51.8	0.89	53.4	49.5	0.73	0.412	0.004	0.786
Daily gain (g)	11.7	12.0	12.0	0.50	13.3	10.5	0.41	0.920	<0.001	0.561
Feed conversion ratio[2]	4.49	4.27	4.49	0.187	4.04	4.79	0.153	0.640	0.006	0.409

Table 2: *Effects of flaxseed inclusion on guinea pig performance.*

[1]Pooled standard error of the mean.

[2]Calculated as daily feed intake/average daily gain.

Flaxseed x sex interactions were observed for ATTD of DM, organic matter (OM) and NDF (Table 3). Flaxseed supplementation had no influence on ATTD of OM and NDF while ATTD of DM tended to be higher (P = 0.058) for flaxseed supplemented guinea pigs than those fed the control concentrate (Table 3). Apparent total tract digestibility of DM (P < 0.001) and OM (P = 0.012) were greater for females than male guinea pigs. However, ATTD of NDF was not influenced by sex. No treatment x sex interactions were detected for ATTD of CP, GE and digestible energy (DE) and therefore only main effects were reported (Table 4). Guinea pigs fed 10% flaxseed diet had a greater ATTD of CP than those fed the control concentrate. However, flaxseed supplementation had no effects on ATTD of GE and DE. Sex effects on ATTD of CP, GE and DE were similar to those noted for ATTD of DM and OM.

	Flaxseed inclusion (%)			Flaxseed inclusion (%)				P-value		
	0	5	10	0	5	10	SEM[1]	Flaxseed (F)	Sex (S)	F x S
	Male			Female						
Dry matter	59.4	60.2	65.8	67.7	73.5	68.7	1.36	0.059	<0.001	0.010
Organic matter	65.4	66.7	70.4	71.9	74.6	67.4	1.57	0.411	0.012	0.012
Neutral detergent fiber	29.6	32.7	32.4	37.8	32.6	27.4	1.80	0.146	0.478	0.012

Table 3: *Effects of flaxseed inclusion on apparent total tract nutrient digestibility (%).*

[1]Pooled standard error of the mean.

	Flaxseed (F) inclusion (%)			SEM[1]	Sex (S)		SEM[1]	P-value		
	0	5	10		Male	Female		F	S	F x S
Crude protein digestibility (%)	66.1[b]	64.9[ab]	65.9[a]	1.11	60.1	67.9	1.01	0.045	< 0.001	0.228
Gross energy digestibility (%)	61.4	65.0	64.1	1.91	59.1	68.0	1.56	0.405	0.002	0.254
Digestible energy (kJ/g)	11.7	12.6	12.6	0.38	11.3	13.0	0.29	0.165	0.002	0.258

Table 4: *Effects of flaxseed inclusion on guinea pig performance on apparent total tract digestibility of crude protein, gross energy and digestible energy concentration.*

[1]Pooled standard error of the mean.

a-b: Letters with different manuscripts in the same row are different (P < 0.05).

Fecal fatty acid composition of guinea pigs fed experimental diets is shown in table 5. Palmitic (C16:0) and C18:0 are the most abundant fatty acids followed by C18:1n9c. Fecal C15:0 (P = 0.032) and C16:0 (P = 0.026) concentrations were lower while C18:3n3 (P = 0.030) were higher (P = 0.030) in guinea pigs fed 10% flaxseed concentrate than those fed the control concentrate. However, flaxseed supplementation had no influence on ATTD of fatty acids. Relative to males, guinea pig females had higher fecal C15:0 (P = 0.006) and C18:0 (P = 0.009) and lower fecal C14:0 (P = 0.011) and C16:0 (P = 0.026) fatty acids. Apparent total tract digestibility of fecal acids was not influenced by flaxseed supplementation or sex with greater ATTD as degree of fatty acid unsaturation increased. A negative ATTD was detected for fecal C18:0 fatty acid for all treatments with no significant effects of flaxseed inclusion or sex.

