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REGULAR ARTICLES

Effects of feeding flaxseed on performance, carcass trait, and meat fatty acid composition of Guinea pigs (*Cavia procellus*) under northern Peruvian condition

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Abstract

A study was conducted to determine the effects of flaxseed supplementation on performance, carcass traits, and hindleg fatty acid composition of guinea pigs. Sixty male and female weaned guinea pigs (1 month old, five animals/cage) were blocked by sex and bodyweight and randomly fed 0 (control) or 100 g/kg flaxseed concentrate diets (15 g/animal) plus ad libitum fresh alfalfa for 30 days. Results showed that flaxseed supplementation had no influence on animal performance. However, final body weight ($P = 0.035$), total feed intake ($P = 0.019$), and body weight gain ($P < 0.001$) were higher in male than female guinea pigs. Similar results were also observed for carcass composition (i.e., hot, chilled, and reference carcass weights). Inclusion of flaxseed reduced saturated ($P < 0.001$), mono-unsaturated ($P = 0.004$), and increased ($P < 0.001$) polyunsaturated (PUFA) fatty acid concentrations in hindlegs. Concentrations of linolenic acid and n-3 PUFA increased ($P < 0.001$) by 49.7 and 37.1%, respectively as a result of flaxseed inclusion. It was concluded that feeding flaxseed to guinea pigs at 100 g/kg of the concentrate diets improves meat PUFA concentrations with no adverse effects on performance or carcass composition.

Keywords Flaxseed · Guinea pigs · Fatty acids

Introduction

Guinea pig is a member of the rodent family which is used as a protein source in Andean countries such as Bolivia, Ecuador, Colombia, and Peru (Colleen 1998). Guinea pig production can potentially improve the livelihood of rural farmers due to the low production cost, rapid return of investments and high meat quality. Peru has the largest guinea population in Latin America with more than 20 million breading stock that yield about 68 million Guinea pigs for slaughter (Chauca 1995). As a hindgut-fermenter, Guinea pigs can consume large quantities of high-fiber diets such as forages and agricultural residues. Kouakou et al. (2013) examined the effects of feeding Guinea grass (*Panicum maximum*) and grass mix of 75% *Panicum maximum* and 25% *Euphorbia heterophylla* on performance and carcass fatty acid composition of guinea pigs. Grass type had no effect on daily intake and final body weight. However, guinea pigs fed a grass mix had greater body weight gain, liver weight, and carcass percentage. Feeding 75% *Panicum maximum* and 25% *Euphorbia heterophylla* diet increased n-3 polyunsaturated fatty acids (PUFA) and decreased n6:n3 in guinea pig muscle and carcass tissues. Minguez and Calvo (2018) evaluated guinea pig performance fed fresh orange pulp as a partial replacement of fresh alfalfa. The authors reported similar, feed intake, daily gain and feed conversion ratio for guinea pigs fed 0 or 15% fresh orange pulp. However, animals fed 30% fresh orange pulp exhibited lower feed intake and weight gain relative those fed the 15% fresh orange pulp or the control treatment.

Research on the effects of feeding concentrate on performance and meat composition of guinea pigs are limited. Three feeding systems for guinea pigs are available under Peruvian condition. These include fresh alfalfa, alfalfa plus concentrate, or concentrate plus added vitamin C (Chauca 1995). The vitamin supplementation is added to the concentrate diets due because the inability of guinea pigs to synthesize vitamin C.

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Flaxseed (*Linum usitatissimum*) is a rich source of polyunsaturated fatty acids particularly omega-3 fatty acids, constituting 53% of total fatty acids (Gonthier et al. 2004). Omega-3 fatty acids such as linolenic acid (C18:3n-3) and docosahexaenoic (C22:6n-3) acids have been evaluated for their health-promoting effects including prevention and treatment of coronary diseases, arthritis, and hypertension (Simopoulos 1991; Bazinetm and Layé 2014). As essential fatty acids, C18:3n-3 and C22:6n-3 cannot be synthesized by humans and therefore must be obtained from dietary sources. Dietary supplementation of flaxseed in monogatric animals such as rabbits (Benatmane et al. 2011), pork (Thacker et al. 2004; Turner et al. 2014), layers (Cherian and Sim 1991; Haung et al. 2018) and broilers (Shin et al. 2011) has been an effective strategy to increase the concentrations of n-3 PUFA. Previous studies with rabbits showed no adverse effects of flaxseed inclusion up to 18% of the on-performance (Benatmane et al. 2011; Peiretti and Meineri 2010) and carcass composition (Peiretti and Meineri 2010). However, feeding lower dietary flaxseed (i.e. 3 to 5%) were effective in improving rabbit meat fatty acid composition (Kouba et al. 2008; Benatmane et al. 2011).

