
Productive performance of growing tricross rabbits considering two commercial feeds

Desempenho produtivo de coelhos tricross em crescimento considerando duas rações comerciais

Performance productiva de conejos tricross en cebo considerando dos piensos comerciales

Luiz Carlos Machado¹, Dianas Luísa Pereira², Denise Stéphanie de Almeida Ferreira³, Cynthia Pieri Zeferino⁴, Guilherme Rocha Moreira⁵, Lucas Silva do Amaral³

¹Professor – IFMG – Brazil. E-mail: luiz.machado@ifmg.edu.br

²Animal Science Undergraduate Student – IFMG - Brazil

³Animal Science Doctorate Student – UFRPE - Brazil

⁴Professor UNIVERSIDADE BRASIL - Brazil

⁵Professor – UFRPE – Brazil

ABSTRACT

Some Brazilian studies have evaluated crossbred rabbits from two breeds, however, there is no research on the performance of rabbits descended from three breeds (tricross), especially involving the Botucatu (BOT) genetic group. Another important aspect to consider is that rabbit feeds produced in Brazil have different qualities and often do not meet the species nutritional requirements. The objective of the study was to evaluate the productive performance of tricross rabbits that received two commercial feeds. On day 35, forty tricross ($\frac{1}{2}$ BOT, $\frac{1}{4}$ NZW, $\frac{1}{4}$ CAL) rabbits were randomly assigned to cages (2 rabbits/cage). A completely randomized design was considered, with two treatments based on commercial feeds (COM1 and COM2) of different qualities and 10 replications per treatment. The productive performance (body weight at 35, 55 and 75 d, and feed intake, daily weight gain and feed conversion from 35 to 55, 55 to 75 and 35 to 75 d) was evaluated. The COM1 contributed to heavier rabbits at 55 and 75 d and better feed conversion rate. Also, the COM1 provided better daily weight gain from 35 to 55 d and 35 to 75 d. In conclusion, considering the Brazilian conditions, tricross rabbits show appropriate productive performance, which will depend too of the quality of the commercial feed chosen by the rabbit breeder.

Key words: Botucatu genetic group, crossbreed, growing kit, rabbit breeding, heterosis

RESUMO

Alguns estudos brasileiros avaliaram coelhos mestiços provenientes de duas raças, porém, não há pesquisas sobre o desempenho de coelhos descendentes de três raças (tricross), principalmente envolvendo o grupo genético Botucatu (BOT). Outro aspecto importante a ser considerado é que as rações para coelhos produzidas no Brasil apresentam qualidades diferenciadas e, muitas vezes, não atendem às exigências nutricionais da

espécie. O objetivo deste estudo foi avaliar o desempenho produtivo de coelhos tricross que receberam duas rações comerciais. Na idade de 35 dias, quarenta coelhos tricross ($\frac{1}{2}$ BOT, $\frac{1}{4}$ NZW, $\frac{1}{4}$ CAL) foram distribuídos aleatoriamente em gaiolas (2 coelhos/gaiola). Foi considerado um delineamento inteiramente casualizado, com dois tratamentos baseados em rações comerciais (COM1 e COM2) de qualidades distintas e 10 repetições por tratamento. Avaliou-se o desempenho produtivo (peso corporal aos 35, 55 e 75 dias e consumo de ração, ganho de peso diário e conversão alimentar dos 35 aos 55, 55 aos 75 e 35 aos 75 dias). A ração comercial COM1 proporcionou coelhos mais pesados aos 55 e 75 dias e melhor conversão alimentar. Além disso, os animais que receberam esta ração demonstraram melhor nível de ganho de peso diário dos 35 aos 55 e dos 35 aos 75 dias de idade. Em conclusão, considerando as condições brasileiras, coelhos tricross apresentam desempenho produtivo apropriado, o qual dependerá também da qualidade da ração comercial escolhida pelo produtor.

Palavras-chave: grupo genético Botucatu, mestiços, láparo, cunicultura, heterose.

