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Muhammad Rizwan
Department of Zoology, University of Okara, Okara, Pakistan

Rana Manzoor Ahmad
Department of Zoology, University of Okara, Okara, Pakistan, manzoor.zoology@uo.edu.pk

Abdul Majid Khan
Institute of Zoology, University of the Punjab,Lahore, Pakistan

Misbah Khalid
Department of Zoology, University of Okara, Okara, Pakistan

Muhammad Wajid
Department of Zoology, University of Okara, Okara, Pakistan

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Craniometric Analysis of European Rabbit (Oryctolagus Cuniculus) Breeds to Trace out Intraspecific and Inter Gender Morphometric Variations

CRANIOMETRIC ANALYSIS OF EUROPEAN RABBIT (*ORYCTOLAGUS CUNICULUS*) BREEDS TO TRACE OUT INTRASPECIFIC AND INTER GENDER MORPHOMETRIC VARIATIONS

MUHAMMAD RIZWAN[1], RANA MANZOOR AHMAD[1], ABDUL MAJID KHAN[2], MISBAH KHALID[1], MUHAMMAD WAJID[1].

[1]*Department of Zoology, University of Okara, Okara, Pakistan.*
[2]*Institute of Zoology, University of the Punjab, Lahore, Pakistan.*

Corresponding author's email: manzoor.zoology@uo.edu.pk

ABSTRACT

The family Liproidae expresses the significant variation of morphometric features at species level. In already available literature on the European rabbit (*Oryctolagus cuniculus)* the idea is proposed that there can be variation in the morphometric character of different breeds of *Oryctolagus cuniculus* but there are negligible scientific research base evidences for it. So in this study interbreed craniometric comparison of the European rabbit is carried out to trace out their intergender and intraspecific morphometric variations. The study material consists of 32 sexually mature rabbits belong to two breeds of European rabbit that are New Zealand rabbit (eight males and eight females) and American Dutch rabbit (eight males and eight females) collected from different districts of the Punjab, Pakistan. There were 29 different measurements taken from the skull and mandible of both breeds by using digital and manual verniar calipers. The results of this study have revealed that there is significant interbreed variation in the nasal length measurement of the New Zealand and American Dutch rabbit. This significant interbreed difference in nasal length is observed in both female as well as male rabbits (p=0.0059 and 0.0069 respectively). The current study also depicts that inter gender craniometric variations exist in the New Zealand as well as American Dutch rabbit. The standard deviation of the foramen magnum index of the both included breeds is comparatively higher than all the other included morphometric features. This study provides the baseline data on interbreed craniometric variations in the *Oryctolagus cuniculus*.

Keywords: American Dutch rabbit, craniometric, interbreed, inter gender, New Zealand rabbit.

INTRODUCTION

The European rabbit is the rodent animal from family Liproidae (Demirsoy et al., 1992). The animals of family Liproidae are differ from that of family Octinidae (pikas) in that they have hind legs (longer than pikas), elongated ears and short, furry tail. Rabbit became popular as a pet because of its wide usage in research studies. Rabbits are frequently in use as a model in laboratories because they are mild and easily to handle and breed. Rabbits have been used as an experimental model for various human diseases, like cardiovascular disease, cancer and ADIS (Acquired Immunodeficiency Syndrome). Rabbit is also used as a bioreactor for the production of protein in pharmaceutical industries. The rabbit is the breed of choice for polyclonal antibody production. Rabbit is commonly used for testing toxicity and safety of substance such as drugs, chemical and medical devices. In past rabbit were used for the pregnancy testing.

There are some preceding morphometric studies implemented on the skulls of various animal species (Onar et al., 2002; Onar et al., 2005; Olopade et al., 2005; Uddin et al., 2013; Çakır et al., 2012). Even though there are also morphometric studies conducted on rabbits (Özkan, et al., 1997; Kahvecioğlu et al., 2000; Abreu et al., 2006). Some previous study show that the difference in the skull measurement is caused not only due to difference between the species and genera but also the age and gender difference between different individuals of the same species (Gürbüz et al., 2015). The comparative macro anatomic studies in rabbits conducted at gender level are limited (Taylor et al., 1977; Özkadif, 2011; Akbulut, 2014). In spite of the role of European rabbit (*Oryctolagous cuniculs*) in the experimental medical science all the previous inter gender craniometrics studies are at only the species but not at the breed level. As per the American Rabbit Breeders Association (ARBA) there are 48 known breeds of *Oryctolagous cuniculs*. This shows that the inter gender craniometric data should also be available to the zoologist and veterinary sciences researchers as a primary information on the breeds of rabbits but no such data is available up to best of our knowledge. This study is planned to conduct the inter gender craniometric analysis in two different breeds of *Oryctolagous cuniculs* that are New Zealand rabbit and American Dutch rabbit.

"There should be recognized that there is a great variety in shape and structure of rabbit skulls depending on breed." This statement is given in Meredith (2007) but no any craniometric comparative analysis has been conducted in any of the 48 known breeds of rabbits. Another aim of our study is to fill up this gap by evaluate the interbreed variation of skull morphometric features by using two different breeds of rabbits including New Zealand rabbit and American Dutch rabbit. The studied samples belong to the New Zealand rabbit breed are of two types; pure white in color with red eyes and pure black in color with black eyes. The New Zealand rabbit exist in five different colors according to ARBA. The two colors used in current study are common in Pakistan and preferred for laboratory use due to their suitable size and docile and calm nature. On the other hand, the second breed used in this study is American Dutch rabbit recognized by their beautifully patched body.

MATERIALS AND METHODS

Study Material

The specimens selected for the research purpose are elected from different villages and farms of the three districts of the Punjab, Pakistan; Okara, Sahiwal and Kasur. In the collected rabbits from these areas, are the animals that have the weight less than one kilogram or appearently not healthy were excluded from the study. One of the pragnent female rabbit was also there in the colletion and was excluded. The 32 sexually mature rabbits were selected for the current craniometric analysis. In these 32 rabbits; 16 belong to New Zealand rabbit breed (eight male and eight female rabbits) and 16 belong to American Dutch rabbit breed (eight male and eight female rabbits). Google lens and ARBA website are used for identification of breed of rabbits. Most of the specimens were collected from different villages, so

the feed of these rabbit are grasses, herbs, fruits and vegitables.

