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RESEARCH ARTICLE

Genetic Animal Heritage of Anatolia: Short-beaked Pigeon Genotypes

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ABSTRACT

This study aimed to determine the morphological and morphometric characteristics of Bango, Mısıri and Baska pigeons, which have been preferred to breed as ornamental and diver pigeons in Anatolia. The ages of the pigeons were classified into four groups: 12-24 months of age (age group I), 25-36 months of age (age group II), 37-48 months of age (age group III), and 48 months of age and over (age group IV). These three pigeon genotypes were included in the bird group with short beak and small body structure. There were statistically significant differences among the genotypes in terms of body weight, head length-width, beak length-depth, chest depth-width, thoracic perimeter, tail and body length, wing span-length, tarsus diameter ($p \leq 0.01$). Considering the body plumage color of pigeons, Mısıri and Bango pigeons show more similar appearance, however Baska pigeons has a different appearance from both genotypes. However, it is thought that it would be appropriate to evaluate morphological data together with genetic analysis. We think that these three pigeon genotypes should be taken under immediate protection in order to protect the domestic gene resources of Turkey.

Keywords: Diver pigeons, Morphological characteristics, Ornamental pigeons, Short-beaked pigeons

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Anadolu'nun Genetik Hayvan Mirası: Kısa Gagalı Güvercin Genotipleri

ÖZ

Bu çalışma ile Anadolu'da süs ve dalgıç güvercini olarak yetiştirilmek üzere tercih edilen Bango, Mısıri ve Baska güvercinlerinin morfolojik ve morfometrik özelliklerinin belirlenmesini amaçlanmıştır. Güvercinlerin yaşları 12-24 aylık (yaş grubu I), 25-36 aylık (yaş grubu II), 37-48 aylık (yaş grubu III) ve 48 aylık ve üzeri olarak (yaş grubu IV) dört gruba ayrılmıştır. Bu üç güvercin genotipi kısa gagalı ve küçük vücut yapısına sahip kuş grubuna dahil edilmiştir. Vücut ağırlığı, baş uzunluğu-genişliği, gaga uzunluğuderinliği, göğüs derinliği-genişliği, göğüs çevresi, kuyruk ve vücut uzunluğu, kanat açıklığı-uzunluğu, tarsus çapı açısından genotipler arasında istatistiksel olarak anlamlı farklılıklar tespit edilmiştir ($p \leq 0.01$). Güvercinlerin vücut tüy rengi göz önüne alındığında Mısıri ve Bango güvercinleri daha benzer görünüm gösterirken Baska güvercinleri her iki genotipten farklı bir görünüme sahiptir. Türkiye yerli gen kaynaklarının korunması amacıyla bu üç güvercin genotipinin ivedilikle koruma altına alınması gerektiğini düşünmekteyiz.

Anahtar Kelimeler: Dalıcı güvercinler, Kısa gagalı güvercinler, Morfolojik özellikler, Süs güvercinleri

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INTRODUCTION

The location on the earth and regional topographic differences, Anatolia have a historical past with a wide biological diversity and local animal genetic resources (Şekercioğlu et al. 2011). The current situation has caused genetic differentiation within the species (Çiplak et al. 1993, Şekercioğlu et al. 2011). Considering these differences, it is possible to come across a large number of pigeon genotypes bred in different regions in Turkey. Mısıri, Bango, and Baska pigeons are short-beaked pigeons that have been widely bred for many years, especially around Istanbul in Turkey. The three genotypes used in the present study are in the subgroup of diving pigeons belonging to the performance bird group. After reaching a certain height in the sky, these pigeons dive immediately when a rotating tool made of a metal called a "glitter" or a female pigeon in the nest is shown (Yılmaz and Boz 2012). In the interviews made with the pigeon breeders, it was stated that due to the environmental changes such as urbanization and tall buildings in the regions where they were raised, the pigeons are bred as "ornamental birds" nowadays. They show similarities in terms of both their external appearance and flight characteristics, and there is a great demand for these genotypes from within the country and abroad. Obtaining some data based on observations and measurements in genotypes and classifying races with similar characteristics under a group is a method that has been used by variousresearchers for many years (Balcı et.al. 2018, Helms and Schneider 2003, Soysal et al. 2011). To date, no research has been conducted to morphologically define the genotypes of short-beaked pigeons, which are the genetic animal heritage of Anatolia. Therefore, the study aimed to compare the morphological and morphometric characteristics of the Bango, Mısıri, and Baska pigeon genotypes, which have been bred for many years in Anatolia. This research is very important for the identification of shortbeaked pigeons, which are among animal genetic resources in Turkey.

