Turkish Journal of Veterinary and Animal Sciences

http://journals.tubitak.gov.tr/veterinary/

Research Article

Turk J Vet Anim Sci
(2020) 44: 945-949
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doi:10.3906/vet-1912-61

Effect of breed on growth performance and carcass quality attributes of apparently healthy male weanling rabbits under a conventional housing system

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Received: 18.12.2019 • **Accepted/Published Online:** 09.06.2020 • **Final Version:** 18.08.2020

Abstract: The present work was devised with an objective to assess growth performance and carcass quality attributes of male weanling rabbits of 5 different rabbit breeds (Dutch, New Zealand white rabbit, American black, wild, and dwarf brown) under a conventional housing system. Male weanling rabbits (n = 50; 10 per breed), weaned at about 4 weeks of age were studied for growth performance and carcass quality attributes at the 19th week of experimentation. The initial and slaughter weights of the animals were significantly ($P \leq 0.05$) different for all breeds, with the highest values noticed in wild rabbits (940.1 ± 48.2 and 1971.0 ± 632.0 g) followed by New Zealand white rabbits (792.1 ± 35.0 and 1594.0 ± 469.0 g) respectively. A similar trend was noticed inslaughter weight and daily weight gain per animal. Wild rabbits had significantly ($P \leq 0.05$) higher values for live weight, chilled carcass weight, reference carcass weight, and dressing–out percentage (2500 ± 676.1 g, 2070 ± 445.0 g, 67 ± 3.2%, and 48 ±1.9% respectively) as compared to their counterpart breeds. The results for mean values ofweight percentages of tissue showed that only the hind limb percentage and bone percentage were found to be significantly ($P \leq 0.05$) different among the 5 study breeds. It is concluded that breed is the main determinant of growth performance and carcass quality attributes in rabbits. In order to attain increased slaughter weight, heavier genotypes (wild and New Zealand white) are recommended.

Key words: Growth performance, carcass quality, weanling rabbits

1. Introduction

It has been well established that the global demand for meat will be 75% higher by 2050 keeping in view the global population boom and decreasing natural resources [1]. The larger part of this increase will be in the developing and underdeveloped countries [2]. Along with this increasing demand, changes in diet pattern and meat consumption are also being witnessed [3]. These trends have led the researchers to navigate various forms of meat for human consumption having prime characteristics of being healthy, affordable, having low saturated fatty acids, and higher unsaturated fatty acids [4].

Lately, the domestic rabbit (*Oryctolagus cuniculus*) is emerging as a potential alternate meat source throughout the world in general, and in developing countries specifically[5,6]. The prime reasons for navigating rabbits as potential meat source are their better meat quality attributes, ease of maintenance, high prolificacy and fecundity, earlier sexual maturity, and short generation cycles [7,8]. Considering the importance and role of this small species, it is being dubbed as 'microlivestock' within other small livestock [9].

The livestock sector in Pakistan shared 60.54% of agriculture and 11.22% of the national gross domestic product (GDP) during 2018–2019 per the economic survey of Pakistan. An increase of 4.0% has been noted in the gross value contribution of livestock as compared to last year. Similarly, there has been a gradual increase in the livestock population on an annual basis. Rabbit farming in Pakistan has not yet attained a commercial status and only smallscale backyard rearing is being carried out, mostly in parts of the Khyber Pakhtunkhwa province. The data reported on rabbits from Pakistan are mostly focused on production parameters [10], morphometric attributes [11], and meat quality parameters under specific feeding regimens [1,12]. However, to the best of our knowledge, no work has been reported on growth performance and carcass attributes/meat quality parameters of apparently healthy rabbits being reared on a smallscale in Pakistan. It seems inevitable to know these physiological parameters of rabbits to incorporate them for meat purposes and to enhance the meat industry in the country. The present work thus has been devised with an objective to assess growth performance and carcass quality attributes of male

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weanling rabbits of 5 different rabbit breeds (Dutch, New Zealand white, American black, wild, and dwarf brown) under a conventional housing system.

2. Materials and methods

2.1. Experimental animals and housing

The present study was conducted at the University of Veterinary and Animal Sciences (UVAS), Lahore, Pakistan (Ravi Campus), in the Wildlife and Ecology Animal Housing Facility. The duration of the experiment was 19 weeks.