RESUMEN

Algunos estudios brasileños han evaluado conejos híbridos de dos razas, sin embargo, no existen investigaciones sobre la performance productiva de conejos descendientes de tres razas (tricross), especialmente involucrando al grupo genético Botucatu (BOT). Otro aspecto importante a considerar es que los piensos comerciales para conejos producidos en Brasil tienen diferentes calidades y muchas veces no cumplen con los requerimientos nutricionales de la especie. El objetivo del estudio fue evaluar la performance productiva de conejos tricross que recibieron dos piensos comerciales diferentes. El día de edad 35, cuarenta conejos tricross ($\frac{1}{2}$ BOT, $\frac{1}{4}$ NZW, $\frac{1}{4}$ CAL) fueron asignados aleatoriamente a 20 jaulas (2 conejos/jaula). Se consideró un diseño completamente al azar, con dos tratamientos a base de piensos comerciales (COM1 y COM2) de diferentes calidades y 10 repeticiones por tratamiento. Se evaluó la performance productiva (peso corporal a los 35, 55 y 75 d, y consumo de pienso, ganancia de peso diaria y conversión alimenticia de 35 a 55, 55 a 75 y 35 a 75 d). El COM1 proporcionó conejos más pesados a los 55 y 75 días y una mejor tasa de conversión alimenticia. Además, el COM 1 proporcionó una mejor ganancia de peso diaria de 35 a 55 d y 35 a 75 d. En conclusión, considerando las condiciones brasileñas, los conejos tricross muestran performance adecuada, la cual dependerá también de la calidad del pienso comercial elegido por el criador.

Palabras clave: grupo genético Botucatu, mestizos, gazapo, cunicultura, heterosis.

Introduction

The rabbit is the most versatile among domestic animals if considered the range of products and services that could be obtained from its commercial production, which may be well suited for the economic, social and environmental sustainability (BONAMIGO et al., 2017; MACHADO, 2019). Studies that involve

strategic crosses for the production of rabbits with excellent performance and, consequently, greater producers' profit margin are recommended for a competitive rabbit meat production.

Unlike Europe and China, where commercial strains of rabbits are used for meat production, in Brazil, most of the animals are descended from matings

between the same breed or without a defined genetic pattern. Although some studies have evaluated crossbred rabbits from two breeds, there is no Brazilian research on the performance of rabbits descended from strategic matings using three breeds (tricross).

Botucatu (BOT) is the only genetic group developed in Brazil, which was obtained from meticulous genetic enhancement for better prolificacy and productive potential of growth (MOURA, 2000). However, due to the high inbreeding in original herd, studies involving the crossing of purebred BOT with synthetic rabbit breeds, such as New Zealand White (NZW) and Californian (CAL) is highly recommended (MOURA, 2017). These crosses have beneficial effects provided by hybrid vigor or heterosis, which provides progeny average higher than the parent's average (JAOUZI et al., 2004; BIANOSPINO et al., 2006).

Another important aspect to consider is that rabbit commercial feeds produced in Brazil have different qualities (MACHADO et al., 2012; RISI, 2021) and often do not meet the nutritional requirements of the species. In addition, the high price of agricultural commodities after pandemic period has impacted the costs in rabbit feeding, with consequent worsening of feed nutritional

quality (MACHADO and MORAES, 2021).

The objective of the present study was to evaluate the productive performance of tricross rabbits ($\frac{1}{2}$ BOT, $\frac{1}{4}$ NZW and $\frac{1}{4}$ CAL) that received two commercial feeds.

Material and Methods

This experiment was conducted in the rabbitry of the Federal Institute of Science and Technology, Bambuí Campus, from December 2020 to February 2021. The approval of the Institutional Animal Care and Use Committee was registered under number 11/2020. The average of the daily minimum and maximum temperatures were 18.9 and 30.0°C, respectively.