Craniometric Analysis

The rabbits having age of 6 to 8 month and body weight between 1-1.5 kg were used for the skull prepration. Slaughtering is the process used for collecting skulls of rabbits. After removing meat and gluteus material from the skull, classical steeping process was applied. The skull was prepared by boiling it in calciun carbonate and calcium bicarbonate and after boiling, the skulls were dunked in hydrogen peroxide (H_2O_2) to make them more apropriate for craniometric analysis. In this study 23 different measurement are taken from the skull (cranial and maxillary) of the New Zealand and American Dutch rabbit according to the morphometric features given in (Özkadif et al., 2016; Gürbüz et al., 2015; Monfared, 2013) and six measurements of mandible of New Zealand and American Dutch rabbit according to Pintur et al., (2014). All measurements are in mm and were taken by digital and manual Varner calipers. Indexes were calculated by using the method introduced by Onar et al., (2001).

Skull Measurements

L1. Skull length: From the dorsal lateral nasal cartilages to the external occipital protuberance, L2. Nasal length: Distance from the central point of the frontonasal sutura to the dorsal lateral nasal cartilages, L3. Cranial length: Distance from the central point of the frontonasal sutura to the external occipital protuberance, L4. Skull width: Distance between two zygomatic arches, L5. Cranial width: Distance between two external auditory meatus, L6. Nasal width: Maximum distance across the nasal bones or maximum distance between the naso-maxillary sutures, L7. Facial length: Distance from the frontonasal structure to the centre of the incisive bone, L8. Facial width: Distance between the caudal extents of the orbital rims, L9. Foramen magnum height: The distance between the midpoints of the dorsal ventral rims of the foramen magnum, L10. Foramen magnum width: The maximum distance between the two occipital condyles, L11. Condylobasal length: Aboral borders of occipital condyle - prosthion, L12. Basal length: L13. Dental length (post dental – prosthion): L14. Largest nasal length: L15. Parietal length (lambda – bregma): L16. Frontal length (bregma – nasion): L17. Length of the cheek teeth row (measured along the alveoli on the buccal side): L18. Diastema length: L19. Palatal length: L20. Maximum neurocranium width (euryon – euryon): L21. Skull width (distance between the temporal fossae): L22. Oral zygomatic width (between the oral parts of zygomatic arch): L23. Palatal width: (Figure 1, 2 and 3).

Mandible Measurements

L24 shows Length from angle to tip (excluding incisors); L25, Length of the cheek teeth row; L26, Length of the aboral border of the alveolus of M3-Infradentale to tip (excluding incisors); L27, Length of the diastema; L28, Height of the vertical ramus; L29, Height of the vertical ramus (Figure 4).

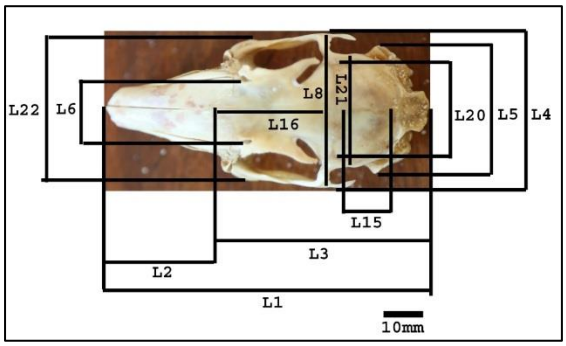

Figure 1: L1. Skull length, L2. Nasal length, L3. Cranial length, L4. Skull width, L5. Cranial width, L6. Nasal width, L8. Facial width, L15. Parietal length, L16. Frontal length, L20. Maximum neurocranium width, L21. Skull width (distance between the temporal fossae), L22. Oral zygomatic width.

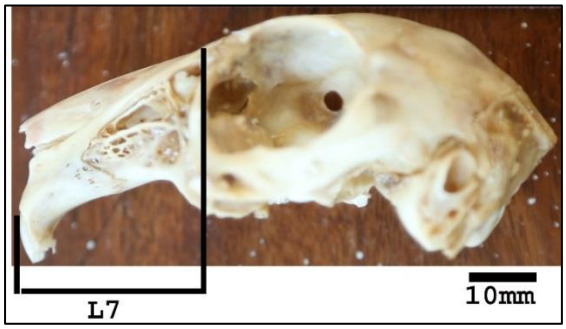

Figure 2: L7. Facial length: Distance from the frontonasal suture to the centre of the incisive bone.

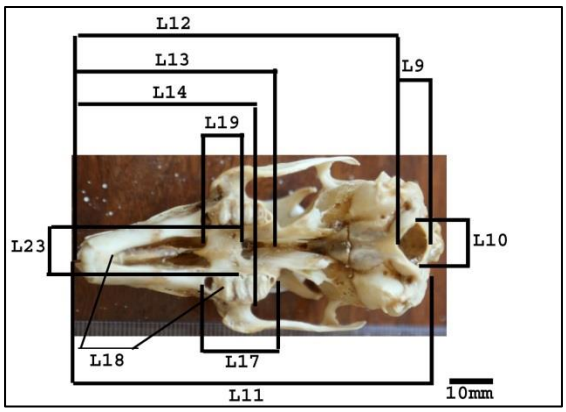

Figure 3: L9. Foramen magnum height, L10. Foramen magnum width, L11. Condylobasal length, L12. Basal length, L13. Dental length, L14. Largest nasal length, L17. Length of the cheek teeth row, L18. Diestema length, L19. Palatal length, L23. Palatal width.

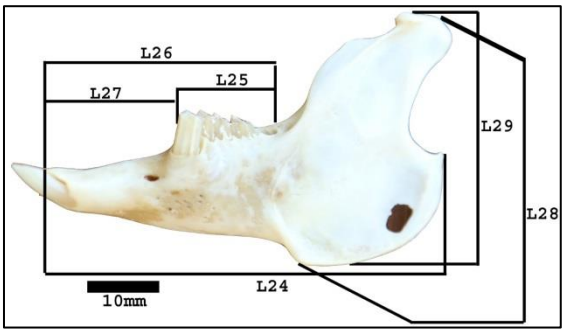

Figure 4: L24. Length from angle to tip (excluding incisors) L25. Length of the cheek teeth row, L26. Length of the aboral border of the alveolus of M3-Infradentale to tip (excluding incisors), L27. Length of the diastema, L28. Height of the vertical ramus, L29. Height of the vertical ramus.