To the best of our knowledge, no research is available regarding flaxseed supplementation on performance and meat fatty acid composition of guinea pigs and therefore the objectives of this study were to determine the effects flaxseed inclusion on feed intake, body weight gain, and hindleg fatty acid composition under Peruvian conditions. Our choice for using lower inclusion level of flaxseed in the present study (i.e., 10%) was due the high cost of flaxseed in Peru. We hypothized that flaxseed inclusion can improve the health-promoting fatty acid profile of guinea pig meat without influencing animal performance.

Materials and methods

Animals and experimental design

All animals were cared for in compliance with the standard regulations of animal care at the National University of Cjamarca. The study was conducted in a commercial farm in Cajabamba, Peru. Sixty 1-month-old-weaned Peruvian line guinea pigs (514.7 ± 54.07) were blocked by weight and sex. Animals were housed in 12 wire mesh cages with six cage per treatment (five separate male and five separate female/cage) and were fed two isonitrogenous concentrates (15 g/animal) containing 0 and 100 g/kg ground flaxseed (Table 1). Concentrates were offered once daily with ad libitum fresh alfalfa for 30 days. Due to high moisture content of fresh alfalfa, water was offered once daily at 1200 h. The temperature and photoperiod were 25 to 19 °C and 16L:8D, respectively. All animals consumed the concentrate diets within 15 min. 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.

Table 1 Ingredients and fatty acid composition of dietary concentrates

	Flaxseed inclusion (%)	
	0	10
Ingredients (% as fed)		
Corn	50	39
Wheat bran	20	21.5
Soybean meal	12	13
Soybean integral	12	5.5
Rice bran	5	10
Flaxseed	0	10
Vitamin-mineral premix[a]	0.5	0.5
Salt	0.5	0.5
Fatty acids (% of total fatty acids)		
C16:0	13.1 ± 1.28	11.4 ± 1.19
C18:0	2.2 ± 0.43	2.6 ± 0.49
C18:1n-9	27.5 ± 4.75	27.0 ± 0.28
C18:2n-6	49.9 ± 6.85	34.8 ± 0.82
C18:3n-3	4.0 ± 0.76	21.7 ± 0.70
Total fatty acids (g/kg)	8.4 ± 0.75	11.2 ± 0.66

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

Carcass analysis

At the end of the study, six unfasted guinea pigs/treatment (three males and three females) were chosen at random and slaughtered by cutting the carotid artery and the jugular vein. Hot carcass (HC) and chilled carcass (CC) weights (24 h at 4 °C) were determined according to Sánchez-Macíasa et al. (2016). Viscera was removed from hot carcass (HC) while liver, kidneys, and lungs were removed from each chilled carcass (CC) and weighed (Sánchez-Macíasa et al. 2016). Left hindlegs (without skin) were separated from CC, minced and freeze-dried for later fatty acid analysis.

Fatty acid analysis

Methyl esters of flaxseed, alfalfa, concentrates, and hindleg samples were directly determined according to O'Fallon et al. (2007). The fatty acid methyl esters were analyzed by gas chromatography (Varian 3900 equipped with flame ionization detector at 260 °C and 117 auto-injector) on a 100 m × 0.25 mm fused silica capillary column (CP74489, Varian, CA). The carrier gas was H_2 and the flow rate was 0.8 ml/

min. Both temperature of injector and detector was 260 °C and the split ratio was 50:1. The initial column temperature was set at 70 °C for 4 min, then increased by 4 °C/min to 175 °C and maintained for 27 min. It was then increased to 214 °C by 4 °C/min and held for 11 min, final temperature increased to 225 °C at the rate of 4 °C/min, held for 5.5 min). Tridecanoic acid (C13:0) was used as internal standard. Fatty acids were identified by comparing their retention times with standard fatty acid methyl esters (NuCheck, Elysian, MN, USA).

