Effect of three feed rations on lipid profile and productive parameters in guinea pigs (Cavia porcellus)

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Research Article

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Abstract

Background

The present investigation was carried out to evaluate productive variables (feed intake, feed conversion, and weight gain), cholesterol and triglyceride levels in the blood of guinea pigs fed different feed rations.

Methods

We worked with 45 male guinea pigs of the Peru breed, weaned at 21 days of age, randomly distributed in three groups of 15 guinea pigs and three replicates each, where the control treatment (T_0) was fed only alfalfa, the first experimental treatment (T_1) with alfalfa and balanced feed in proportions of 3:1, respectively, and the second experimental treatment (T_2) with Ryegrass and balanced supplement, also in a 3:1 ratio.

Results

At the end of the study (nine weeks), average live weights of T_0 = 917.67 g, T_1 = 948.13 g, and T_2 = 911.60 g were obtained; average feed intake on a dry matter basis (DM) per guinea pig/day was increasing (T_0 = 59.3 g, T_1 = 60.96 g, and T_2 = 65.51 g), with a feed conversion of 6.89, 6.59 and 7.57 for T_0, T_1, and T_2, respectively; likewise, guinea pig live weight gain/day was 8.54 g for T_0, 9.13 g for T_1 and 8.58 for T_2. As for cholesterol, the lowest value was obtained in T_0 (40.7 mg/dL), and triglycerides were lower in T_2 (54.6 mg/dL).

Conclusions

The guinea pigs fed with alfalfa and concentrate supplement have a higher weight gain and feed conversion; however, they have high levels of cholesterol and triglycerides in the blood, unlike guinea pigs fed with Rye Grass and alfalfa; the latter had the lowest values.

Background

Guinea pigs (*Cavia porcellus*) are distributed worldwide, where their breeding has attracted increasing interest as they are positioned as a regular source of high-quality animal protein for domestic consumption, contributing to food security and providing a small but frequent economic income for people in developing countries because they are prolific, reproduce and adapt to a wide range of climates and diets [1–3].

Guinea pig breeding takes on greater importance due to the fact that their protein production is possible at a low cost since their diet is based on feed, forages, and vegetable residues from crops and traditional markets, although if meat production is to be increased, they can be fed with concentrates and supplements [4]. High nutritional values have been reported, which vary by different factors, even in different anatomical regions of the same guinea pig, varying according to origin and gender; thus, females contain higher lipid content at the thigh and shoulder level [5]. Likewise, of the total polyunsaturated fatty acids, guinea pig meat has proportions of more than 50%, whereas the carcass of a guinea pig without skin covers more than 21% daily of polyunsaturated fatty acids required (Omega-3) by humans, increasing with the consumption of the skin [6].

On the other hand, guinea pig lipoprotein metabolism and remodeling are similar to that of humans, in addition to carrying LDL cholesterol, they also have CETP (cholesterol ester transfer protein), making them excellent models to evaluate diets and their impact on plasma lipid profiles, protein metabolism and other characteristics [7, 8].

Guinea pig breeding is increasingly distributed to more and more places in Peru and the world, where it represents an important source of animal protein supply and economic income; However, there is still limited information on nutritional values influenced by feed that have a direct impact on the health of consumers. For this reason, the present research was conducted to evaluate the blood lipid profile of guinea pigs in the fattening phase fed with different feed rations, as well as to determine the productive parameters (feed consumption, feed conversion, and weight gain) with the same rations.

Methods

Location

The present investigation was carried out on a guinea pig farm (named San José: -7.12810721202040161 S, -78.47922044289862 W), located in the district of Baños del Inca, Cajamarca (Peru), at an altitude of 2749.53 masl, with a cold climate. A clinical analysis laboratory in the same district performed lipid profile determination tests for lipid profile determination.

Experimental design

Forty-five 21-day-old male guinea pigs of the Peruvian breed were used. These were distributed in three treatments (T_0, T_1, and T_2) of 15 individuals each, which were housed in cages built with galvanized wire mesh and wood (dimensions of 3 m long, 0.90 m wide, and 0.90 m high). Each cage constituted a treatment, divided into three compartments where 05 guinea pigs were placed in each one of them, thus forming three replicates per cage.