Indexes of Skull Measurements

1. Skull index: Skull width/ Skull length× 100

2. Cranial index: Cranial width/ cranial length× 100

3. Nasal index: Nasal width/ Nasal length× 100

4. Facial index: Facial width/ Facial length× 100

5. Foramen magnum index: Foramen magnum height/Foramen magnum width× 100

Statistical Analysis

Standered daviation and Mean value of the measurement were analysed and Independant t-test was applied to determine the level of significance of the difference of the craniometric measurements between gender and breeds by using SPSS (20.0 version) programm.

RESULTS

The table 1 illuminates the standered daviations,mean value and level of significance of the skull of New Zealand and American Dutch female rabbit in which the nasal length of New Zealand female is 32.04±1.16 and female of American Dutch is 26.52±3.70. This

difference in the nasal length of the female of the both included breeds is statistically significant ($p < 0.05$). Table 2 shows the standered daviation, mean value and level of significance of the skull of New Zealand and American Dutch male rabbit in which the nasal length of New Zealand male is 32.18±1.22 and American Dutch male is 26.35±3.70 and the difference is statisticlly significant ($p < 0.05$).

The results of the study (table No 3) show that the New Zealand rabbit basal length 73.57±5.31mm in females and 62.51±1.58 mm in males, dental length was 42.83±0.74 mm in females and 41.05±1.12 mm in males and largest nasal length was 38.40±1.84 in female and 35.56±1.3 mm in male. All these skull measurements have shown a significant inter gender difference in the New Zealand rabbit breed ($p < 0.05$). The table 3 also indicates that the mandible measurement like length from angle to tip (excluding incisors) is 57.80±1.43 in female and 55.17±1.68in male and length of the cheek teeth row is 15.46±0.34 in female and 15.01±0.11 in male. These all differences in measurements are statistically significant ($p < 0.05$) (table 3).

The standered daviation, mean value and level of significance of skull measurement of American Dutch rabbit are given in table 4, in which skull length is 70.96±7.89mm in female and 78.77±3.16 in male, skull width (distance between two zygomatic arches) is 36.67±1.98 mm in female and 38.82±1.19 in male, foramen magnum height is 9.41±0.31 mm in female and 10.22±0.57 in male, diestema length is 23.71±0.23 mm in female and 22.10±1.29 in male, maximum neurocranium width are 23.92±1.62 and 22.09±0.98 mm in female and male and skull width (distance between the temporal fossae) is 27.53±0.33mm in female and 28.6±0.3 mm in male rabbits respectively. The differences in all these measurements are statistically significant ($p < 0.05$). The table 4 also shows the standered daviation, mean value and level of significance of mandible measurement of the American Dutch rabbit in which length of the aboral border of the alveolus of M3-Infradentale to tip (excluding incisors) is 34.63±0.59in female and 33.10 ±1.11in male. The difference in these measurements is statistically significant ($p < 0.05$).

DISCUSSION

The current comparative analysis of measurements in the skull size of male and female rabbits of different breeds indicates a greater degree of variations in skull size in the different breeds. While there are no significant interbreed differences in the mandible morphometric features of female and male rabbits of the included two breeds. This depicts that the mandible measurements are almost same but interbreed difference is there in the skull of the New Zealand and American Dutch rabbit.

The results of our measurements (table 3) indicate that the significant differences are present in the basal length, dental length (postdentale – prosthion) and largest nasal length between the male and female of the New Zealand rabbit. In this study the skull length and nasal length are matched with the result of Özkadif et al., (2016) rabbit craniometrics analysis and skull length, nasal length observed in current study are also matched with the results of Gürbüz et al.,(2015).

Table 1: Mean value and level of significance of the skull and mandible of the New Zealand rabbit and American Dutch rabbit females.

Skull and Mandibular Measurements of Female Rabbits	New Zealand Rabbit(mm)	American Dutch Rabbit(mm)	Level of Significance	Skull and Mandibular Measurements of Female Rabbits	New Zealand Rabbit(mm)	American Dutch Rabbit(mm)	Level of Significance
L1	79.42±1.57	73.5±7.83	0.1023	**L16**	29.05±1.17	30.03±1.28	0.1943
L2	32.04±1.16	26.52±3.7	0.0059	**L17**	14.87±1.05	15.26±0.91	0.5161
L3	50.26±4.86	51.8±1.4	0.4745	**L18**	23.29±0.54	23.76±1.28	0.0756
L4	37.71±1.81	36.98±2.28	0.5464	**L19**	7.3±0.33	7.43±0.26	0.7031
L5	32.11±2.54	31.27±1.5	0.496	**L20**	21.73±2.19	22.54±3.1	0.3342
L6	15.32±1.41	14.7±1.91	0.5034	**L21**	27.63±0.63	27.46±0.4	0.5677
L7	40.39±1.99	37.29±5.03	0.1917	**L22**	36.03±1.27	35.76±1.58	0.3219
L8	36.09±1.82	36.63±1.18	0.5452	**L23**	10.71±0.44	11.23±0.53	0.099
L9	9.41±0.63	9.41±0.31	0.982	**L24**	57.8±1.6	56.99±0.9	0.3493
L10	9.71±0.64	9.72±0.93	0.9749	**L25**	15.39±0.33	15.52±0.99	0.7713
L11	75.19±1.79	73.43±2.33	0.1752	**L26**	34.2±0.4	34.7±1.12	0.7461
L12	65.86±5.59	64.69±1.29	0.6296	**L27**	19.2-1.3	19.93±0.69	0.4355
L13	42.89±0.8	42.65±0.62	0.6117	**L28**	35.8±1.16	36.47±1.62	0.5935
L14	38.29±1.87	37.51±1.09	0.4049	**L29**	36.7±0.87	37.57±1.7	0.4762
L15	15.09±1.35	15.04±1.22	0.3292				

Table 2: Mean value and level of significance of the skull and mandible of the New Zealand rabbit and American Dutch rabbit males.