The saturation (S/P), atherogenic (AI), and thrombogenic (TI) indices were calculated according to Ulbricht and Southgate (1991) as follows:

$$S/P = (C14:0 + C16:0 + C18:0) / [\Sigma MUFA + \Sigma PUFA]$$

$$AI = (C12:0 + 4xC14:0 + C16:0) / [\Sigma MUFA + \Sigma(n{-}6) + \Sigma(n{-}3)]$$

$$TI = (C14:0 + C16:0 + C18:0) / [0.5x\Sigma MUFA + 0.5x\Sigma(n{-}6) + 3\ x\ \Sigma(n{-}3) + \Sigma(n{-}3)/\Sigma(n{-}6)]$$

where MUFA, PUFA, SFA are monounsaturated, polyunsaturated, and saturated fatty acids, respectively.

Statistical analysis

Data were analyzed using the MIXED procedure of SAS (2014) with a 2 × 2 factorial arrangement of treatments with pens (blocks) as a random effect. Mean effects of treatment (0 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

Ingredients and fatty acid composition of dietary concentrates are presented on Table 1. Inclusion of flaxseed supplementation decreased dietary C18:2 and increased C18:3n-3 concentration by 31 and 443%, respectively, likely due to the high concentration of C18:3n-3 in flaxseed (Table 2). Dietary treatments had no effects on total feed intake (alfalfa + concentrate), body weight gain, and FCR of guinea pigs (Table 3). However, males consumed more feed ($P = 0.019$), exhibited better daily gain ($P < 0.001$) and therefore showed improved FCR ($P = 0.036$) than females. Carcass performance was not influenced by flaxseed supplementation (Table 4). Relative to females, male guinea pigs had greater slaughter weight ($P = 0.008$), HC ($P = 0.006$), CC ($P = 0.029$), and reference carcass (RC) weights ($P = 0.027$). Offal weight and offal percentage were not influenced by dietary treatments and sex.

Table 2 Fatty acid composition of alfalfa and flaxseed (% of total fatty acids)

	Flaxseed	Alfalfa
C14:0	ND[a]	2.3 ± 0.1
C16:0	5.9 ± 0.01	21.1 ± 0.23
C16:1	ND	2.0 ± 0.13
C18:0	4.2 ± 0.01	2.4 ± 0.16
C18:1	19.6 ± 0.03	1.3 ± 0.2
C18:2n-6	13.7 ± 0.02	11.5 ± 2.04
C18:3n-3	56.4 ± 0.08	59.6 ± 0.50
Total fatty acids (%)	47.8 ± 0.05	3.3 ± 0.04

[a] *ND*, not detected

Fatty acid composition in guinea pig hindlegs is depicted in Table 5. Animals fed flaxseed diet had lower ($P < 0.001$) SFA, MUFA ($P < 0.004$), and higher ($P < 0.001$) PUFA relative to those fed the control diet. Concentrations of n-3 ($P < 0.001$) and n-6PUFA ($P < 0.028$) were also greater for guinea pigs fed flaxseed concentrate compared with those fed the control diet. Inclusion of flaxseed reduced ($P < 0.009$) n6:n3 ratio in guinea pig supplemented concentrate by 15.4%. Health indices (S/P, 0.70 vs 0.56, AI, 0.58 vs 0.45, and TI, 0.62 vs 0.43) were also lower ($P < 0.001$) for flaxseed-supplemented guinea pigs than those fed the control diet.

Discussion

The objective of the present study was to investigate the inclusion of flaxseed on performance and tissue fatty acid composition of guinea pigs fed ad libitum fresh alfalfa. Under Latin American conditions, guinea pigs are usually fed fresh alfalfa with or without supplemental concentrates (Minguez and Calvo 2018). Huamaní et al. (2016) examined the effects of different feeding systems (fresh alfalfa, fresh alfalfa + concentrate or concentrate only) on Peruvian guinea pig performance. The authors reported that animals fed fresh alfalfa + concentrate or concentrate alone had higher daily gain, feed intake and better FCR than guinea pigs fed the fresh alfalfa. Our guinea pig performance data were similar to those reported for Latin American guinea pigs (Huamaní et al. 2016; Minguez and Calvo 2018) and were greater than those reported for African guinea pigs (Kouakou et al. 2013) while our carcass data were similar to those reported by Minguez and Calvo (2018).