T_0 was fed only with fresh alfalfa, T_1 with fresh alfalfa, and commercial concentrate (Nutri-Cuy: 87.90% DM; CF 7.98%; CP 18%; DE 2.73 Mcal/kg; total fat 4.65%; unsaturated fatty acids 3.24%; Ca 0.90% and available P 0.61%) in a 3:1 ratio, finally T2 was fed with Ryegrass and commercial concentrate (Nutri-Cuy) in a 3:1 ratio, respectively. Water was supplied through nipple drinkers. Seven days before the start of the study, the guinea pigs were dosed against gastrointestinal and hepatic parasites with a formulation of ivermectin/clorsulon, at a dose of 0.2 mg/kg, subcutaneous, and during the study period of 63 days (nine weeks), a strict sanitary and biosecurity program was followed, cleaning and collection of manure and food waste were carried out daily, and disinfection with lime (CaO) was carried out periodically on a weekly basis.

Data collection

The live weights of each guinea pig, weight gain (Wg = Final weight - Initial weight), amount of feed intake (subtracting the residual of the given feed) and feed conversion (FCR = Total feed/Weight gain), were calculated weekly by weighing on a digital scale and applying the formulas.

For the determination of cholesterol and triglyceride levels, whole blood samples were obtained at the beginning and end of the study. One guinea pig per treatment was randomly selected, giving a total of six whole blood samples, which were taken on an empty stomach (7:00 h), by puncture of the jugular vein with a tuberculin syringe, after asepsis of the area, obtaining 2 mL for each animal, followed by their deposit in a tube without additive (red cap) for their transfer to the clinical laboratory for their respective analysis.

Statistical analysis

The data obtained were adjusted to the unpaired Student's t test. A completely randomized analysis of variance ($Yij = \mu + \tau i + \xi ij$) was performed with normally distributed variables.

Results

At the end of the nine weeks of the study, T_1 showed better live weights, and T_0 and T_2 guinea pigs showed statistically similar weights ($p < 0.05$). Similarly, T_1 guinea pigs showed higher weekly and daily weight gain in the ninth week compared to T_0 and T_2 ($p < 0.05$). During the first two weeks, feed consumption on a dry matter (DM) basis was statistically similar in the three groups ($p < 0.05$), likewise, in this period no statistical difference was found in feed conversion ($p < 0.05$). Between the third and eighth week, a statistical difference was found in the amount of feed intake and feed conversion between T_0 and T_2 ($p < 0.05$), where T_2 had the highest feed intake and highest feed conversion; however, in the ninth-week feed intake is again similar ($p < 0.05$), feed conversion also shows no statistical difference between T_0 and T_2, differing from T_1 ($p < 0.05$), which shows the lowest feed conversion value. Table 1.

Table 1
Productive parameters of guinea pigs were measured during the nine weeks of the research.