Crossbred rabbit does ($\frac{1}{2}$ NZW, $\frac{1}{2}$ CAL) received semen from BOT males. On day 35, a total of 40 (no gender balance) tricross ($\frac{1}{2}$ BOT, $\frac{1}{4}$ NZW, $\frac{1}{4}$ CAL) rabbits were randomly assigned to galvanized steel cages (60 x 60cm; 2 rabbits per cage), equipped with semi-automatic feeders and nipple drinkers.

The treatments consisted of two commercial feeds (COM1 and COM2) of different qualities, according to the guarantee levels (Table 01). Feed and water were provided on *ad libitum*

access. Each cage with two rabbits was considered a repetition

Table 01 – Commercial feeds used for raising of tricross rabbits

Parameter	Guarantee levels per kg of the product	
	COMMERCIAL1*	COMMERCIAL2**
Minimum crude protein (%)	17.0	17.0
Maximum moisture (%)	13.0	12.0
Minimal ethereal extract (%)	3.0	2.9
Maximum fibrous matter (%)	17.0	15.0
Maximum acid detergent fiber (%)	16.0	18.0
Maximum mineral matter (%)	10.0	10.0
Minimum phosphorus (%)	0.5	0.5
Minimum calcium (%)	0.9	0.9
Maximum calcium (%)	1.2	1.0
Nutritional value obtained from chemical-bromatological analysis		
Crude protein (%)	16.7	14.7
Acid detergent fiber (%)	17.7	17.8
Dry matter (%)	90.4	90.3
Moisture (%)	9.6	9.7
Mineral Matter (%)	9.7	14.3

*Enrichment provided per kilogram of product (minimum values) - Na: 0.2%, Fe: 30 mg, Cu: 15 mg, Mn: 40 mg, Zn: 65 mg, I: 1.3 mg, Co: 1.0 mg, Se: 0.2 mg, vitamin A: 10,000 IU, vitamin D3: 1,200 IU, vitamin E: 20 IU, vitamin K3: 1.0 mg, vitamin B1: 1.5mg, vitamin B2: 2.5mg, niacin: 15 mg, pantothenic acid: 5.7 mg, vitamin B6: 1.5 mg, folic acid: 2.0 mg, biotin: 0.07 mg, vitamin B12: 10mcg, choline: 650 mg, lysine: 0.8%, methionine: 0.3%. *Basic composition*: ground whole corn, corn gluten meal 21, rice husk, wheat bran, soybean bran, rice bran, oat hulls, cottonseed bran, dehydrated alfalfa, molasses, limestone, dextrin, sodium chloride, kaolin, carrot powder, iron sulfate, copper sulfate, manganese monoxide, zinc oxide, calcium iodate, cobalt sulfate, sodium selenite, vitamin A, vitamin D3, vitamin E, vitamin K3, vitamin B1, vitamin B2, niacin, pantothenic acid, vitamin B6, folic acid, biotin, vitamin B12, choline chloride, methionine, lysine, carvacrol-based flavoring, yucca extract, citrus fruit extract, oregano extract, ethoxyquin, propionic acid, acetic acid, ammonium propionate.

**Enrichment provided per kilogram of product (minimum values) - Na: 0.2%, Fe: 110 mg, Cu: 26 mg, Mn: 80 mg, Zn: 100 mg, I: 1.2 mg, Co: 10.0 mg, Se: 0.36 mg, vitamin A: 12,000 IU, vitamin D3: 1,440 IU, vitamin E: 45 IU, vitamin K3: 1.09 mg, vitamin B1: 8.9 mg, vitamin B2: 4.3 mg, niacin: 57 mg, pantothenic acid: 16.0 mg, vitamin B6: 5.8 mg, folic acid: 1.8 mg, biotin: 139 mg, vitamin B12: 11.76 mcg, choline: 1100 mg, lysine: 0.8%, methionine: 0.3%. *Basic composition*: whole ground corn, flavoring additive, limestone, sodium chloride, soybean hulls, soybean meal, wheat bran, kaolin, dicalcium phosphate, iron sulfate, copper sulfate, manganese sulfate, zinc sulfate, calcium iodate, cobalt sulfate, vitamin A, vitamin D3, vitamin E, vitamin B1, vitamin B2, niacin, calcium pantothenate, folic acid, antioxidant additive.