To the best of our knowledge, no previous data are available regarding flaxseed supplementation in guinea pigs. However, previous studies showed no adverse effects of flaxseed inclusion on rabbit performance (Benatmane et al. 2011;

Table 3 Effects of flaxseed inclusion on guinea pig performance

	Flaxseed inclusion (g/kg)		Sex		SEM[a]	*P* value		
	0	100	Males	Females		Flaxseed (F)	Sex (S)	F × S
Initial body weight (g)	510.2	518.3	511.4	517.9	12.62	0.680	0.727	0.770
Final body weight (g)	844.7	853.3	883.1	815.1	17.78	0.738	0.035	0.238
Alfalfa intake (g)	37.4	37.5	39.3	35.6	0.83	0.886	0.019	0.421
Total feed intake (g/d)	51.0	51.1	52.9	49.2	0.83	0.886	0.019	0.421
Daily gain (g)	11.7	12.0	13.3	10.4	0.32	0.616	< 0.001	0.134
FCR[b]	4.40	4.42	4.00	4.82	0.132	0.905	0.005	0.237

[a] Pooled standard error of the mean

[b] *FCR*, feed conversion ratio calculated as daily feed intake/average daily gain

Peiretti and Meineri 2010) and carcass composition (Peiretti and Meineri 2010). Benatmane et al. (2011) examined the performance and carcass composition of rabbits fed 5% flaxseed diet. The authors reported no effects on growth rate, feed intake, carcass weight, and meat quality as a result of flaxseed inclusion. Similar results were also reported for pigs fed up to 15% flaxseed (Romans et al. 1995). Mridulaa et al. (2015) evaluated the effect flaxseed supplementation on growth performance of broilers. The authors found that feeding flaxseed at 0, 5, 7.5, and 10% had no effect on broiler performance during the first 4 weeks. However, broiler performance was significantly reduced during week 4 to 6 as the level dietary flaxseed.

The reduction in female guinea pig performance compared with males is in accordance with other monogatric species such as pigs. Juárez et al. (2010) reported that barrows fed flaxseed (5 to 10% of the diet) had higher feed intake, average daily gain, and lower FCR than gilts.

Table 4 Effects of flaxseed inclusion on carcass composition of guinea pigs

	Flaxseed inclusion (g/kg)		Sex		SEM[a]	*P* value		
	0	100	Males	Females		Flaxseed (F)	Sex (S)	F × S
Slaughter weight (g)	888.5	889.7	889.7	836.3	19.31	0.967	0.008	0.902
Hot carcass weight (g)	812.3	802.3	862.3	752.3	18.67	0.718	0.006	0.464
Chilled carcass weight (g)	600.2	583.5	629.5	554.2	18.59	0.496	0.029	0.248
Dressing %	67.4	65.7	66.9	66.3	1.42	0.414	0.773	0.143
Reference carcass weight[b] (g)	443.3	446.2	475.7	413.8	15.07	0.899	0.027	0.531
Offal weights (g)								
Gastro-intestinal tract	205.0	194.0	207.2	191.8	4.93	0.166	0.070	0.855
Liver	30.1	30.7	32.0	28.9	2.34	0.852	0.387	0.883
Kidney	9.4	8.1	9.1	8.4	0.57	0.168	0.450	0.917
Lung	6.4	5.7	6.4	5.6	0.30	0.147	0.090	0.718
Perirenal fat	3.2	3.2	3.0	3.4	0.29	0.927	0.343	0.093
Offal %								
Gastro-intestinal tract[c]	23.15	21.84	22.03	22.96	0.583	0.152	0.293	0.989
Liver[d]	5.03	5.27	5.08	5.21	0.328	0.632	0.794	0.667
Kidney[d]	1.58	1.39	1.47	1.53	0.118	0.302	0.655	0.540
Lung	1.06	0.97	1.03	1.01	0.056	0.282	0.863	0.258
Perirenal fat[e]	0.73	0.83	0.63	0.93	0.107	0.535	0.093	0.138

[a] Pooled standard error of the mean

[b] Chilled carcass weight—head, liver, kidney, thymus, trachea and esophagus

[c] Percentage of hot carcass weight

[d] Percentage of chilled carcass weight

[e] Percentage of reference carcass weight

Table 5 Effects of flaxseed inclusion on meat (hindleg) fatty composition of guinea pigs (% of total fatty acids)