MATERIAL AND METHODS

Study area, Birds and Their Management

This research was conducted in İstanbul province (located at 41°00'19.0"N 29°00'43"E), Turkey in 2020. The animal materials of this study consisted of Bango (46 male and 54 female), Mısıri (52 male and 48 female), Baska (49 male and 51 female) pigeon genotypes. During the research, the birds were kept in the hands of the breeder and no change was made in the management, care, and feeding conditions of the pigeons. The sex and age of the pigeons were determined according to the records kept at the breeders. The ages of the pigeons were classified into four groups: 12-24 months of age (age group I), 25-36 months of age (age group II), 37-48months of age (age group III), and 48 months of age and over (age group IV).

Morphological Characteristics

Each pigeon was morphologically examined in detail concerning their head type, head marks, eye color, plumage color, body marks, wing and tail marks, presence or absence of muffs (foot-feathered). Tail and wing feather numbers were recorded. The wing feathers were counted in the order of the primary-axial and secondary (p-a-s) feathers (Erdem et al. 2021).

Morphometric Characteristics

Morphological measurements were carried out by visiting 16 private enterprises (5 enterprises for Bango pigeons, 7 enterprises for Mısıri pigeons, and 4 enterprises for Baska pigeons) in total. The body weights of the pigeons were individually weighed using a scale with sensitive to 0.01 g. While determining the morphometric characteristics, a metal ruler was used to detect body length, measuring tape was used to determine trunk length, wingspan, wing length, thoracic perimeter, and tail length. A digital caliper was used to determine the head length and head width, beak length and depth, chest width and depth, and tarsus diameter (Atasoy et al. 2013, Özbaşer et al. 2021).

Statistical Analysis

The general linear model (GLM) was used to identify the differences between age and sex groups. When a significant difference was found among groups for post hoc multiple comparisons, Tukey's test was used 4 (Özdamar 2015). A value of $p<0.05$ was considered statistically significant. Statistical analyses were performed using SPSS (IBM Corp., Armonk, NY, USA) for Windows.

RESULTS

Morphological Characteristics

As a mutual trait in all three pigeon genotypes examined, it was determined that the head structures were large and slightly oval-shaped. The forehead is wide and angular in all three genotypes. All three pigeon genotypes have a soft tissue on the upper side of their beaks, which is the thickened part of the skin (integument), called the 'cere' or 'nasal cere' which surrounds the nostrils. Cere shape and color are similar in all three genotypes, and it was described as small in structure, lime-white color, and powdery appearance. In addition, in pigeons, there was a featherless area around the eyes surrounded by a white or pale pink color, soft skin fold called as the 'orbital ring' or 'eye cere' (Figure 1 d, e, f). The

