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Reproductive Performance and Morphological Diversity in Indigenous Rabbits in Kurdistan and Standard White Strains

Bana sarwar[1].Questan Ali Ameen

Department of Animal Science, College of Agricultural Engineering Sciences, University of Sulaimani, Sulaymaniyah 46001, Iraq.

Abstract

This study investigated the morphometric and anatomical differences between local Kurdish rabbits and commercial rabbits. A total of 36 rabbits (18 Kurdish and 18 commercial, equally divided by sex) were assessed for external body measurements and internal organ weights. Results showed that there were considerable differences ($p \leq 0.05$) between the two strains. Commercial rabbits had higher body weight (1.693 kg vs. 0.640 kg), body length (35.5 cm vs. 25.0 cm), and internal organs like liver, kidney, and heart, as compared to Kurdish rabbits. Reproductive characteristics in females also benefited commercial rabbits, with higher ovary and uterus weight, but Kurdish strain had longer ears as well as higher phenotypic variation indicating local adaptation and genetic diversity.The statistical inference revealed solidly positive correlations for body weight with hip size ($r = 0.994$) and for liver and kidney weights ($r = 0.602$), reflecting a connection between the external morphology and internal development. Commercial strains may be more productive and fit for intensive meat production, but Kurdish rabbits' adapting characteristics and genetic diversity emphasize their merit in maintaining biodiversity as well as in sustainable breeding.

Keywords: Commercial White Rabbit, local rabbit, phenotypic.

Introduction

Rabbits are widely reared across the world for various purposes, including meat production, fur harvesting, and companionship as pets (Rabie et al., 2019). Different rabbit breeds exhibit variations in growth performance, body conformation, and organ development, which can influence their suitability for specific farming conditions (Dalle Zotte, 2002). In many developing countries, rabbit farming plays an essential role in improving household nutrition and generating income (Lebas et al., 1997; FAO, 1992).Commercial rabbits developed in the 1950s as a dwarf breed (around 2–4 lbs.), and Kurdish rabbits developed in the Kurdistan region (Iraq, Iran, Turkey, and Syria). Medium to large (varies by region) The Kurdish rabbit is not formally recognized by international rabbit breed organizations like ARBA or BRC but is considered a local or indigenous breed. (Ali, S. H. et al. (2022). Among the diverse breeds, local (Kurdish) rabbits and exotic (Commercial/Dutch) rabbits demonstrate distinct morphological and physiological traits that may affect their productivity and adaptability Iraqi, M. M. (2003) The local rabbit, a local breed, is known for its resilience and adaptation to regional environmental conditions, whereas the commercial rabbit, a standardized commercial breed, is recognized for its compact body size and high meat yield (Lukefahr et al., 2004). Comparative studies on these breeds' external characteristics—body length, waist circumference, ear length, tail size, and limb proportions—can provide insights into their growth patterns and breed-specific advantages (Ezzerouget.al.2019) Besides, the internal organ sizes entail liver, kidney, heart, and reproductive system dimensions that may determine metabolic efficiency and reproductive formation according to Szendrő et al. (2012). Knowing such anatomical peculiarities will provide selective breeding for meat characteristics, disease resistance, and general profitability for the farm. The present study does internal and external characteristics of local and commercial strain rabbits for comparative purposes relevant to how these differences may influence the commercial valuation of the rabbits under various farming systems toward a sustainable outcome (Adu et al., 2023).

MATERIAL AND METHODS

2.1 Data Collection

At the Department of Animal Science, College of Agricultural Engineering Sciences, University of Sulaimani, from February 9 to 12, 2025, the study was carried out. Thirty-six rabbits that were at least six months old were selected: 16 mixed-colored local rabbits and 16 commercially bred white rabbits, with an equal number of males and females (eight males and eight females in each group). So, two breeds were considered in this experiment: 18 Kurdish local rabbits and 18 commercial white rabbits. All rabbits were in good health and were about 6-7 months old.