	Flaxseed inclusion (g/kg)		Sex		SEM[a]	*P* value		
	0	100	Males	Females		Flaxseed (F)	Sex (S)	F × S
C14:0	1.24	1.07	1.15	1.17	0.044	0.967	0.008	0.902
C15:0	0.60	0.67	0.65	0.62	0.062	0.449	0.797	0.337
C16:0	27.89	23.80	25.77	25.92	0.505	< 0.001	0.839	0.618
C16:1	0.90	0.71	0.84	0.77	0.034	0.008	0.207	0.618
C18:0	10.90	9.74	9.92	10.72	0.639	0.237	0.402	0.417
C18:1	23.38	20.13	21.60	21.91	0.593	0.005	0.727	0.960
C18:2n-6	18.24	21.24	19.99	19.60	0.663	0.013	0.773	0.205
C18:3n-3	10.84	16.23	13.96	13.15	0.505	< 0.001	0.287	0.508
C20:2	0.40	0.34	0.37	0.37	0.038	0.333	0.953	0.419
C20:3n-3	1.63	1.58	1.62	1.59	0.233	0.869	0.938	0.260
C20:4n-6	0.35	0.34	0.36	0.33	0.043	0.855	0.697	0.137
C20:5n-3	1.09	1.16	1.10	1.15	0.181	0.794	0.871	0.206
C22:6n-3	0.78	0.63	0.72	0.73	0.050	0.157	0.911	0.168
C24:0	1.02	0.96	1.02	0.96	0.059	0.453	0.544	0.151
SFA	42.06	37.21	39.46	40.37	0.495	< 0.001	0.243	0.150
MUFA	24.28	20.84	22.44	22.68	0.596	0.004	0.788	0.910
PUFA	33.33	41.59	38.00	36.92	0.909	< 0.001	0.428	0.580
n-6PUFA	18.59	21.58	20.24	19.93	0.672	0.020	0.579	0.257
n-3PUFA	14.34	19.66	17.40	16.61	0.598	< 0.001	0.386	0.661
n6:n3	1.30	1.10	1.18	1.23	0.051	0.036	0.540	0.166
C20:4n-6	0.35	0.34	0.36	0.33	0.043	0.855	0.697	0.137
Saturation index	0.70	0.56	0.61	0.64	0.017	< 0.001	0.325	0.353
Thrombogenic index	0.58	0.45	0.51	0.52	0.015	< 0.001	0.606	0.662
Atherogenic index	0.62	0.43	0.51	0.54	0.180	< 0.001	0.246	0.936

[a] Pooled standard error of the mean

The high linolenic acid concentration in hindlegs of guinea pigs fed the control diet (i.e., concentrate + fresh alfalfa) is likely due the ad libitum intake of fresh alfalfa, which is contained > 50% of total fatty acid as linolenic acid (Table 2). Huamaní et al. (2016) determined linolenic acid concentration in carcass of guinea pigs fed fresh alfalfa, fresh alfalfa + concentrate, and concentrate alone. The carcass linolenic acid concentration for the three dietary treatements were 20.6, 7.3, and 4.0%, respectively. Similarly, Dal Bosco et al. (2014) reported that feeding fresh alfalfa relative to a concentrate diet, significantly increase PUFA, n-3 PUFA and reduced MUFA in rabbit meat.

Results of our study indicated that inclusion of flaxseed at 10% of the concentrate diet significantly altered the fatty acid composition of guinea pig hindlegs. In the present study, inclusion of flaxseed relative to the control diet reduced SFA and MUFA by 11.5 and 14.0%, respectively and increase PUFA and linolenic acid concentrations by 24.8 and 49.7%, respectively10. The increase in total n-3 PUFA concentration can be attributed mostly to the greater deposition of linolenic acid in guinea pig hindlegs. Similar to our results, feeding diets rich in PUFA such as *Euphorbia heterophylla* increased n-3PUFA and linolenic acid concentrations in guinea pig meat by 12.0 and 26.4%, respectively (Kouakou et al. 2013). Our results are also consistent with previous studies that showed significant increase in linolenic acid and total n-3 PUFA concentrations in monogastric animals as a result of flaxseed supplementation. Peiretti and Meineri (2010) found that feeding flaxseed at 8 and 16% of the diet decreased concentrations of SFA and MUFA in rabbit meat by 22 and 24%, respectively, and increased PUFA concentration by 36%. Juárez et al. (2010) examined the response of feeding extruded flaxseed on pork backfat fatty acid composition. The authors found that feeding 10% extruded flaxseed increased linoleic acid, linolenic acid, total PUFA, n-3 PUFA, and n-6 PUFA and reduced the SFA concentrations.