Variable		Weeks										Final average
		Beginning	1	2	3	4	5	6	7	8	9	
Weight (g) $\bar{x}$	T_0	379.40[a]	427.67[a]	475.80[a]	534.40[a]	592.40[a]	660.13[a]	726.93[a]	786.13[a]	852.73[ab]	917.67[b]	
	T_1	373.20[a]	421.20[a]	476.40[a]	538.53[a]	601.87[a]	667.47[a]	737.13[a]	802.40[a]	872.93[a]	948.13[a]	
	T_2	371.00[a]	419.00[a]	466.60[a]	530.00[a]	588.53[a]	651.20[a]	721.40[a]	779.53[a]	844.53[b]	911.60[b]	
Weight gain (g) $\bar{x}$	T_0	Week	48.27[a]	48.13[a]	58.60[a]	58.00[a]	67.73[a]	66.80[a]	59.20[a]	66.60[a]	64.93[b]	59.81
		Daily	6.90[a]	6.88[a]	8.37[a]	8.29[a]	9.68[a]	9.54[a]	8.46[a]	9.51[a]	9.28[b]	8.54
	T_1	Week	48.00[a]	55.20[a]	62.13[a]	63.33[a]	65.60[a]	69.67[a]	65.27[a]	70.53[a]	75.20[a]	63.88
		Daily	6.86[a]	7.88[a]	8.88[a]	9.05[a]	9.37[a]	9.95[a]	9.32[a]	10.08[a]	10.74[a]	9.13
	T_2	Week	48.00[a]	47.60[a]	63.40[a]	58.53[a]	62.67[a]	70.20[a]	58.13[a]	65.00[a]	67.07[ab]	60.07
		Daily	6.86[a]	6.80[a]	9.06[a]	8.36[a]	8.95[a]	10.03[a]	8.31[a]	9.29[a]	9.58[ab]	8.58
Feed consumption DM (g) $\bar{x}$	T_0		43.20[a]	44.50[a]	48.40[b]	50.80[b]	59.80[b]	63.00[b]	67.00[b]	76.00[b]	82.00[a]	59.30
	T_1		40.00[a]	43.70[a]	50.00[b]	54.00[b]	62.00[b]	68.00[b]	69.00[b]	76.00[b]	85.00[a]	60.96
	T_2		44.00[a]	45.00[a]	60.00[a]	61.00[a]	65.80[a]	73.80[a]	73.00[a]	82.00[a]	85.00[a]	65.51
Feed conversation	T_0		6.26[a]	6.47[a]	5.78[b]	6.13[b]	6.18[b]	6.60[b]	7.80[b]	7.99[b]	8.84[a]	6.89
	T_1		5.83[a]	5.55[a]	5.63[b]	5.97[b]	6.62[b]	6.83[b]	7.51[b]	7.54[b]	7.91[b]	6.59
	T_2		6.41[a]	6.62[a]	6.62[a]	7.30[a]	7.35[a]	7.36[a]	8.78[a]	8.83[a]	8.87[a]	7.57

[a,b]Different letters in the same column within each variable indicate statistically significant difference ($p < 0.05$).

According to the results, the lowest cholesterol values were obtained in guinea pigs fed with fresh alfalfa only (T_0); on the other hand, in guinea pigs fed with Ryegrass and concentrate (T_2), triglycerides showed the lowest values; however, in the three groups, the amounts were close. Table 2.

Table 2
Blood cholesterol and triglyceride values in guinea pigs, by treatment.

Parameters	Treatment	n	Beginning	Final	Average
Cholesterol (mg/dL)	T_0	1	37.9	43.5	40.7
	T_1	1	54.8	59.6	57.2
	T_2	1	66.8	70.2	68.5
Triglycerides (mg/dL)	T_0	1	56.9	61.7	59.3
	T_1	1	56.0	59.0	57.5
	T_2	1	52.2	57	54.6

Discussion

Guinea pigs have a wide capacity to utilize different types of food, they make good use of all types of food, from food rich in fiber to food rich in protein; even though fiber has a lower nutritional value, guinea pigs make better use of it than other monogastric animals by having a functional caecum, generating a lower utilization of nutrients and metabolizable energy, likewise, the protein contribution contributes to the higher utilization of energy, even concentrates and other supplements improve their nutritional contribution when they are included in the diet [4, 6, 9], seeking to insert and meet the requirements that the market demands, standard guinea pigs of size and quality [10]. In this way, guinea pigs with better live weights could be obtained by feeding alfalfa supplemented with balanced feed, as happened in the present research work.

Although the average values obtained in the integral and mixed feeding systems are close or have no statistical differences [11–13], guinea pigs fed under a mixed system acquire better productive parameters [14], with higher final weights and daily weight gains, translated into better carcass yield; however, with higher feed consumption [15]. Similarly, in the present study, a higher weight gain was achieved in the group fed with alfalfa and balanced feed (T_1), and no statistical differences were found at the end of the evaluation in terms of feed consumption.