2.2 Morphometric Assessments

Phenotypic characterization involved the assessment of observable traits such as coat color, facial features, and overall body size. These were complemented by morphometric measurements, including body length, chest circumference, and hind limb length, obtained using precision digital calipers. Standardized photography under controlled lighting conditions was employed to document coat pattern complexity, which was subsequently analyzed using ImageJ software. Post-mortem evaluations of the reproductive system included measurements of testicular volume, ovary weight, and uterine horn length, in addition to reproductive performance indicators such as litter size and birth weight.

External body:

Measurements were collected for all animals using a measuring tape (in centimeters) and a digital weighing scale (in kilograms). The recorded morphometric traits included:

1- Body weight (kg)

2-Body length (cm)

3-Waist circumference (cm)

4-Ear length (cm)

5-Tail length (cm)

6-Thigh length (cm)

7- Leg length (cm)

8-Forelimb (hand) length (cm)

9-Coat color (qualitative)

10-Eye color (qualitative)

Internal Organ Weights:

Following ethical euthanasia, internal organs were carefully dissected and weighed using a digital scale. The anatomical traits assessed included:

1-Breast weight (g)

2-Wing weight (g)

3-Leg weight (g)

4-Liver weight (g)

5-Kidney weight (g)

6-Heart weight (g)

7-Reproductive organ weight (g), differentiated by sex

Statistical Analysis

Statistical analyses were conducted using the General Linear Model (GLM) procedure in XLSTAT (version 2019). Group means were compared using Duncan's multiple range test. Descriptive statistics were reported as mean ± standard deviation. A two-way ANOVA was employed to examine the effects of sex, breed, and their interaction on the measured variables.

Result and Discussion

The morphometric comparison between commercial and local rabbit strains found that most morphological and anatomical parameters differed significantly, as shown in table (1). The commercial strain had a greater average weight of 1.693 kg compared to the local strain's 640.17 g, and also had a longer body length, measuring 35.5 cm on average compared to the local strain at 25.0 cm. Hand and leg measurements also differed significantly, with commercial birds measuring hands at lengths of 11.67 cm and legs at lengths of 10.0 cm, compared to the local rabbit with measurements of 8.33 cm and 6.83 cm for hands and for legs. Hip and ear measurements also had the same trend, being larger in the commercial strain (12.67 cm for hips and 10.17 cm for ears compared to the local strain (7.83 cm and 7.42 cm).Waists and tail lengths did not differ significantly, with the commercial strain that 25.83 cm and the tail length at 7.67 cm, as opposed to the local strain measuring at 23.5 cm and 6.5 cm.

Organ masses also found substantial differences in liver weight in the commercial strain, which was greater at 54.89 g vs. that in the local strain, which was at 24.47 g. Kidney masses weighed in at 12.54 g and 6.41 g, and heart masses weighed 5.10 g and 1.90 g in commercial and local birds, respectively. The testes and penis masses were not found to differ significantly (2.03 g vs. 0.17 g and 0.40 g vs. 0.11 g), but those of the ovary and uterus weighed in greater measure in commercial strain, at 1.01 g and 4.89 g, compared to those in the local birds at 0.51 g and 0.13 g. The carcass-yielding characteristics further reinforced the higher production potential in the commercial strain, with breast, back,

hand, and leg weight being significantly higher at 240 g, 237 g, 133 g, and 232 g, respectively, against those being 58 g, 80 g, 40 g, and 74 g in the local strain. These results are consistent with prior studies demonstrating that intensive selection in commercial breeds enhances growth rate, carcass yield, and organ development (Dalle Zotte & Szendrő, 2011; Lukefahr et al., 2014). In contrast, the Kurdish rabbits, traditionally reared under low-input backyard systems with minimal reproductive control, showed lower overall body measurements but exhibited longer ears and greater variation in coat color and temperament. Such features could be reflecting local adaptations to environmental stressors and reduced genetic homogenization (Khalil, 2002; Lebas et al., 1997). The lack of significant differences in waist and tail lengths and in testes and penis weights, may indicate that these traits are less subjected to artificial selection and thus probably remain largely under natural selection. In contrast, internal organ weights showed significant differences in the opposite direction: Commercial Lops had larger livers, kidneys, and hearts, calling to mind an enlarged metabolic and physiological aptitude that far surpasses the existing capacity imposed by reciprocal organ and system size and output due to the volume of the animal and higher productivity. In contrast to Commercial Lop representatives, the Commercial Lop showed a significant increase ($p < 0.01$) in weights of breast, back, leg, and hand muscles, thereby emphasizing its superiority as a meat-producing breed. In contrast, the Kurdish breed retains valuable traits such as adaptability, disease resistance, and genetic diversity, which are essential for sustainable breeding programs and resilience under diverse environmental conditions. Therefore, while commercial breeds offer advantages in productivity, conserving and selectively improving local breeds remains crucial for maintaining biodiversity and long-term genetic resources.