A total of 50 male weanling rabbits (10 per breed for Dutch, New Zealand white, American black, wild, and dwarf brown), weaned at about 4 weeks of age, and belonging to homogenous litters were attained from a local vendor and breed identification was finalized through morphometric attributes and color [13]. These breeds are already being reared on a smallscale basis in Pakistan. The rabbits were reared under a conventional housing system in colony cages (65 × 40 × 32cm) at a stocking density of 0.06 m^2 per rabbit. They were acclimatized to their housing and feeding pattern for 1 week prior to the initiation of the experimental trial. An appropriate and similar diet pattern was maintained throughout the trial with pelleted feed (17.7 CP, 12.13 MJ/kg DE) and ad libitum alfalfa hay from the 2nd week until slaughtered at the 19th week of the experiment.

2.2. Growth performance and carcass attributes

The growth attributes i.e. body weight, head length, body length, tail length, trunk length, ear length, fur length, forelimb length, and hind limb length of animals were recorded weekly at postweaning age (4 weeks) until slaughter.

At 19th week of the study, all the animals were slaughtered,and carcasses were prepared per the protocols levied by the World Rabbit Science Association as given elsewhere [1]. The skin, distal parts of tail, hindlimbs, forelimbs, digestive tract, and urogenital organs were removed. Hot carcasses were suspended in a ventilated area for 30 min and later on chilled at 3–4 °C. Accordingly, the live weight, chilled carcass weight (CCW), reference carcass weight (RCW), dressingout percentage (DOP), and dissectible fat (DFaP) were calculated. The DOP was calculated as [14]:

Carcass weight/live body weight × 100

The RCW was the carcass without the head and organs but included only meat, fat, and bone.

The weight percentages of various tissues/organs (head, meat–to–bone ratio, loin, forelimb, hind limb, thoracic viscera, liver, kidney, stomach, small intestine, large intestine, bone, and thoracic cage) were deduced from the total percentage of CCW at the time of slaughter (19th week) [1].

2.3. Statistical analysis

All statistical analyses were conducted using the Statistical Package for Social Sciences (SPSS for Windows Version 13, SPSS Inc., Chicago, IL, USA). Results were expressed as mean (±SE) and the difference of various growth performance and carcass quality attributes within the 5 breeds of rabbits were deduced using ANOVA, followed by Duncan's multiple range test posthoc. Significance was considered at $P \leq 0.05$.

3. Results and discussion

The present study is the first of its kind being reported on 5 different breeds of rabbits (Dutch, New Zealand white rabbit, American black, wild, and dwarf brown) under a conventional housing system. These breeds are being reared at a smalllocal scale in Pakistan. Apart from lowlevel usage for meat consumption, they are used in various research facilities and academic institutes in Pakistan. Growth performance and carcass quality attributes of male weanling rabbits were assessed in the present study.

The initial body weight at weaning in the rabbit breeds of the present study was significantly different within all breeds at the time of initiation of the experiment. It was highest in the wild breed followed by the New Zealand breed. This difference is attributed to genetic differences in differing breeds as elucidated earlier [15]. By the time of their weaning, differences in weight became evident in different rabbit breeds.

The mean (± SE) values for body weight of 5 breeds of rabbits are given in Table 1. The initial and slaughter weights of animals were significantly ($P \leq 0.05$) different for all breeds with the highest values noted in wild rabbits (940.1 ± 48.2 and 1971.0 ± 632.0 g), followed by New Zealand White rabbits (792.1 ± 35.0 and 1594.0±469.0 g), respectively. A similar trend was observed in the slaughter weight and daily weight gain per animal in the 5 breeds being highest in wild rabbits followed by New Zealand rabbits. Comparing the results with earlier published reports, it was noted that wild indigenous rabbits in various geographical entities of the world have higher daily weight gain and hence earlier maturity, weight gain, and body size [16,17]. Our results are in line with earlier published data on New Zealand rabbits [18,19]. However, a higher slaughter weight ranging from 1700 g to 1730 g for male New Zealand rabbits has been reported earlier [20,21]. Lower values have been reported while working on sesame seed meal [6]. The differences could be attributed to difference in slaughter age, timing of experimentation, weaning age, and feeding pattern [19,21].

The overall mean (± SE) values forvarious growth performance attributes of the 5 breeds of male rabbits i.e. head length, body length, tail length, trunk length, ear length, fur length, forelimb length, and hind limb length as recorded at the 19th week are given in Table 2. All of the parameters were significantly (P ≤ 0.05) different in the males of all 5 rabbit breeds under study except for head length and fur length. The wild rabbits had higher values followed by New Zealand rabbits. However, all of the parameters were within physiological ranges as presented elsewhere [13,16,19].