eyelids were fleshy. Iris colors were determined as color tones from light to dark brown in all of the pigeons examined (100%) (Table 1). The condition of having brown and black color tones in the irisis called "bull". The beak is short, thick and curved downward in all three genotypes. However, the beak structure of Baska pigeons was slightly longer than the other two short-beaked pigeon genotypes (Mısıri and Bango pigeons). It was determined that Mısıri and Bango pigeons were morphologically very similar to each other, but Baska was different from these two genotypes. The difference between the Mısıri and Bango genotypes is the curled feather structure called the "rosette". Mısıri pigeons have curly, frill-shaped feathers on the chest (Figure 1c). It was determined that all pigeons in the three genotypes examined in the present study were free from crest and muffs. Head, body and wing primary feathers are white, wings and/or tail are colored in Mısıri and Bango pigeon genotypes (Fig. 2a-j). While the colors seen on the wings and/or tail was considered by some researchers as 'marks' (Akçapınar and Özbeyaz 2021), fanciers refer to it as the plumage color used to identify the pigeon individually. The plumage color of the pigeons is given in Table 1 according to the wing and/or tail color declared by the pigeon breeders. It was determined that the coloration seen in either body parts (wing and tail) of these pigeons is uniform. It was determined that when the bird had colored wings in 5 both pigeon genotypes, varying numbers of white feathers were observed in the primary feathers on the wings with completely white plumage color were found in 5% and 3% of the Mısıri and Bango genotypes, respectively. In the Mısıri and Bango pigeon genotypes, the ratio of birds with colored wings only was determined as 40 % and 41 %, respectively. The ratio of colored tail birds in the same genotypes is 20 % and 26 %, respectively. In all three genotypes, white primaries, which we describe as 'mark', can be found on the wing, the number of which can vary between 4 and 8 (Table 1). In Baska pigeon, the head is white, the body, wings, and tail are colored (Figure 3 a-f). White feathers on the head cover the area to the beak line from the top of the head. This situation is defined as a mark. However, it is a breed characteristic in Baska pigeons. In some Baska pigeons, while the line view the of white feathers is straight (straight-mark line) (35%) (Figure 4a), this line in other is dashed and curved with a slight inward curve at the eye level (camber-mark line) (65%) (Figure 4b). Some Baska pigeons (43%) may have white primary feathers known as wing markings (Figure 1a,b). If this structure is not seen, the pigeons are called "Akbaş (white-head)" in Turkey. Red, yellow, black, chocolate (feather color is dark brown), blue (feather colour is blue, and the tip of wing primaries are covered with dark black bars), chickpea (nohudi in Turkish) (plumage color is blue and the tip of wing primaries are covered with light gray bars), lemon-yellow (limoni in Turkish) (feather colour is light yellow and tip of wing primaries are covered with dark yellow bars) colors were determined in all three pigeon genotypes (Figure 2, 3). In Baska genotype, as in the other two genotypes, no white feather color was observed on the trunk.

Morphometric Characteristics

The difference among genotypes was statistically significant in all morphological characteristics except the trunk length. Baska genotype had higher values than other genotypes in terms of body weight, head length, beak depth, tail length, wing span, tarsus diameter and body length ($p<0.01$). In all three genotypes, males had higher values than females in terms of body weight, head length, wing span-length, chest depthwidth, thoracic perimeter, and tarsus diameter ($p\leq0.01$). While body weight and head length were significantly affected by age group in all three genotypes ($p\leq0.05$), head width, body weight-length, head length-width, tail length and wing span in Bango and Mısıri genotypes were significantly affected by age 6 group ($p\leq0.05$). In the Baska pigeon, body weight, head length, chest depth-width, thoracic perimeter and tarsus diameter were significantly affected by the age group ($p\leq0.01$). In the present study, the morphological characteristics of all three pigeon genotypes are shown in Table 1 and the morphometric characteristics are shown in Table 2, 3.

Table 1. Morphological characteristics of Bango, Mısıri and Baska pigeons.

Morphological characteristics	Bango	Mısıri	Baska
	Ratio (%)		
Eye color			
Bull	100	100	100
Plumage color			
Black	26	23	17
Red	11	12	15
Yellow	23	18	10
Chocolate	9	14	16
Blue	13	15	25
Chickpea (Nohudi)*	10	5	10
Lemon-yellow (Limoni)**	5	8	7
White	3	5	-
Number of white feathers on wings			
4 to 6	36	37	27
6 to 8	31	31	16
8 and above	4	7	-
No white feathers on the wings	-	-	57
Number of wing feather			
9-1-8	73	69	-
10-1-9	27	31	-
9-1-11	-	-	55
10-1-9	-	-	25
10-1-10	-	-	20
Number of tail feather			
11	55	51	59
12	45	49	41

Chickpea*: Plumage colour is blue and tip of wing primaries are covered with light gray bars
Lemon-yellow**: Feather colour is light yellow and tip of wing primaries are covered with dark

Figure 1: a, b: The appearance of white feathers on the wings of Mısıri and Baska pigeons, c: Frill structure on chest in Mısıri pigeon, d, e and f: Eye cere and nasal cere in Bango, Mısıri and Baska pigeons, respectively.

Table 2. Body weight, wing, head and beak morphometric characteristics of Bango, Mısıri, Baska pigeons.