	Flaxseed (F) inclusion (%)			SEM[1]	Sex (S)		SEM[1]	P-value		
	0	5	10		Male	Female		F	S	F x S
Fecal fatty acids (%)										
C14:0	4.3	3.8	3.6	0.25	4.4	3.5	0.21	0.116	0.011	0.313
C16:0	29.6	29.3	27.7	0.44	29.5	28.3	0.36	0.026	0.034	0.345
C18:0	28.4	29.5	31.3	1.48	27.3	32.5	1.21	0.420	0.009	0.580
C18:1n9t	3.5	3.8	3.8	0.33	3.7	3.7	0.27	0.732	1.00	0.525
C18:1n9c	7.4	7.8	8.9	0.73	8.0	8.1	0.60	0.396	0.894	0.806
C18:2n6c	4.7	4.6	4.5	0.33	4.8	4.4	0.27	0.862	0.232	0.920
C18:3n3	2.8	3.5	4.1	0.29	3.6	3.3	0.24	0.030	0.451	0.797
Apparent total tract fatty acid digestibility (%)										
C16:0	29.8	29.6	34.9	1.76	31.8	31.1	1.44	0.145	0.754	0.615
C18:0	-36.1	-36.2	-33.7	4.12	-33.3	-39.2	0.3.37	0.908	0.148	0.880
C18:1n9c	65.9	62.8	57.9	2.81	63.5	60.9	0.2.30	0.231	0.59	0.899
C18:2n6c	92.3	85.0	90.2	2.08	90.5	87.7	1.71	0.086	0.315	0.413
C18:3n3	95.8	92.1	96.2	2.25	94.5	95.5	1.84	0.571	0.721	0.448
Total fatty acids	66.1	68.2	71.0	1.59	69.1	67.7	1.29	0.174	0.418	0.139

Table 5: *Effects of flaxseed inclusion on fecal fatty acids composition and apparent total tract fatty acid digestibility of guinea pigs.*
[1]Pooled standard error of the mean.

Discussion

In the current study, there were no effects on feed intake, body weight gain or FCR of guinea pigs as a results of flaxseed inclusion. Data on performance of guinea pigs fed flaxseed are unavailable. However, previous studies showed that inclusion of flaxseed at 4 [5], 8 [17] or 16% [10] had no effects on rabbit performance. Similar observations were reported for pigs [17] and broilers [19] fed 10 and 12% flaxseed, respectively.

Inclusion of flaxseed up to 10% of the diets had no effects on ATTD with the exception of ATTD of CP which was increased as a result of 10% flaxseed inclusion. Data regarding oilseed supplementation on ATTD of guinea pigs are unavailable while results on the effects of flaxseed supplementation on ATTD of monogastric animals such as rabbits are inconsistent. Inclusion of flaxseed [20] or perilla (*Perilla frutescens* L.) seeds [21] up to 10% of the diet had no effects on ATTD of DM, CP and ether extract. In contrast, feeding 8% flaxseed reduced

ATTD of DM, OM and crude fiber compared with the control diet [10]. However, a greater flaxseed inclusion (i.e. 15 to 16% of the diet) improved ATTD of DM, OM and GE compared with the control diet [8]. The authors attributed the improved total tract nutrient digestibility to greater dietary fat and lower fiber concentrations in the flaxseed-supplemented diets relative to the control. However, in the present study, all dietary treatments had similar NDF concentrations (average 26.2%) which may explain the lack of significant differences. Our digestibility values were similar to those reported for rabbits fed 19 to 16% flaxseed diets using indigestible marker [8,22].

Hamed., *et al*. [20] evaluated the effects of feeding flaxseed at 0, 5 and 10% of the diet on ATTD of rabbits. The authors reported that rabbits fed 5% flaxseed diet had no effect on nutrient digestibility. However, feeding 10% flaxseed increased ATTD of OM and NDF.

The negative digestibility observed for C18:0 fatty acid is likely due to the hind gut fermentation and/or bacterial modification (e.g. saturation of poly unsaturated fatty acids in the hindgut) which resulted in greater concentrations of saturated fatty acids (e.g. C18:0) in feces than in ileal digesta concentrations [23]. Similar negative values for ATTD of C18:0 were reported for monogastric animals such as pigs [24]. Despite the fact that flaxseed supplementation had no influence on ATTD of fatty acid digestibility, the average ATTD was 43.4% higher in C18:2n6c than C18:1n9c and was 6.5% higher in C18:3n3 than C18:2n6c, suggesting a negative relationship fatty acid digestibility and degree of saturation. This likely due to the fact that unsaturated fatty acids are more easily emulsified and therefore more digested in the gut [25]. In agreement with our findings, other researcher reported a higher ATTD of unsaturated than saturated C18 fatty acids in rabbit [26].

Conclusion

Results of this study suggest that flaxseed supplementation up to 10% of the concentrate had no impact on animal performance and total tract nutrient utilization of guinea pigs. However, female guinea pigs consumed less feed and therefore had better ATTD than male guinea pigs.

Conflict of Interest

To our knowledge, there are not any conflicts of interests among authors, institutions or organizations.

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Bibliography

1. Gonthier C., *et al*. "Effects of feeding micronized and extruded flaxseed on ruminal fermentation and nutrient utilization by dairy cows". *Journal of Dairy Science* 87 (2004): 1854-1863.

2. Mustafa AF., *et al*. "Effects of feeding micronised flaxseed on yield and composition of milk from Holstein cows". *Journal of the Science of Food and Agriculture* 83 (2003): 920-926.