The productive performance of growing rabbits was evaluated according to the parameters: body weight at 35, 55 and 75 d of age, and daily feed intake, daily weight gain and feed conversion from 35 to 55, 55 to 75 and 35 to 75 d of age.

The experimental design was completely randomized, balanced in a double factorial between treatments (different types of feed) and periods (days or intervals). Therefore, variance

analysis (ANOVA) was performed with split plots, and Tukey's test was applied to compare means, with a significance level of 5% probability. All analyzes were performed using R software, version 4.1.2., considering the packages *easyanova* and *ExpDes.pt.* (R Project, 2022).

Results and Discussion

The COM1 contributed to heavier rabbits at 55 and 75 d of age

(Tables 02 and 03), which is related to its better nutritional quality, and confirmed by the best feed conversion rate. From the use of tricross rabbits fed with commercial feeds (COM1 and COM2), it would be possible to supply the slaughterhouses that require a minimum body weight of 2.3 kg, although for others that require 2.5 kg of body weight, it might be necessary to extend the growing phase for a few more days. There was no mortality during the experimental period.

Although weaning weight is closely related to birth weight (POIGNER et al., 2000), as well as the environment and weaning age, this parameter is extremely important for the rabbit farming, because it has direct impact on producer profits. In this sense, tricross rabbits show excellent weaning weight at 35 days (863.2g), which is higher than that observed by Falcone et al. (2020), who found values of 671.2g for NZW rabbits.

Table 02. Descriptive analysis of the productive performance of tricross rabbits from 35 to 75 days of age, according to two different commercial feeds.

<u>Variables</u>	COM 1					
	Minimum	Maximum	Average	Median	SD	CV(%)
Body weight at 35 d (g)	780.00	942.50	868.80	882.20	58.39	6.72
Body weight at 55 d (g)	1620.00	1832.00	1727.00	1722.00	69.09	4.00
Body weight at 75 d (g)	2297.00	2681.00	2461.00	2436.00	127.05	5.16
Daily weight gain from 35 to 55 d (g)	37.35	48.33	42.91	43.60	3.48	8.11
Daily weight gain from 55 to 75 d (g)	31.98	42.55	36.70	36.50	3.48	9.49
Daily feed intake from 35 to 55 d (g)	115.50	168.20	138.40	139.00	18.36	13.27
Daily feed intake from 55 to 75 d (g)	144.20	178.00	161.80	163.20	9.55	5.90
Feed conversion from 35 to 55 d	2.45	4.14	3.24	3.18	0.59	18.30
Feed conversion from 55 to 75 d	3.98	5.09	4.44	4.32	0.37	8.30

<u>Variables</u>	COM 2					
	Minimum	Maximum	Average	Median	SD	CV(%)
Body weight at 35 d (g)	769.00	955.00	857.50	863.00	67.30	7.85
Body weight at 55 d (g)	1435.00	1760.00	1616.00	1640.00	106.54	6.59
Body weight at 75 d (g)	2138.00	2503.00	2333.00	2348.00	125.05	5.36
Daily weight gain from 35 to 55 d (g)	30.55	47.50	37.92	38.14	6.02	15.88
Daily weight gain from 55 to 75 d (g)	31.90	40.52	35.84	35.65	2.74	7.65
Daily feed intake from 35 to 55 d (g)	109.60	188.20	143.2	135.50	30.54	21.32
Daily feed intake from 55 to 75 d (g)	139.00	198.30	168.8	173.10	20.63	12.22
Feed conversion from 35 to 55 d	2.83	4.99	3.84	3.84	0.64	16.67
Feed conversion from 55 to 75 d	4.23	5.27	4.69	4.76	0.37	7.80

SD: standard deviation; CV: coefficient of variation

Table 03. Multiple comparisons between the types of feed (COM 1 and COM 2) in the period from 35 to 75 days of age, considering the parameters of body weight, daily weight gain, daily feed intake and feed conversion of growing tricross rabbits.