Variable		n	Body weight (g)	Wing span (cm)	Wing length (cm)	Head length (mm)	Head width (mm)	Beak depth (mm)	Beak length (mm)
	Sex		**	***	***	**	-	-	*
	Male	46	272.53 ± 2.94^{a}	56.56 ± 0.58^{a}	25.97 ± 0.25^{a}	33.17 ± 0.26^{a}	26.49 ± 0.20	5.36 ± 0.05	7.97 ± 0.09^{a}
	Female	54	260.38 ± 3.10^{b}	54.00 ± 0.47^{b}	24.86 ± 0.19^{b}	32.07 ± 0.24^{b}	26.53±0.41	5.22 ± 0.05	8.20 ± 0.07^{b}
	Age group		**	**	-	***	***	-	*
Bango	I	29	254.93 ± 1.39^{a}	53.27 ± 0.32^{a}	24.58 ± 0.15^{a}	31.15 ± 0.15^{a}	24.74 ± 0.28^{a}	5.23 ± 0.04	7.96 ± 0.12^{a}
	II	11	275.18 ± 5.98^{b}	54.00 ± 1.12^{ab}	24.72 ± 0.41^{ab}	33.77 ± 0.59^{c}	26.68 ± 0.12^{b}	5.36 ± 0.18	8.14 ± 0.09^{ab}
	III	28	269.08 ± 4.61^{b}	55.70 ± 0.79^{bc}	25.58 ± 0.33^{bc}	32.60 ± 0.29^{b}	26.03 ± 0.23^{b}	5.34 ± 0.07	7.94 ± 0.07^{a}
	IV	32	270.09 ± 4.74^{b}	56.85 ± 0.77^{c}	26.12 ± 0.32^{c}	33.44 ± 0.29^{bc}	28.49 ± 0.50^{c}	5.27 ± 0.05	8.32 ± 0.10^{b}
	Grand mean	100	265.97 ± 2.22	55.18 ± 0.39	25.37 ± 0.16	32.58 ± 0.18	25.74 ± 0.28	5.29 ± 0.04	8.09 ± 0.06
	Sex		*	***	***	*	-	-	-
	Male	52	274.16 ± 2.86^{a}	60.18 ± 0.30^{a}	27.00 ± 0.11^{a}	32.64 ± 0.29^{a}	27.22 ± 0.22	5.34 ± 0.37	8.10 ± 0.04
	Female	48	266.25 ± 2.71^{b}	56.23 ± 0.59^{b}	25.07 ± 0.26^{b}	31.88 ± 0.23^{b}	26.83 ± 0.38	5.22 ± 0.05	8.05 ± 0.06
	Age group		**	***	***	*	***	-	-
Mısıri	I	24	257.00 ± 1.38^{a}	54.36 ± 0.75^{a}	24.22 ± 0.34^{a}	31.43 ± 0.28^{a}	25.35 ± 0.31^{a}	5.24 ± 0.05	7.94 ± 0.11
	II	18	276.33 ± 4.02^{b}	58.77 ± 0.71^{b}	26.11 ± 0.30^{b}	31.96 ± 0.55^{ab}	26.95 ± 0.16^{b}	5.31 ± 0.12	8.11 ± 0.06
	III	27	274.05 ± 4.61^{b}	59.59 ± 0.57^{bc}	26.72 ± 0.24^{bc}	32.46 ± 0.36^{ab}	27.02 ± 0.28^{b}	5.32 ± 0.07	8.06 ± 0.06
	IV	31	270.36 ±2.00^{b}	59.91 ± 0.48^{c}	26.94 ± 0.11^{c}	32.94 ± 0.33^{b}	28.40 ± 0.48^{c}	5.26 ± 0.06	8.17 ± 0.04
	Grand mean	100	270.36 ± 2.00	58.29 ± 0.37	26.08 ± 0.17	32.27 ± 0.19	27.03 ± 0.21	5.28 ± 0.04	8.08 ± 0.04
	Sex		-	-	*	*	-	-	-
	Male	49	290.30 ± 1.84	59.36 ± 0.29	26.68 ± 0.09^{a}	35.73 ± 0.21^{a}	22.37 ± 0.11	5.12 ± 0.03	9.73 ± 0.08
	Female	51	286.37 ± 1.56	59.71 ± 0.20	27.00 ± 0.09^{b}	35.14 ± 0.19^{b}	22.02 ± 0.15	5.09 ± 0.02	9.62 ± 0.07
	Age group		*	-	-	***	-	-	-
Baska	I	24	291.57 ± 1.83^{b}	59.52 ± 0.18	27.10 ± 0.01	35.91 ± 0.35^{b}	21.79 ± 0.26	5.12 ± 0.04	9.65 ± 0.10^{ab}
	II	22	289.95 ± 1.96^{b}	59.68 ± 0.21	26.77 ± 0.07	35.49 ± 0.26^{ab}	21.77 ± 0.26	5.13 ± 0.04	9.43 ± 0.09^{a}
	III	35	288.92 ± 2.13^{b}	59.74 ± 0.32	26.84 ± 0.13	34.94 ± 0.19^{a}	22.45 ± 0.15	5.13 ± 0.03	9.72 ± 0.07^{ab}
	IV	19	281.10 ± 3.54^{a}	59.05 ± 0.65	26.60 ± 0.16	35.67 ± 0.38^{ab}	22.71 ± 0.57	5.01 ± 0.01	9.91 ± 0.15^{b}
	Grand mean	100	288.30 ± 1.21	59.54 ± 0.17	26.84 ± 0.06	35.43 ± 0.14	22.19 ± 0.09	5.11 ± 0.02	9.68 ± 0.05
			***	***	***	***	***	***	***
Genotype	**Bango**	100	267.18±1.88^{b}	53.59±0.29^{a}	25.38±0.13^{c}	32.63±0.17^{b}	26.42±0.17^{a}	5.30±0.03^{a}	8.05±0.05^{b}
	Mısıri	100	270.52±1.84^{b}	54.04±0.29^{a}	26.02±0.12^{b}	32.24±0.17^{b}	26.92±0.17^{a}	5.28±0.03^{a}	8.08±0.05^{b}
	Baska	100	289.32±1.84^{a}	51.37±0.29^{b}	26.84±0.13^{a}	35.55±0.17^{a}	22.32±0.17^{b}	5.10±0.03^{b}	9.68±0.05^{a}