The association of alfalfa and balanced feed gave a better feed conversion, differing statistically from the group fed with Ryegrass and balanced feed; this difference is due to the nutritional properties of the forage since, in general, a more efficient feed conversion has been obtained with integrated feeding [15–17]. Despite the fact that feeding alfalfa alone or associated with concentrate does not give the same results as mixed or integral feeding [11, 13], the addition of alfalfa or other green forage is necessary for tooth wear and thus avoid malocclusions that affect feed intake [18].

The lowest cholesterol values were obtained in guinea pigs fed fresh alfalfa, a forage with high protein content; being higher in the other groups supplemented with balanced feed (high in carbohydrates), which agrees with a study indicating that dietary carbohydrate restriction decreases the accumulation of cholesterol in the aortas and decreases the expression of aortic cytokines, in addition, plasma triglycerides are reduced, increasing HDL cholesterol and promoting the formation of larger and less atherogenic LDL [7].

Although there were no significant differences, triglyceride values were lower in the group fed Ryegrass (54.6 mg/dL). Compared with other species, as in pigs with genetically high (150 mg/dL) or low (124 mg/dL) serum cholesterol levels [19], cows (135.8 ± 1.362 mg/dL) [20], sheep (82.74 ± 4.36 mg/dL) [21], lambs (83.4 mg/dL) [22], rabbit (215.99 mg/dL) [23]; even Muscovy and mallard ducks have much higher serum cholesterol values [24] than those found in the present study.

Thus, the guinea pig is positioned as a contributor to food safety due to its health properties and high protein, B vitamins, linoleic and linolenic acid, and low saturated fat and cholesterol content [25, 26].

Desirable fats are those referred to as the sum of monounsaturated fatty acids, polyunsaturated fatty acids, and C18 fatty acids [27]. The recommended ratio of polyunsaturated fatty acids (PUFA) to saturated fatty acids (P/S) should be greater than 0.4; given that some meats naturally have a P/S ratio of about 0.1, meat has been implicated in causing unbalanced fatty acid intake by consumers [28]. In addition, a dietary imbalance of the n-6:n-3 polyunsaturated fatty acid ratio can affect human health, especially with a high n-6:n-3 ratio; therefore, it is recommended a ratio of n-6:n-3 be nearly 3:1 to 1:1 [29]. Therefore, P/S and n-6/n-3 ratios should be improved in guinea pig meat; however, in this process, also undesirable fats increase [30], then it is necessary to deepen the subject since the concentration of n-3 PUFA in animal tissues depends mainly on the fatty acid composition of the diet [31], where linoleic acid (C18:2 n6), linolenic acid (C18:2 n3), oleic acid (C18:1 n9), stearic acid (C18:0) and especially palmitic acid (C16:0), palmitoleic acid (C16:1), myristic acid (C14:0) and lauric acid (C12:0) are found [30].

Finally, It is concluded that guinea pigs fed alfalfa and balanced supplement have superior weight gain and feed conversion; however, blood cholesterol and triglyceride levels are lower in guinea pigs fed only fresh alfalfa and Ryegrass/balanced feed, respectively.

Declarations

Ethics approval and consent to participate

Written permission of owner was taken for the usage of their animal in the study. All experimental protocols of the present study were approved by the Comité de la Unidad de Investigación de la Facultad de Ciencias Veterinarias, de la Universidad Nacional de Cajamarca. They also declare that all methods were carried out in accordance with the pertinent guidelines and norms regarding animal welfare and the use of animals in research. In turn, all methods are reported in accordance with the ARRIVE guidelines for the reporting of animal experiments. In addition, the study was contemplated under the guidelines of the Ley de protección y bienestar animal del Estado peruano (Ley N° 30407) and European ethical regulations (European Directive 2010/63/EU).

Consent to publish

NA.

Availability of data and materials

The authors declare that they have the availability of data and materials available if needed. Please, contact LVR (lvargasr17_1@unc.edu.pe).

Competing interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Authors Contribution

All authors contributed to the conception, design of the study, supervised, and conducted the research. Henry Herrera Collantes and José Niño Ramos contributed to the Software, validation, data curation, writing-preparation of original drafts. Luis Vargas Rocha and Severino Torrel Pajares collaborated in viewing, writing-reviewing and editing the manuscript. All authors read and approved the final manuscript.

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