Table 1 illustrates the effect of strain on Morphometric and Organ Weight Parameters in Rabbits

Parameter s	Commercial (strain)	Local (strain)	Pr > F
weight	1.693±0.1 a	640.167 ±36.18b	0.000
length	35.500±1.05 b	25.000±0.89 a	0.001
waist	25.833±0.79 a	23.500±0.84 a	0.280

hands	11.667±0.33 b	8.333± 0.33a	0.001
leg	10.000± 0.25b	6.833±0.16 a	0.000
hip	12.667±0.98 b	7.833± 0.54a	0.009
ear	10.167±0.30 b	7.417 ±0.20a	0.001
tail	7.667 ±0.49a	6.500±0.22 a	0.256
liver	54.888 ±2.77b	24.471± 1.60a	0.000
kidney	12.538 ±1.17b	6.412±0.43 a	0.005
heart	5.097±0.36 b	1.903± 0.06a	0.000
testes	2.031±1.41 a	0.173±0.79 a	0.118
penis	0.398±0.25 a	0.107± 0.10a	0.121
ovary	1.010± 0.51a	0.510 ±0.22a	0.002
uterus	4.886±2.60 a	0.130 ±0.13a	0.005
breast weight	0.240± 0.015b	0.058±0.006 a	0.000
back weight	0.237± 0.020b	0.080± 0.005a	0.001
hand weight	0.133± 0.01b	0.040 ±0.001a	0.001
leg weight	0.232± 0.18b	0.074 ±0.004a	0.000

Different letters in the same column indicate significant differences between the lines at a significance level of $p \leq 0.05$).

Interaction between Strain and Sex

The comparative analysis of morphological traits and organ weights by interaction between commercial and local rabbit strains and sex, revealed several statistically significant differences. Notably, body weight was higher in local birds (693.67 ± 58 g for females and 586.67 ± 17 g for males) than in commercial birds (1.653 ± 0.20 kg for females and 1.733 ± 0.11 kg for males), indicating a substantial divergence in carcass mass. In contrast, commercial birds displayed significantly greater body lengths, averaging around 35 cm, whereas local birds measured closer to 25 cm. Waist circumference showed no significant variation between groups. Regarding extremities, commercial rabbit demonstrated superior measurements. Hand lengths were significantly longer in commercial females (12.00 ± 0.57 cm) and males (11.33 ± 0.33 cm) compared to their local counterparts. Similarly, leg lengths were significantly greater in commercial rabbit, whereas a questionable value was recorded for local males (0.292 ± 0.00 cm), suggesting a possible measurement error. Hip width followed the same trend, with the highest value observed in commercial females (14 ± 1.73 cm), and the differences were statistically significant. Ear length was also significantly higher in commercial birds, while tail length showed no significant

differences across groups. Internal organ analysis revealed that liver weight was considerably higher in commercial birds (approximately 53–57 g) compared to locals (24–25 g), with strong statistical support. The kidneys and heart followed similar patterns favoring commercial rabbit. As expected, reproductive organs displayed sexual dimorphism. Commercial females had significantly heavier ovaries and uteri than local females, while male reproductive organs (testes and penis) did not differ significantly between strains.

Regarding carcass components, commercial birds consistently exhibited higher weights in the breast, back, hand, and leg. For example, the breast weight peaked at 0.247 ± 0.02 kg in commercial males, whereas local birds recorded notably lower values. These trends were consistent across all carcass parts, with highly significant differences. In summary, commercial rabbit exhibited superior external dimensions and internal organ development, except for total body weight, which remained higher in local birds. These findings underscore the anatomical and phenotypic distinctions between commercial and local strains, offering insights relevant to breeding strategies, production efficiency, and consumer preferences.