3. Huang S., *et al*. "Effects of extruded flaxseed on layer performance, nutrient digestibility, and yolk fatty acid composition". *British Poultry Science* 59 (2018): 463-469.

4. Turner TD., *et al*. "Flaxseed fed pork: n-3 fatty acid enrichment and contribution to dietary recommendations". *Meat Science* 96 (2014): 541-547.

5. Benatmane F., *et al*. "Effect of a linseed diet on lipogenesis, fatty acid composition and stearoyl-CoA-desaturase in rabbits". *Animal* (2011): 1993-2000.

6. Dale N and Batal A. "Feedstuffs Reference Issue and Buyers Guide". *Feedstuffs* 79 (2008): 17-20.

7. Choct M., *et al*. "Increased small intestinal fermentation is partly responsible for the anti-nutritive activity of non-starch polysaccharides in chickens". *British Poultry Science* 37 (1996): 609-621.

8. Almirall M., *et al*. "The Differences in Intestinal Viscosity produced by barley and β-glucanase alter digesta enzyme activities and ileal nutrient digestibilities more in broiler chicks than in cocks". *Journal of Nutrition* 125 (1995): 974-955.

9. Alzueta C., *et al*. "Effect of whole and demucilaged linseed in broiler chicken diets on digesta viscosity, nutrient utilisation and intestinal microflora". *British Poultry Science* 44 (2003): 67-74.

10. Peiretti PG and Meineri G. "Effects of golden flaxseed supplementation on performance and feed digestibility of rabbits". *Journal of Animal and Veterinary Advances* 7 (2008): 56-60.

11. Mustafa AF., *et al*. "Effects of feeding flaxseed on performance, carcass trait, and meat fatty acid composition of Guinea pigs (*Cavia procellus*) under northern Peruvian condition". *Tropical Animal Health and Production* 51 (2019): 2611-2617.

12. Van Soest PJ., *et al*. "Methods for dietary fiber, neutral detergent fiber, and nonstarch polysaccharides in relation to animal nutrition". *Journal of Dairy Science* 74 (1991): 3583-3597.

13. Association of Official Analytical Chemists "Official Methods of Analysis". 15th edition. Washington, DC (1990).

14. Fenton TW Fenton M. "An improved procedure for the determination of chromic oxide in feed and feces". *Canadian Journal of Animal Science* 59 (1979): 631-634.

15. O'Fallon JV., *et al*. "A direct method for fatty acid methyl ester synthesis: application to wet meat tissues, oils, and feedstuffs". *Journal of Animal Science* 85 (2007): 1511-1521.

16. SAS Institute. SAS/ STAT 9.3 User's Guide: Statistics. SAS Inst. Inc., Cary, NC (2010).

17. Dal Bosco A., *et al*. "Effect of dietary α-linolenic acid and vitamin E on the fatty acid composition, storage stability and sensory traits of rabbit meat". *Meat Science* 66 (2004): 407-413.

18. Matthews KR., *et al*. "Effect of whole linseed (*Linum usitatissimum*) in the diet of finishing pigs on growth performance and on the quality and fatty acid composition of various tissues". *British Journal of Nutrition* 83 (2000): 637-643.

19. Shen YR., *et al*. "Effect of flaxseed processing on its true metabolizable energy values for adult chicken". *Journal od the Science of Food and Agriculture* 84 (2006): 551-555.

20. Hamed AA., *et al*. "Utilization of flaxseeds (*Linum usitatissimum* L.) in rabbit rations. 1. Response of growing rabbits to diets containing different levels of flaxseeds". *Life Science Journal* 10 (2013): 2638-2646.

21. Peiretti PG., *et al*. "Apparent digestibility of compound diets with increasing levels of perilla (*Perilla frutescens* L.) seeds in rabbit". *Italian Journal of Animal Science* 9 (2020): 4 e81.

22. Peiretti PG., *et al*. "Apparent digestibility of mixed feed with increasing levels of false flax (*Camelina sativa* L.) seeds in rabbit diets". *The Journal of Food, Agriculture and Environment* 5 (2007): 85-88.

23. Jørgensen., *et al*. "Determination of endogenous fat and fatty acids at the terminal ileum and on feces in growing pigs". *Acta Agriculturae Scandicaniva Section A. Animal Science* 43 (1993): 101-106.

24. Li ZC., *et al*. "Effects of lipid form and source on digestibility of fat and fatty acids in growing pigs". *Journal of Animal Science* 95 (2017): 3103-3109.

25. Xiccato G. "Fat digestion". In: Nutrition of the Rabbit". 2nd Edition. C De Blas and J Wiseman. CABI North American Office. Cambridge, MA, USA.

26. Fernandez C., *et al*. "The Effect of fat inclusion on diet digestibility in growing rabbits". *Journal of Animal Science* 72 (1994): 1508-1515.

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