The mean (± SE) values for carcass characteristics revealed that all of the studied parameters were significantly (P ≤ 0.05) different within the breeds (Table 3). Wild rabbits had significantly (P ≤ 0.05) higher values of live weight, CCW, RCW, and DOP (2500 ± 676.1 g, 2070 ± 445.0 g, 67 ± 3.2%, and 48 ± 1.9% respectively) as compared to their counterpart breeds. These were followed by the values in New Zealand white rabbits (2055 ± 633.3g, 1590 ± 334.0 g, 64 ± 2.0%, and 44 ± 1.8% respectively). The results of wild rabbits are in line with various research conducted on wild and indigenous rabbits [13,16,22].

Table 1. Mean (±SE) values of body weight of 5 breeds of male rabbits of 19 weeks at slaughter*.

Breeds	Initial body weight (g)	Slaughter weight(g)	Daily weight gain per rabbit(g)
Dutch	673.2 ± 16.1^c	1414.0 ± 438.0^c	5.8 ± 0.8^b
New Zealand white	792.1 ± 35.0^b	1594.0 ± 469.0^b	6.3 ± 1.2^b
American black	605.2 ± 30.1^d	1147.0 ± 338.0^d	4.3 ± 0.6^c
Wild	940.1 ± 48.2^a	1971.0 ± 632.0^a	8.1 ± 1.3^a
Dwarf brown	533.3 ± 33.2^e	1093.0 ± 350.0^e	4.4 ± 0.6^c

*Different superscripts within columns differ at P ≤ 0.05.

Table 2. Mean (± SE) values ofgrowth attributes of 5breeds of male rabbits as recorded at19 weeks at slaughter*.

Breed	HL (g)	BL (g)	TL (g)	TrL (g)	EL (g)	FL (g)	FLL (g)	HLL (g)
Dutch	13.1 ± 0.3	46.5 ± 3.7^b	6.3 ± 0.3^b	33.3 ± 3.4^a	8.1 ± 0.3^a	1.6 ± 0.2	17.6 ± 2.4^b	25.7 ± 2.4^c
New Zealand white	14.0 ± 0.4	48.8 ± 3.5^b	6.4 ± 0.3^b	34.7 ± 3.1^a	6.8 ± 0.3^b	1.7 ± 0.2	19.3 ± 3.1^a	32.6 ± 3.8^b
American black	14.1 ± 0.5	45.0 ± 4.9^b	6.2 ± 0.4^b	30.8 ± 4.3^b	6.6 ± 0.5^b	1.6 ± 0.1	15.4 ± 1.4^b	22.1 ± 1.1^d
Wild	13.5 ± 0.2	56.2 ± 3.8^a	6.6 ± 0.2^b	42.6 ± 3.5^c	6.8 ± 0.3^b	1.7 ± 0.2	19.4 ± 2.4^a	34.6 ± 2.1^a
Dwarf brown	14.2 ± 0.5	46.4 ± 5.6^b	7.1 ± 0.2^a	32.0 ± 5.4^a	7.4 ± 0.3^a	1.8 ± 0.1	14.3 ± 0.7^b	21.4 ± 0.8^d

*Different superscripts within columns differ at P ≤ 0.05.
HL = Head length; BL = Body length; TL = Tail length; TrL = Trunk length; EL = Ear length; FL = Fur length; FLL = Forelimb length; HLL = Hindlimb length.

Table 3. Mean (±SE) values of carcass characteristics of 5 different breeds of male rabbits of 19 weeks at slaughter.

Breed	LW (g)	CCW (g)	RCW (%)	DOP (%)	DFap (%)
Dutch	1715 ± 502.0^d	1050 ± 342.1^d	61 ± 2.3^a	39 ± 1.2^c	2.9 ± 1.3^b
New Zealand white	2055 ± 633.3^b	1590 ± 334.0^b	64 ± 2.0^a	44 ± 1.8^b	3.0 ± 1.2^b
American black	1805 ± 425.0^c	1200 ± 202.1^c	53 ± 2.0^b	38 ± 1.2^c	3.2 ± 1.0^a
Wild	2500 ± 676.0^a	2070 ± 445.0^a	67 ± 3.2^a	48 ± 1.9^a	3.1 ± 1.2^b
Dwarf brown	1890 ± 429.1^c	1480 ± 312.2^b	57 ± 2.8^b	45 ± 1.9^b	2.7 ± 1.0^b

LW = Live weight; CCW = Chilled carcass weight; RCW = Reference carcass weight; DOP = Dressing out %; DFaP = Dissectible fat.
*Different superscripts within columns differ at P ≤ 0.05.