Overall, the data clearly illustrate significant breed-related differences in morphometric and reproductive traits, with Commercial rabbits outperforming Kurdish rabbits in all measured parameters. Such discrepancies may be because of genetic selection for productivity in commercial breeds. These results go excellent with those of earlier studies attesting to the phenotypic superiority of exotics over indigenous rabbit lines with respect to body and organ development (Szendrő et al., 2012; El-Raffa, 2007).

Table 3. Illustrates Interaction of Breed and Sex on Morphological and Anatomical Parameters

Parameters	Commercial♀	Commercial ♂	Local ♀	Local ♂	Pr > F	Significant
weight	1.653±0.20 a	1.733 ±0.11 a	693.667 ±58 b	586.667 ± 17b	0.000	Yes
length	35.667 ±2.33 b	35.333 ±0.33 b	24.667 ± 1.85a	25.333 ±.66 a	0.001	Yes
waist	26.667± 1.45 a	25.000 ±.577 a	23.333 ±0.33a	23.667 ±1.85 a	0.280	No
hands	12.000 ±0..57c b	11.333 ±0.33bc	8.667 ±0.33ab	8.00±0.57 a	0.001	Yes
leg	10.333 ±0.33 b	9.667 ±0.33 b	6.667 ±0.33a	0.292 ±0.00a	0.000	Yes
hip	14±1.73	11.333 ± 0.33ab	7.667 ±1.20 a	8±0.00	0.009	Yes
ear	10.333±0.33 b	10.000 ±0.57 b	7.500 ±0.28 a	7.333 ±0.33 a	0.001	Yes
tail	0.333±0.57 a	7.333 ±0.88 a	6.667 ±0.33 a	6.333 ±0.33 a	0.256	No
liver	52.827 ±4.83 b	56.949 ±4.05b	24.114 ± 0.34a	24.828 ±3.55 a	0.000	Yes
kidney	11.196 ±1.20ab	13.879 ±1.89 b	6.990 ±0.70 ab	5.834 ± 0.35a	0.005	Yes
heart	4.758 ± 0.61b	5.437 ± 0.43b	1.948 ±0.09 a	1.857 ± 0.09a	0.000	Yes
testes	0.000 a	4.062 ±2.2 a	0.000 a	0.346 ±0.03 a	0.118	No
penis	0.000 a	0.796 ±0.41 a	0.000 a	0.213 ±0.21 a	0.121	No
ovary	2.020± 0.54b	0.000 a	1.021 ±0.04 ab	0.000 ±a	0.002	Yes
uterus	9.773 ±3.16a b	0.000 a	0.260 ±0.02 a	0.000 ±a	0.005	Yes
breast weight	0.233 ±0.03 b	0.247 ± 0.02b	0.063 ±0.001 a	0.036± 0.002a	0.000	Yes
back weight	0.230 ±0.03b	0.243 ± 0.02b	0.085 ± 0.09a	0.075 ±0.003 a	0.001	Yes
hand weight	0.140 ±0.02 b	0.127 ± 0.02b	0.048 ±0.01a	0.048±0.00 a	0.001	Yes
leg weight	0.232 ±0.03 b	0.232 ±0.02 b	0.078 ±0.006a	0.070 ±0.003 a	0.000	Yes

Different letters in the same column indicate significant differences between the lines at a significance level of $p \leq 0.05$).

Correlation Analysis

Table 4 presented the coefficients common between the body weight and the morphometric traits. The strongest positive correlations were found between body weight and hip size (r = 0.994) and body weight and waist size (r = 0.804). Meanwhile, El-Maghawry et al. (2018) also reported the same findings in New Zealand White and Baladi rabbits.

Positive correlations were also found in internal organs, particularly those for liver weight with kidney weight (r = 0.602). Such a case indicates that the development of organs scales with strong overall body growth, thus confirming reports by Ghosh et al. (2010).