ns: $p > 0.05$; *: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$. a–c: means within a column with different letters are significantly different ($p < 0.05$)

Table 3. Body length, chest, trunk, tail and Tarsus morphometric characteristics of Bango, Mısıri, Baska pigeons.

Variable			Body length (cm)	Chest depth (mm)	Thoracic perimeter (cm)	Chest width (mm)	Trunk length (cm)	Tail length (cm)	Tarsus diameter (mm)
	Sex		*	***	***	***	-	-	***
	Male	46	25.58 ± 0.37^{a}	56.23 ± 0.45^{a}	22.02 ± 0.16^{a}	54.69 ± 0.50^{a}	7.84 ± 0.09	12.04 ± 0.01	4.91 ± 0.06^{a}
	Female	54	26.48 ± 0.24^{b}	52.33 ± 0.41^{b}	21.12 ± 0.12^{b}	52.61 ± 0.45^{b}	7.77 ± 0.06	11.77 ± 0.14	4.66 ± 0.05^{b}
	Age group		***	***	-	-	-	***	-
Bango	I	29	24.71 ± 0.28^{a}	52.67 ± 0.72^{a}	21.30 ± 0.14	52.68 ± 0.54^{a}	7.75 ± 0.10	11.15 ± 0.20^{a}	4.67 ± 0.05
	II	11	27.34 ± 0.63^{b}	52.27 ± 0.54^{a}	21.54 ± 0.28	53.66 ± 0.85^{a}	7.90 ± 0.13	11.59 ± 0.20^{ab}	4.74 ± 0.12
	III	28	26.27 ± 0.51^{b}	54.06 ± 0.67^{a}	21.47 ± 0.18	51.90 ± 0.58^{a}	7.69 ± 0.11	11.78 ± 0.16^{b}	4.79 ± 0.07
	IV	32	26.68 ± 0.29^{b}	56.15 ± 0.52^{b}	21.79 ± 0.24	55.79 ± 0.63^{b}	7.92 ± 0.07	12.59 ± 0.13^{c}	4.87 ± 0.09
	Grand mean	100	26.09 ± 0.22b	54.13 ± 0.36	21.53 ± 0.11	53.56 ± 0.35	7.80 ± 0.05	12.10 ± 0.10	4.78 ± 0.04
	Sex		**	***	-	-	-	***	*
	Male	52	27.18 ± 0.12^{a}	57.03 ± 0.43^{a}	21.53 ± 0.15	54.47 ± 0.58	7.77 ± 0.07	12.40 ± 0.12^{a}	4.76 ± 0.04^{a}
	Female	48	26.63 ± 0.15^{b}	54.70 ± 0.46^{b}	21.45 ± 0.12	53.72 ± 0.40	7.91 ± 0.07	11.77 ± 0.14^{b}	4.62 ± 0.04^{b}
	Age group		***	-	-	**	**	***	-
Mısıri	I	24	26.51 ± 0.22^{a}	54.57 ± 0.63	21.45 ± 0.20	53.17 ± 0.42^{a}	7.88 ± 0.10^{ab}	11.62 ± 0.23^{a}	4.59 ± 0.04