Treatments	Body weight (g)			Averages*	<i>p-value</i> (ANOVA)		
	35d	55d	75d		Treatments	Periods	Interaction
COM1	868.75	1727.00	2460.90	1685.55 A	0.0015	<0.001	0.1276
COM2	857.55	1616.00	2332.90	1602.15 B			
Averages*	863.15 a	1671.50 b	2396.90 c				
Treatments	Daily weight gain (g)			Averages*	<i>p-value</i> (ANOVA)		
	35-55d	55-75d			Treatments	Periods	Interaction
COM1	42.91	36.69	39.80 A	0.0314	0.003	0.1212	
COM2	37.92	35.85	36.88 B				
Averages*	40.42 a	36.27 b					
Treatments	Daily feed intake (g)			Averages*	<i>p-value</i> (ANOVA)		
	35-55d	55-75d			Treatments	Periods	Interaction
COM1	138.36	162.39	150.37 A	0.4613	0.0026	0.9201	
COM2	143.20	168.75	155.98 A				
Averages*	140.78 a	165.57 b					
Treatments	Feed conversion			Averages*	<i>p-value</i> (ANOVA)		
	35-55d	55-75d			Treatments	Periods	Interaction
COM1	3.24	4.51	3.87 A	0.0387	<0.001	0.2405	
COM2	3.84	4.68	4.26 B				
Averages*	3.54 a	4.60 b					

* Values followed by distinct letters, being capitalized for treatments and lowercase for periods, represent a statistical difference (Tukey's test, $p < 0.05$).

Most Brazilian researches evaluated the performance of growing NZW rabbits. Ferreira et al. (2015) verified a body weight of 2.07 kg for 65-day-old rabbits. Araújo et al. (2016) found a value of 2.16 kg for 70-day-old rabbits. Falcone et al. (2020) indicated a body weight of 2.01kg for 84-day-old rabbits. Finally, Pascoal et al. (2020) registered a value of 1.94 kg for rabbits at 67 d of age. The great variation in the experimental conditions is evident, as well as the lack of experimental standardization for slaughter age in Brazilian experiments.

Some Brazilian researchers have worked with crossbred rabbits.

Bianospino et al. (2006) studied purebred (BOT) and crossbred (BOT x German Giant) rabbits and obtained an average weight of 2.00 kg, at 91 d of age. Gomes et al. (2021) studied hybrids ($\frac{1}{2}$ NZW x $\frac{1}{2}$ California) and recorded a body weight of 2.07 kg, at 90 d, which was very low when compared to the present work. Using the same commercial feed (COM1) and crossbred rabbits ($\frac{1}{2}$ NZW x $\frac{1}{2}$ BOT), Machado et al. (2021) showed lower weight (2.24kg) at 74 d of age. Although the experimental conditions are different in both studies, the results suggest an improvement in productive performance from the blend of three breeds.

The COM1 provided better daily weight gain from 35 to 55 d and 55 to 75 d of age (Tables 02 and 03), and this factor was correlated with the nutritional quality of the feed. The parameters daily weight gain and feed conversion are related too with the genetic potential of the rabbits, although they are influenced by several other factors. In this sense, considering the commercial feed with the best nutritional quality, it is noticed that tricross rabbits gain almost 40g per day. The use of tricross rabbits could be very interesting for the Brazilian rabbit farming, which lacks of strategies that provide better productive performance for the animals.