Skull and Mandibular Measurements of Male Rabbits	New Zealand Rabbit(mm)	American Dutch Rabbit(mm)	Level of Significance	Skull and Mandibular Measurements of Male Rabbits	New Zealand Rabbit(mm)	American Dutch Rabbit(mm)	Level of Significance
L1	79.5±1.57	73.8±3.59	0.1023	**L16**	29.17±1.87	29.53±1.8	0.7359
L2	32.18±1.22	26.35±3.70	0.0069	**L17**	13.3±4.2	15.33±0.86	0.2727
L3	50.36±4.86	51.9±1.4	0.4745	**L18**	22.71±2.91	22.1±1.29	0.6458
L4	37.72±1.81	36.88±2.28	0.5464	**L19**	7.22±0.48	7.02±0.64	0.555
L5	32.22±2.54	31.37±1.5	0.496	**L20**	22.83±1.57	22.21±0.33	0.3493
L6	15.42±1.41	14.8±1.91	0.5034	**L21**	27.5±1.28	27.63±1.02	0.8647
L7	40.53±1.99	37.49±5.03	0.1917	**L22**	36.7±2.07	37.76±1.58	0.3915
L8	36.44±1.82	36.73±1.18	0.5452	**L23**	11.86±0.36	12.13±0.71	0.4037
L9	9.46±0.63	9.45±0.31	0.982	**L24**	55.5±1.4	56.8±3.21	0.3851
L10	9.71±0.64	9.72±0.93	0.9749	**L25**	15.01±0.11	15.11±0.67	0.7253
L11	73.43±2.33	74.17±3.6	0.6946	**L26**	33.3±1.08	33.1±1.11	0.7579
L12	62.66±1.34	65.3±5.04	0.2343	**L27**	18.09±1.06	18.81±1.24	0.2951
L13	41.05±1.09	41.51±2.2	0.35	**L28**	34.33±1.71	35.09±2.31	0.5384
L14	35.51±1.28	35.7±2.57	0.8788	**L29**	35.69±1.61	36.46±2.27	0.5152
L15	15.61±1.50	15±1.21	0.4541				

Table 3: Mean value and level of significance of the skull and mandible of female and male of the New Zealand rabbits.

Measurement taken from the Skull of New Zealand Rabbit	Female (mm)	Male (mm)	Level of Significance	Measurement taken from the Skull of New Zealand Rabbit	Female (mm)	Male (mm)	Level of Significance
L1	79.14±1.6	77.31±1.24	0.0513	**L16**	29.31±0.97	29.17±1.87	0.8642
L2	31.83±1.14	30.91±2.43	0.4196	**L17**	14.22±1.14	14.54±0.51	0.5485
L3	51.89±1.41	49.8±2.84	0.1401	**L18**	23.33±0.57	22.61±2.92	0.5688
L4	38.03±1.6	37.73±1.3	0.7326	**L19**	7.37±0.33	7.21±0.48	0.5382
L5	31.61±2.08	31.34±0.96	0.7739	**L20**	22.19±2.08	22.83±1.56	0.5539
L6	15.36±1.4	14.19±1.76	0.2363	**L21**	27.69±0.64	27.51±1.28	0.7806
L7	38.40±4.96	40.31±2.02	0.4016	**L22**	36.03±1.27	35.76±1.58	0.7376
L8	36.71±1.12	36.57±1.06	0.8145	**L23**	10.77±0.4	10.76±0.5	0.9506
L9	9.39±0.7	9.61±0.76	0.6217	**L24**	57.80±1.43	55.17±1.68	0.0153
L10	9.78±0.92	9.84±0.84	0.8939	**L25**	15.46±0.34	15.01±0.11	0.0155
L11	75.21±1.72	73.43±2.33	0.1633	**L26**	33.97±1.74	33.09±0.63	0.2712
L12	73.57±5.31	62.5±1.58	0.0006	**L27**	18.93±0.9	18.09±1.06	0.1651
L13	42.83±0.74	41.05±1.12	0.0089	**L28**	36.21±1.42	34.33±1.71	0.0655
L14	38.40±1.84	35.56±1.3	0.0118	**L29**	36.6±1.63	35.69±1.61	0.3509
L15	15.17±1.36	15.±1.21	0.8271				

Table 4: Mean value and level of significance on the skull and mandible of female and male of the American Dutch rabbit.

Measurement taken from the skull of American Dutch Rabbit	Female (mm)	Male (mm)	Level of Significance	Measurement taken from the skull of American Dutch Rabbit	Female (mm)	Male (mm)	Level of Significance
L1	70.96±7.89	78.77±3.16	0.048	**L16**	29.62±1.63	29.53±1.8	0.9358
L2	25.62±3.88	29.07±2.04	0.0902	**L17**	14.91±0.83	15.36±0.83	0.3882
L3	50.26±4.86	53.3±1.67	0.1787	**L18**	23.71±0.23	22.10±1.29	0.0126
L4	36.67±1.98	38.82±1.19	0.0452	**L19**	7.43±0.34	7.01±0.64	0.1951
L5	31.09±1.36	31.3±1.3	0.788	**L20**	23.92±1.62	22.09±0.98	0.0450
L6	14.47±1.74	15.27±1.1	0.3625	**L21**	27.53±0.33	28.6±0.3	0.0009
L7	36.47±4.54	38.9±1.7	0.2486	**L22**	36.1±0.7	36.7±2.07	0.5162
L8	35.74±1.57	37.3±1.24	0.0862	**L23**	11.2±0.54	11.19±0.69	0.9637
L9	9.41±0.31	10.22±0.57	0.0123	**L24**	56.97±0.8	56.91±3.01	0.9695
L10	9.58±0.7	10.1±0.57	0.1806	**L25**	15.1±0.93	14.93±0.41	0.6982
L11	77.01±1.4	74.16±3.67	0.1042	**L26**	34.63±0.59	33.10±1.11	0.0137
L12	64.58±1.64	63.46±3.63	0.3732	**L27**	19.93±0.6	18.81±1.24	0.6982
L13	42.81±0.73	41.4_.22	0.1695	**L28**	36.79±1.18	37.6±1.29	0.3576
L14	37.37±0.97	35.70.0.97	0.1669	**L29**	37.57±1.52	36.43±2.3	0.3374
L15	16.49±1.13	16.49±1.13	0.2765				

Length from angle to tip and length of cheek teeth row show statistical significant difference on the mandible portion of the New Zealand rabbits.