The lower MUFA concentrations in meat of guinea pigs fed flaxseed is likely due to the higher PUFA in the flaxseed relative to control concentrate. Polyunsaturated fatty acids have been shown to inhibit the activity of Δ^9 desaturase which involves in MUFA synthesis (Mahfouz et al. 1984; Garg et al. 1988). Flaxseed inclusion at 10% of the concentrate increased linoleic acid concentration in hindlegs by 20.8 and 14.5% in male and female guinea pigs, respectively. The effects of flaxseed on linoleic acid concentration are inconsistent. Flaxseed supplementation had no effect (Shin et al. 2011), increased (Juárez et al. 2010) or decreased (Turner et al. 2014) linoleic concentration in monogastric meat tissues.

Despite the significant increase in linolenic acid in guinea pig hindlegs, no differences were observed in long chain fatty acids (e.g., eicosapentaenoic acid) suggesting limited capacity of guinea pigs to synthesize long chain PUFA from linolenic. The lack of increase in docosahexaenoic acid (C22:6n-3) can be explained by competition for Δ^6 desaturase activity between linolenic acid and linolenic acid (precursor for C22:6n-3) with high dietary C18:3n-3 (Cameron et al. 2000). In agreement with our findings, Kouakou et al. (2013) reported a reduction in C22:6n-3 concentration of guinea pig carcass fed linolenic acid-enrich grass. Other researchers also found no effects of flaxseed supplementation in C22:6n-3 concentration in rabbit muscle (Olomu and Baracos 1990) and pork backfat (Juárez et al. 2010).

The n-6:n-3 ratio decreased from 1.30 to 1.11 as a result of flaxseed inclusion. These findings suggested that the increase in n-3 PUFA caused by flaxseed supplementation was greater than the increase in n-6 PUFA. This can be attributed to the competition between n-6 and n-3 PUFA in which n-3 PUFA are used as the preferred substrate in the desaturation–elongation pathway, leading to a decreased n-6:n-3 ratio in the hindlegs of flaxseed fed guinea pigs (Brenner 1971; Cherian et al. 1993). In agreement with our findings, Kouakou et al. (2013) reported 13.6% reduction in n6:n3 ratio for guinea pig muscles fed Paneuphorbia diet (rich in C18:3) relative to guinea pigs fed Panicum diet. Similar observations have also been reported for rabbits (Peiretti and Meineri 2010; Benatmane et al. 2011) and pigs (Turner et al. 2014; Thacker et al. 2004) fed flaxseed supplemented diets. It should be emphasized that the n-6:n-3 ratio in the control concentrate is lower than recommendation. An ideal n-6:n-3 ratio for improving the human cardiovascular system and reducing atherosclerosis ranges between 4:1 and 1:1 (Simopoulos 1991).

Flaxseed supplementation reduced S/P, AI, and TI indices in hindlegs of guinea pigs, likely due to reduction in SFA and increase in PUFA concentrations. These indices take into account the different fatty acids affecting human health, particularly the risk of heart diseases and clot formation. High concentrations of SFA such as C14:0 and C16:0 are considered pro-atherogenic and pro-thrombogenic while PUFA act as anti-atherogenic and anti-thrombogenic (Garaffo et al. 2011; Mansoreh et al. 2013). Data of S/P, TI and AI indices for guinea pig meat are unavailable. However, our TI value for flaxseed supplemented guinea pigs were similar (0.49) while our S/*P* value were higher than those reported for rabbit fed 8% flaxseed with a similar AI value (0.38) achieved with 16% flaxseed supplementation (Peiretti and Meineri 2010).

Conclusion

Results of this study suggest that flaxseed supplementation at 10% of the concentrate had no negative impact on animal performance and carcass characteristics of guinea pigs. Inclusion of flaxseed in the concentrate diet can alter fatty acid composition in guinea pig meat by increasing omega-3 enrich fatty acids, accompanied by reduction in saturated and n-6 PUFA as well as significant improvement in human health indices. More research is warranted to investigate the effects of lower levels of dietary flaxseed on omega-3 enrich guinea pig meat.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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