Table 4. Correlation Matrix among Morphometric and Anatomical Traits in Rabbits

Variables	weight	length	Waist	hands	leg	hip	ear	tail	liver	kidney	heart	testes	penis	ovary	uterus	breast weight	back weight	hand weight	leg weight
weight	**0**																		
length	**0.272**	**0**																	
waist	**0.804**	**1.000**	**0**																
hands	**0.149**	**0.516**	**0.115**	**0**															
leg	**0.020**	**0.374**	**0.824**	**0.432**	**0**														
hip	**0.994**	**0.259**	**0.946**	**0.639**	**0.554**	**0**													
ear	**0.600**	**0.725**	**0.505**	**0.876**	**0.226**	**0.330**	**0**												
tail	**0.420**	**0.752**	**0.193**	**0.374**	**0.374**	**0.132**	**0.725**	**0**											
liver	**0.860**	**0.895**	**0.002**	**0.187**	**0.920**	**0.888**	**0.591**	**0.142**	**0**										
kidney	**0.001**	**0.331**	**0.595**	**0.098**	**0.016**	**0.821**	**0.526**	**0.231**	**0.602**	**0**									
heart	**0.087**	**0.489**	**0.227**	**0.102**	**0.103**	**0.544**	**0.663**	**0.039**	**0.167**	**0.022**	**0**								
testes	**0.168**	**0.686**	**0.742**	**0.252**	**0.386**	**0.800**	**0.575**	**0.477**	**0.978**	**0.206**	**0.478**	**0**							
penis	**0.379**	**0.670**	**0.491**	**0.704**	**0.704**	**0.908**	**0.226**	**0.374**	**0.563**	**0.418**	**0.415**		**0**						
ovary	**0.194**	**0.637**	**0.862**	**0.427**	**0.405**	**0.680**	**0.704**	**0.463**	**0.865**	**0.253**	**0.546**	**0.001**	**0.376**	**0**					
uterus	**0.672**	**0.016**	**0.824**	**0.704**	**0.704**	**0.141**	**0.876**	**0.374**	**0.949**	**0.738**	**0.893**	**0.386**	**0.704**	**0.282**	**0**				
breast weight	**0.028**	**0.498**	**0.679**	**0.213**	**0.006**	**0.442**	**0.280**	**0.124**	**0.587**	**0.005**	**0.012**	**0.342**	**0.626**	**0.395**	**0.873**	**0**			
back weight	**0.001**	**0.106**	**0.811**	**0.167**	**0.028**	**0.803**	**0.735**	**0.536**	**0.815**	**0.005**	**0.093**	**0.365**	**0.395**	**0.405**	**0.395**	**0.045**	**0**		
hand weight	**0.111**	**0.026**	**0.773**	**0.448**	**0.070**	**0.650**	**0.534**	**1.000**	**0.915**	**0.129**	**0.297**	**1.000**	**1.000**	**0.898**	**0.070**	**0.155**	**0.040**	**0**	
leg weight	**0.010**	**0.225**	**0.791**	**0.521**	**0.014**	**0.848**	**0.680**	**0.539**	**0.817**	**0.028**	**0.191**	**0.380**	**0.289**	**0.322**	**0.651**	**0.064**	**0.010**	**0.096**	**0**

Conclusion

This study gives a comparative study of morphometric and reproductive-related characters between native Kurdish rabbits and commercial whites raised under a controlled environment in the Kurdistan Region. Commercial rabbits showed the best growth performance, with a significant increase in body weight, body length, and internal organs, mainly liver, kidney, heart, ovaries, and uterus, probably as a result of genetic selection for enhanced productivity. In contrast, Kurdish rabbits are smaller but exhibit longer ears and greater phenotypic variability, which may be adaptive traits affected by certain environmental conditions or may be an indication of their high genetic diversity. A strong correlation was seen between body weight and organ size, mainly in hip and liver measurements. Also, females from both strains showed a higher degree of development of reproductive organs, as expected for their function. Thus, for intensive meat production, commercial strains are better, but for their adaptive traits and genetic variability, there is ample rationale for preserving indigenous rabbits. The results suggest the sustainability of breeding programs both for promoting productivity and for the conservation of native genetic resources.

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