The table 4 elucidates that skull length, skull width, foramen magnum height, diastema length, maximum neurocranium width and skull width (distance between temporal fossae) values have statistically significant difference between male and female of American Dutch rabbit ($p < 0.05$). Likewise, the values of mandible portion of American Dutch rabbits provide a strong evidence about the skull size difference in males and female rabbits (table 4) in which the difference in the length aboral border of the alveolus of M3-Infradentale to tip (excluding incisors) is statistically significant between the mandibles of the males and females of American Dutch rabbit breed.

In this study we also have the statistical results for difference of skull index, cranial index, nasal index, facial index and foramen magnum index value (table 5, 6, 7 and 8). Our results are different with the previous studies. In previous study skull index Özkadif et al., (2016) and facial index Gürbüz et al., (2015) have statistical significant difference but in our study there is no statistically significant difference present at gender level in both New Zealand rabbit (table 7) as well as American Dutch rabbit (table 8) but in our results cranial index have statistically significant difference at breed level in the male rabbits (table 6). These differences in the current result from the craniometric results of the other studies on the rabbits might be due to difference in the breed of the rabbits included in the study as the breeds of the rabbits are not mentioned in these studies.

The skull of female rabbit is bigger than male as per the already available information in the literature, Özkadif et al. (2016) and Gürbüz et al., (2015) but in our study some craniometric values of female are bigger than male and some value of male are bigger than female. The facial length (40.31±2.02 mm) for the male of New Zealand rabbit are bigger then facial length (38.40±4.96 mm) of female. Similarly, the skull length for male (78.77±3.16 mm) of American Dutch rabbit is bigger than the skull length (70.96±7.89 mm) of female.

Graphical Representation

Graphical representation of the current inter gender and interbreed craniometric comparison (figures 5, 6, 7 and 8) and indexes of the measurements comparison (figures 9, 10, 11, 12) shows that the foramen magnum index has the highest standard deviation as compare to all other measurements used in this study. This indicates that there can be high variation in the foramen magnum index values at the individual level in the New Zealand as well as American Dutch rabbit.

Table 5: Craniofacial index of New Zealand and American Dutch rabbit females.

Craniofacial index of Female Rabbit	New Zealand Rabbit	American Dutch Rabbit	Level of Significance
Cranial index	62.97±3.22	60.9±14.55	0.5105
Nasal index	49.06±6.27	55.43±9.0	0.2714
Facial index	91.63±5.42	96.79±6.25	0.2185
Foramen magnum index	102.27±38.22	100.99±37.52	0.7172

Table 6: Craniofacial index of New Zealand and American Dutch rabbit males.

Craniofacial index of Male Rabbit	New Zealand Rabbit	American Dutch Rabbit	Level of Significance
Skull index	53.93±10.93	49.14±2.04	0.3601
Cranial index	57.50±2.74	63.93±4.95	0.0401
Nasal index	52.98±5.11	47.3±3.81	0.0819
Facial index	92.25±5.22	94.79±5.52	0.3792
Foramen magnum index	104.71±38.66	98.32±32.55	0.2305

Table 7: Craniofacial index of male and female of New Zealand Rabbits.

Craniofacial index of New Zealand Rabbit	Female	Male	Level of Significance
Skull index	48.94±2.44	48.15±5.64	0.6131
Cranial index	63.94±3.21	60.91±6.33	0.378
Nasal index	47.99±5.94	47.30±3.81	0.8335
Facial index	91.63±5.42	92.25±4.80	0.8548
Foramen magnum index	102.26±38.78	104.71±10.94	0.6723

Table 8: Craniofacial index of the male and female of American Dutch Rabbits.

Craniofacial index of American Dutch Rabbit	Female	Male	Level of significance
Skull index	53.93±2.22	50.74±2.04	0.5449
Cranial index	58.42±12.63	62.97±3.21	0.0719
Nasal index	52.98±5.11	55.43±9.01	0.6104
Facial index	96.79±6.25	98.5±6.02	0.2581
Foramen magnum index	101.01±38.52	118.7±10.36	0.2826

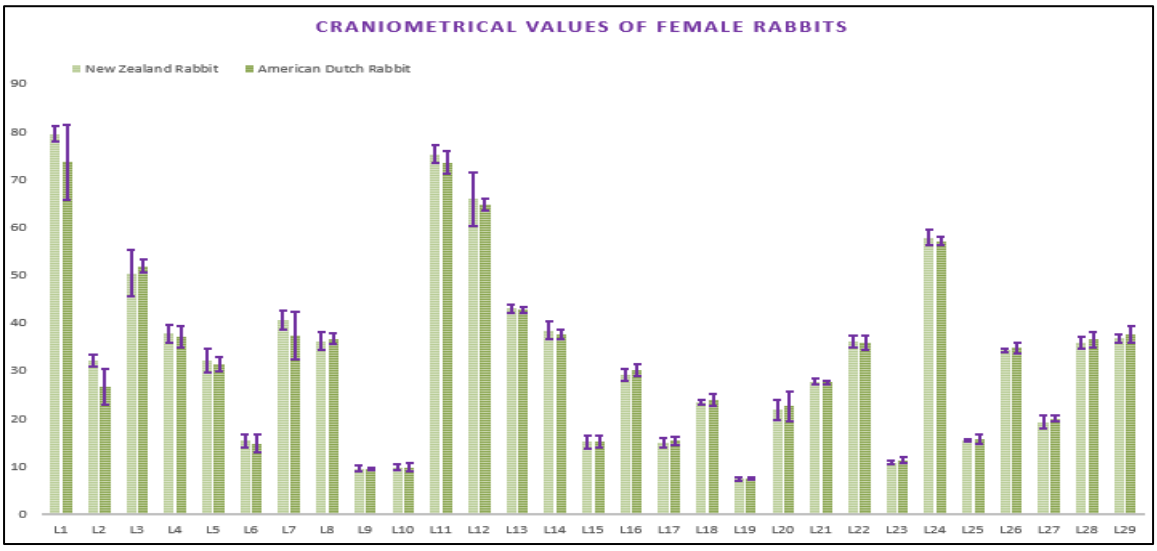

Figure 5: Craniometric values of females of New Zealand and American Dutch rabbits.