Table 4. Mean (±) values of weight percentages of tissue from 5 different breeds of male rabbits as calculated from total percentage of chilled carcass weight of 19 weeks age at slaughter.

Breed	HP %	M/B	LP %	FLP %	HLP %	LHP %	LvWP %	KvWP %	SP %	SIP %	LIP %	GITP %	BP %	TCP %
Dutch	8.0 ± 0.8	4.9 ± 0.1	24 ± 1.3	12 ± 0.7	37 ± 2.7^{a}	2.5 ± 0.2	7.3 ± 0.6	1.3 ± 0.2	3.6 ± 0.2	3.3 ± 0.2	76.1 ± 3.2	16.1 ± 1.9	10 ± 0.7^{b}	9.3 ± 0.8
New Zealand white	9.0 ± 0.7	4.8 ± 0.1	24 ± 1.3	13 ± 0.8	38 ± 2.7^{a}	2.7 ± 0.2	7.6 ± 0.7	1.3 ± 0.2	3.6 ± 0.2	3.5 ± 0.2	76.3 ± 3.1	15.9 ± 1.8	11 ± 0.8^{b}	9.4 ± 0.8
American black	8.0 ± 0.8	4.9 ± 0.2	23 ± 1.1	12 ± 0.7	35 ± 1.7^{b}	2.4 ± 0.3	7.4 ± 0.6	1.2 ± 0.2	3.6 ± 0.2	3.1 ± 0.1	76.4 ± 3.2	15.8 ± 1.8	12 ± 0.9^{a}	9.3 ± 0.7
Wild	9.0 ± 0.6	5.3 ± 0.2	24 ± 1.0	13 ± 0.8	38 ± 2.7^{a}	2.6 ± 0.2	7.5 ± 0.7	1.3 ± 0.2	3.6 ± 0.2	3.6 ± 0.2	76.6 ± 3.2	16.1 ± 1.5	13 ± 0.9^{a}	9.4 ± 0.8
Dutch brown	7.0 ± 0.8	4.8 ± 0.1	23 ± 1.1	11 ± 0.8	35 ± 1.7^{b}	2.5 ± 0.1	7.6 ± 0.8	1.3 ± 0.2	3.6 ± 0.2	3.5 ± 0.2	76.4 ± 2.9	15.9 ± 1.8	11 ± 0.7^{b}	9.2 ± 0.8

HP = Head %; M/B = Meat to bone ratio; LP = Loin %; FLP = Forelimb %; HLP = Hind limb %; LHP = Set of thoracic viscera %; LvWP = Liver weight %;
KyWP = Kidney weight %; SP = Stomach %; SIP = Small intestine %; LIP = Large intestine %; GITP = Gastrointestinal tract %; BP = Bone %; TCP = Thoracic cage %.
*Different superscripts within columns differ at $P \leq 0.05$.

However, in the New Zealand rabbits, it was noted that our values for CCW (1590 ± 334.0) were quite higher than those reported earlier [6,20,21], whereas the DOP values were in range per earlier references [6,21]. The genetic variation in breeds could be a plausible justification for these variations.

The results for mean values (± SE) of weight percentages of tissues as calculated from the percentage of CCW at slaughter are presented in Table 4. Among all studied parameters, only the hind limb percentage and bone percentage were found to be significantly ($P \leq 0.05$) different among the 5 study breeds. The hind limb percentage was higher in wild, New Zealand white, and Dutch breeds whereas the bone percentage was higher in wild and American black breeds. However, the values of all the parameters studied were those presented in previous studies [20,21,23]. The difference in hind limb and bone percentage in the present study could be a genetic attribute of the rabbits.

In general, it may be concluded that the wild and New Zealand white rabbit breeds show substantially better growth performance and meat quality attributes under a conventional housing system. This study also depicts that breed is a main determinant of growth performance and carcass quality attributes in rabbits. In order to attain increased slaughter weight, heavier genotypes (wild and New Zealand white) are recommended for commercial rearing in Pakistan. Also, a delay in the age of slaughter can also be utilized to attain maximum growth performance and carcass quality of rabbits. The study envisages future projects on rabbits with a larger population under various feeding regimens, use of feed additives, and extensive/detailed meat quality attributes such as oxidant/antioxidant levels.

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