Considering the Brazilian experiments for comparison purposes, the average daily weight gain (39.8 g/day; Table 03) obtained with the COM1 in the present study was similar to Zeferino et al. (2011) (39.0g/day), who studied purebred (BOT) and crossbred (BOT x NZW) rabbits, and better than Ferreira et al. (2015), Araújo et al. (2016), Pascoal et al. (2020) and Machado et al. (2021) who observed the respective values of 38.1; 37.0; 34.9 and 36.5 g/day. Values below 30g/day were evidenced by Falcone et al. (2020), Gomes et al. (2021) and Sousa et al. (2022). These last authors worked in hot

climate conditions, which contribute for a fall in the performance level.

However, a negative aspect in the present study must be highlighted. A high level of daily feed intake (Tables 02 and 03) was necessary to reach that level of daily weight gain, which is not desirable in commercial farms, given that feeding is responsible for most of the costs on rabbit farming. In this sense, we encourage future research that includes the economic analysis of rabbit farming.

In addition to the great variation in the productive performance of rabbits in Brazil, the importance of improvements in breeding conditions should be highlighted, considering not only genetic aspects, but also ambience, health, management and nutritional factors. Based on optimized conditions in Europe, Araujo et al. (2017) recorded a value of 44.7 g/day for daily weight gain, from 37 to 71 d of age. This fact reinforces the need for greater specialization in Brazilian rabbit farming.

There was no statistical difference in daily feed intake ($p>0.05$, Table 03) between rabbits that received COM1 and COM2 feeds. The feed intake of growing rabbits is greatly influenced by different conditions. It was verified that the daily feed intake was very high when compared to other experiments.

According to this, it is postulated that rabbits had to regulate their nutrient intake from a higher feed intake, which suggests a lower load of absorbable nutrients provided by the commercial feeds, although digestibility was not carried out in the present study.

The COM2 (Table 01) has high mineral matter content, as well as different levels of some microminerals and vitamins when compared to those proposed by De Blas and Mateos (2010), for growing rabbits. This fact reinforces the need to improve Brazilian commercial feeds (Machado et al., 2012), which showed decreased quality from the pandemic period due to the higher agricultural commodity prices (MACHADO & MORAES, 2021). A high feed intake (129.3g/day) for commercial feed was also evidenced by Zeferino et al. (2011).

For comparison purposes, the feed intake (Tables 02 and 03) was higher in the present study when compared to Ferreira et al. (2015), Araújo et al. (2016), Falcone et al. (2020), Pascoal et al. (2020) and Gomes et al. (2021) who reported values of 119.8; 118.9; 104.5; 98.9 and 81.4 g/day, respectively. These authors used better balanced experimental feeds when compared to commercial feeds. It is evident that quality of feeds strongly

contributes to the great variation in the results of research carried out with rabbits in Brazil.

Feed conversion is one of the main production parameters and it is strictly related to the profits from rabbit farming. In the present study, the COM1 showed better feed conversion rate (Table 03), and thus greater feed efficiency when compared to the COM2. However, the rates are very high, and also representative from an economic point of view, which reinforces the need to improve nutritional aspects. Corroborating this statement, values such as 3.18; 3.22; 3.64; 3.01 and 3.32 (FERREIRA et al., 2015; ARAÚJO et al., 2016; FALCONE et al., 2020; PASCOAL et al., 2020 and GOMES et al. 2021, respectively) could be obtained from experimental feeds. The great variation in the values is also due to the duration of the experimental period, because rabbits slaughtered later show worse feed conversion rate.

Another genetic component may also be influencing these results. Bianospino et al. (2006) reported worse feed conversion rate (4.12) in both purebred (BOT) and crossbred (BOT x German Giant) rabbits, being these values similar to the average of the present study (4.06). In this sense, it is postulated that the genotype of giant

rabbits present in the BOT genetic group could have a negative influence on feed conversion (MOURA et al., 2000).

Conclusion

Tricross rabbits ($\frac{1}{2}$ BOT, $\frac{1}{4}$ NZW, $\frac{1}{4}$ CAL) show appropriate potential considering the productive performance, which will depend on the quality of the commercial feed chosen by the rabbit raiser. The use of these rabbits in Brazilian farms is promising and new studies associated with balanced feeds will allow to elucidate their real productive potential.

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