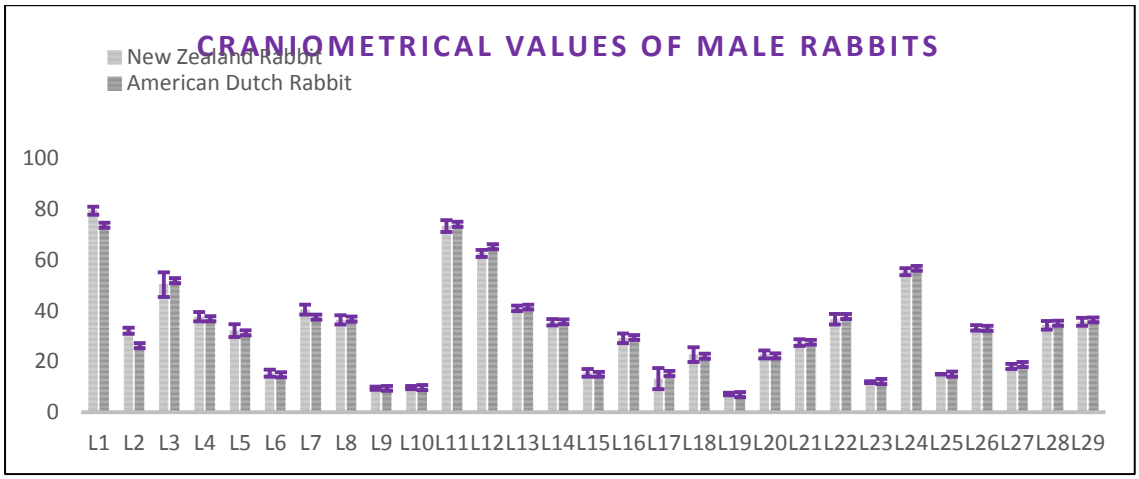

Figure 6: Craniometric value of Male of New Zealand and American Dutch rabbits.

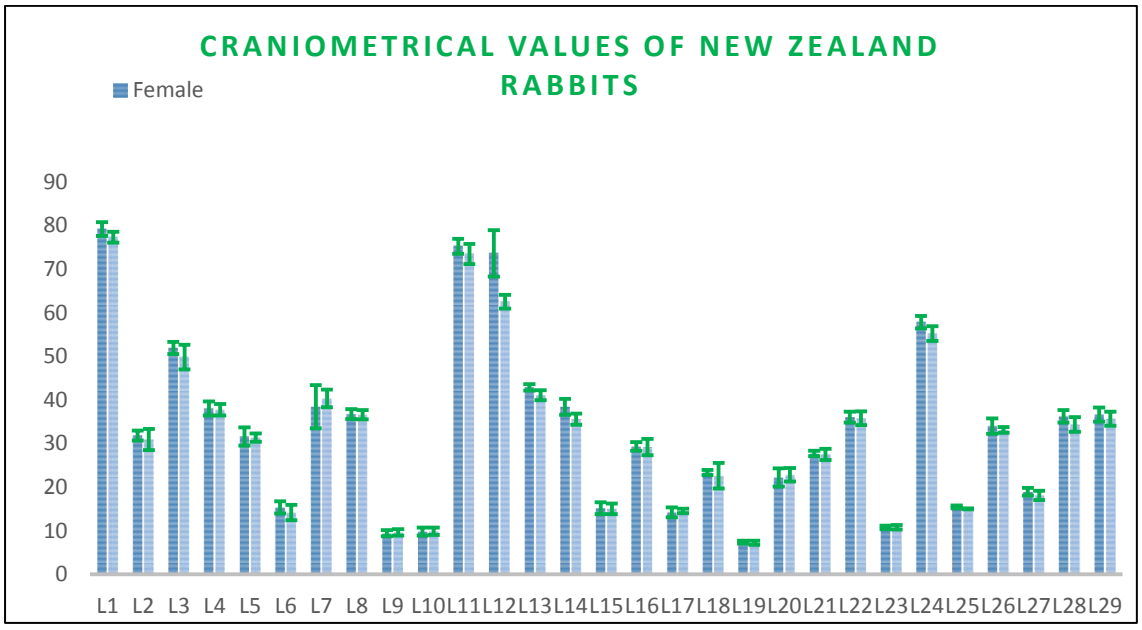

Figure 7: Craniometric values of male and female of New Zealand rabbits.

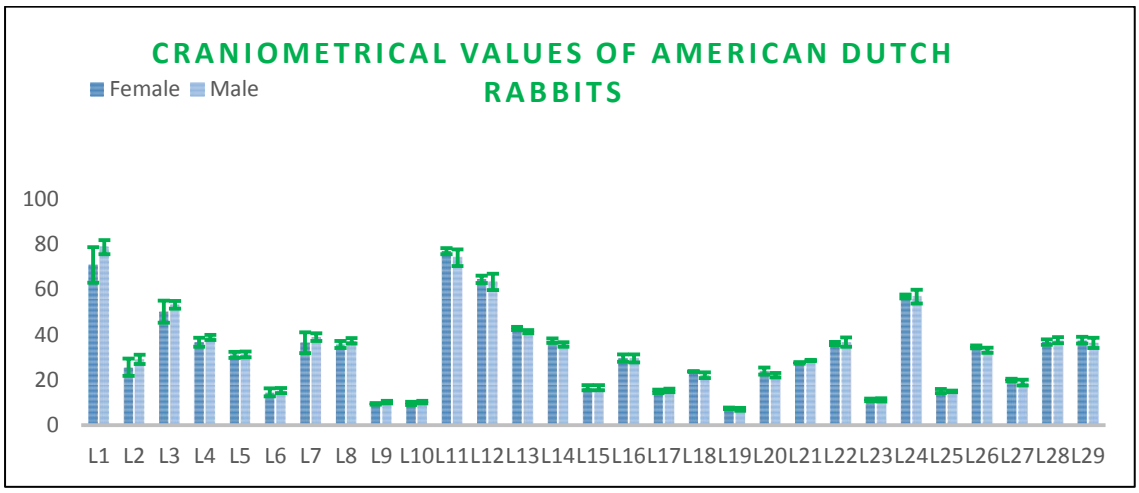

Figure 8: Craniometric value of Male and female American Dutch rabbits.

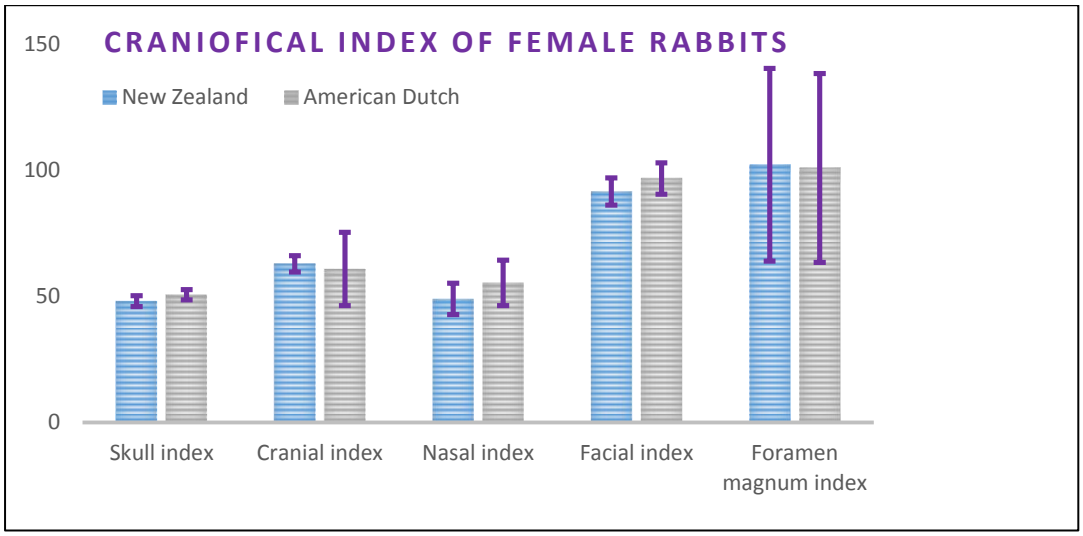

Figure 9: Craniofical index value of female of American Dutch and New Zealand rabbits.

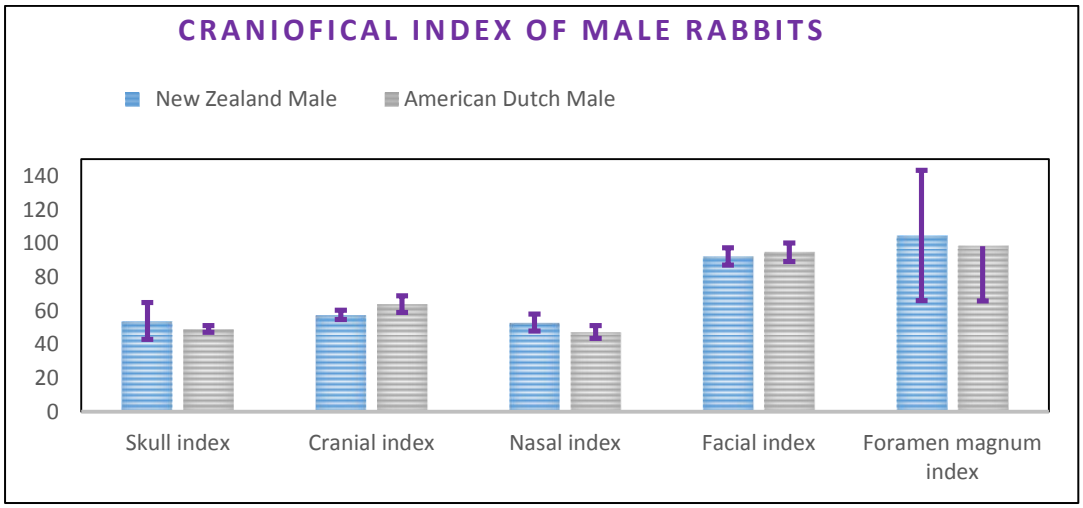

Figure 10: Craniofical index value of male of American Dutch and New Zealand rabbits.

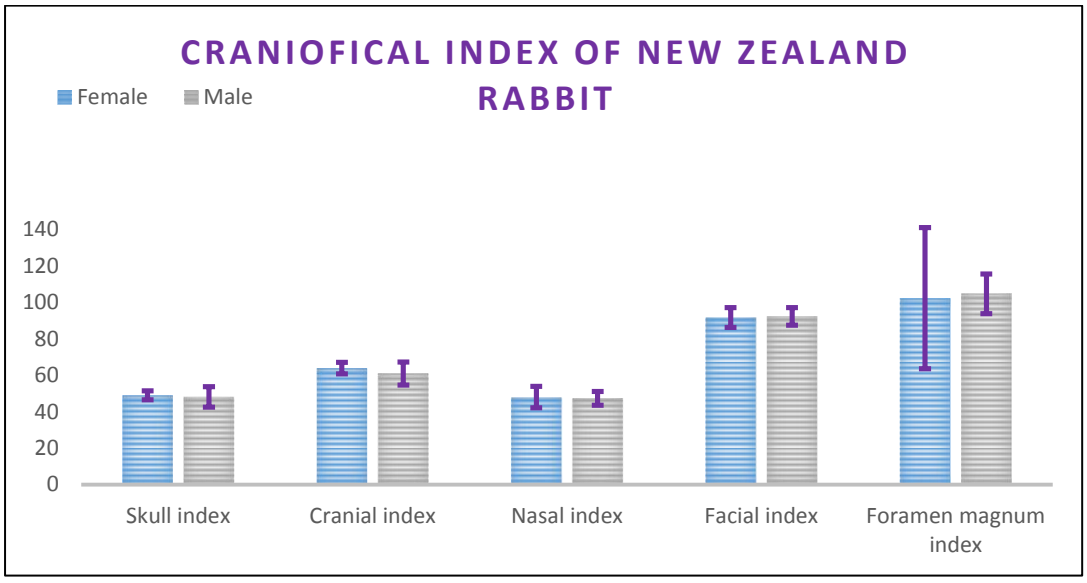

Figure 11: Craniofical index value of New Zealand Male And Female rabbits.

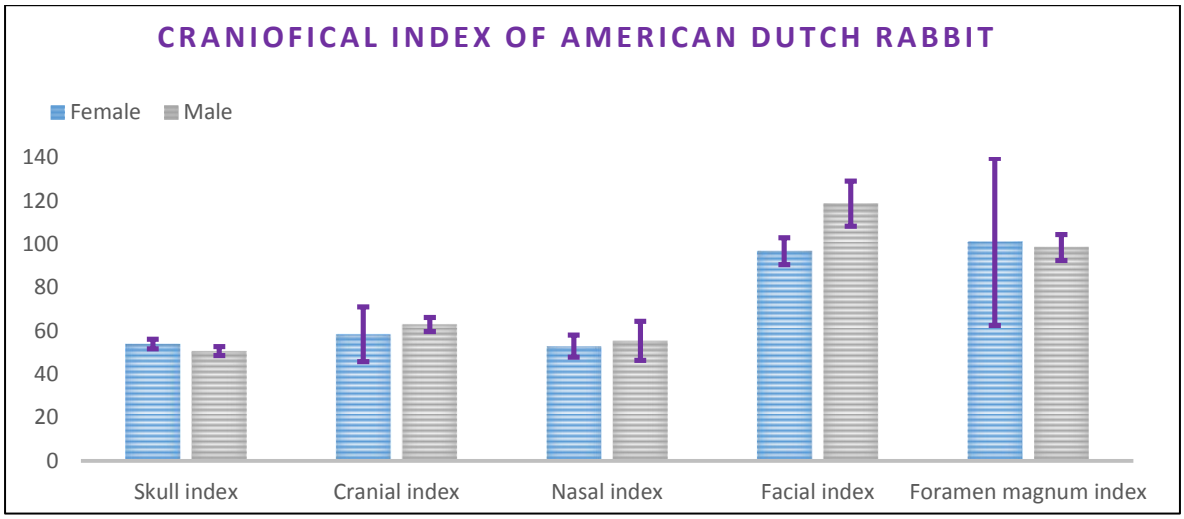

Figure 12: Craniofacial index values of male and female of American Dutch rabbits.

CONCLUSION

This study gives a research based evidence for the existence of craniometric variations in two breeds of rabbit that are the New Zealand and the American Dutch rabbits. This study is limited to these breeds due to the unavailability of other rabbit breeds. This is a baseline finding on interbreed craniometric variations in rabbits so this same study is recommended to be replicated on the different other breeds of *Oryctolagous cuniuclus* depending on their availability. This was not clear previously that the inter gender variations exist in specific morphometric features in all rabbit breeds or not. This study has cleared this confusion as the results of current study has shown that the craniometric features having significant inter gender variations are different in the New Zealand and American Dutch rabbit. This indicates that the features having inter gender variations can be different in different breeds of rabbits.

CONFLICT OF INTEREST

Authors have no conflict of interest.

REFERENCES

Abreu AT, Veeck EB, Costa NP (2006). Morphometric methods to evaluate craniofacial growth: study in rabbits. Dentomaxillofac Radio., 35 (2): 83-87.

Akbulut Y, Demiraslan Y, Gürbüz İ, Aslan K (2014). Yeni Zelanda tavşanı (Oryctolagus cuniculus L.)'nda cinsiyet faktörünün mandibula morfometrisine etkisi. Fırat Üniv Sağ Bil Vet Derg., 28 (1): 15-18.

Çakır A, Yıldırım IG, Ekim O (2012). Craniometric measurements and some anatomical characteristics of the cranium in Mediterranean Monk seal (Monachus monachus, Hermann 1779). Ankara Üniv Vet Fak Derg., 59: 155-16.

Demirsoy A, Yaşamın TK (1992). Omurgalılar (Sürüngenler, Kuşlar ve Memeliler), 1st ed. Meteksan AŞ, Ankara.

Gürbüz İ, Demiraslan Y, Aslan K (2015). Morphometric analysis of the skull of New Zealand Rabbit (Oryctolagus cuniculus L.) according to gender. AJAVS., 1: 27-32.

Kahvecioğlu KO, Onar V, Alpak H, Pazvant G (2000). The morphometry of the Foramen magnum in rabbits and its

correlation with craniometric measurements. Folia Vet., 44 (2): 62-69.

Meredith A (2007). Rabbit dentistry. EJCAP., 17(1): 55-62.

Monfared AL (2013). Applied anatomy of the rabbit's skull and its clinical application during regional anesthesia. Global Vet., 10: 653-657.

Onar V, Özcan S, Pazvant G (2001). Skull typology of adult male Kangal dogs. Anat Histol Embriyol., 30 (1): 41-48.

Özkadif S (2011). Yeni Zelanda Tavşanlarında Sinus Paranasales'in Multidedektör Bilgisayarlı Tomografi Görüntülerinin Üç Boyutlu Rekonstrüksiyonu, Selçuk Üniv Sağ Bil Ens Doktora Tezi, Konya.

Olopade JO, Onwuka SK (2005). Morphometric study of the skull of the west African Dwarf Goat from South West Nigeria. Niger Vet J., 26 (2): 1-21.

Onar V, Belli O, Owen PR (2005). Morphometric examination of Red Fox (Vulpes vulpes) from the Van-Yoncatepe necropolis in Eastern Anatolia. Int J Morphol., 23 (3): 253-260.

Onar V, Kahvecioğlu KO, Cebi V (2002). Computed tomographic analysis of the cranial cavity and neurocranium in the German shepherd dog (Alsatian) puppies. Veterinarski Arhiv., 72 (2): 57-66.

Özkadif S, Eken E (2016). Craniometric measurements of New Zealand rabbits skull from three-dimensional reconstruction images. J Anim Vet Sci., 2: 9-14.

Özkan ZE, Dinç G, Aydın A, Tavşan (1999). (Oryctolagus cuniculus), kobay (Cavia porcellus) ve ratlarda (Rattus norvegicus) scapula, clavicula, skeleton brachii ve skeleton antebrachii'nin karşılaştırmalı gross anatomisi üzerinde incelemeler. Fırat Üniv Sağ Bil Derg., 11: 171-175.

Pintur K, Dančević N, Štedul I, Popović N, Slijepčević V (2014). Craniometric features of European hare (Lepus europaeus Pall.) from North-west Croatia and the island of Vir. Veterinarski arhiv., 84(4): 387-400.

Taylor J, Freedman L, Oliver TJ, McCluskey J, (1977). Morphometric differences between Australian wild rabbit populations. Aust J Zool., 25 (4): 721-732.

Uddin M, Sarker MHR, Hossain, ME, Islam MS, Hossain MB, Shill SK (2013). Morphometric investigation of neurocranium in domerstic cat. Bangl J Vet Med., 11 (1): 69-73.