	II	18	26.55 ± 0.19^{a}	55.99 ± 0.81	21.36 ± 0.15	53.41 ± 0.75^{a}	8.08 ± 0.12^{b}	11.47 ± 0.17^{a}	4.67 ± 0.09
	III	27	26.75 ± 0.22^{a}	56.20 ± 0.73	21.58 ± 0.16	53.22 ± 0.62^{a}	7.72 ± 0.11^{a}	12.12 ± 0.16^{b}	4.73 ± 0.05
	IV	31	27.58 ± 0.11^{b}	56.65 ± 0.53	21.53 ± 0.22	56.01 ± 0.36^{b}	7.77 ± 0.07^{ab}	12.80 ± 0.11^{c}	4.74 ± 0.07
	Grand mean	100	26.91 ± 0.10a	55.91 ± 0.34	21.49 ± 0.10	54.11 ± 0.36	7.84 ± 0.05	12.10 ± 0.09	4.69 ± 0.03
	Sex		*	*	-	-	-	-	-
	Male	49	29.18 ± 0.24^{a}	56.62 ± 0.48^{a}	19.97 ± 0.11	51.12 ± 0.23	8.01 ± 0.05	12.30 ± 0.11	4.33 ± 0.06
	Female	51	28.64 ± 0.12^{b}	53.02 ± 0.40^{b}	19.81 ± 0.10	51.26 ± 0.25	7.87 ± 0.06	12.36 ± 0.12	4.31 ± 0.06
	Age group		-	***	**	***	-	-	**
Baska	I	24	28.87 ± 0.17	54.73 ± 0.50^{a}	19.47 ± 0.10^{a}	50.31 ± 0.30^{a}	7.95 ± 0.08	12.62 ± 0.16	4.54 ± 0.01^{b}
	II	22	28.61 ± 0.26	56.86 ± 0.45^{c}	20.00 ± 0.13^{b}	52.35 ± 0.41^{b}	7.90 ± 0.07	12.31 ± 0.21	4.13 ± 0.05^{a}
	III	35	29.12 ± 0.31	52.46 ± 0.67^{b}	19.90 ± 0.12^{ab}	51.18 ± 0.21^{a}	7.97 ± 0.07	12.24 ± 0.12	4.28 ± 0.06^{a}
	IV	19	28.90 ± 0.17	56.75 ± 0.65^{c}	20.28 ± 0.23^{b}	51.04 ± 0.44^{a}	7.92 ± 0.01	12.15 ± 0.17	4.33 ± 0.11^{ab}
	Grand mean	100	28.91 ± 0.13c	54.79 ± 0.36	19.89 ± 0.77	51.19 ± 0.17	7.94 ± 0.04	12.33 ± 0.08	4.32 ± 0.04
			***	**	***	***	-	***	***
Genotype	**Bango**	100	25.98±0.19^{c}	54.37±0.30^{b}	21.55±0.09^{a}	53.59±0.3^{a}	7.82±0.05	11.78±0.09^{b}	4.80±0.04^{c}
	Mısıri	100	26.89±0.18^{b}	55.87±0.30^{a}	21.48±0.09^{a}	54.04±0.3^{a}	7.84±0.05	12.04±0.09^{b}	4.66±0.04^{b}
	Baska	100	28.82±0.16^{a}	55.01±0.30^{ab}	19.90±0.09^{b}	51.37±0.3^{b}	7.97±0.05	12.36±0.09^{a}	4.34±0.03^{a}

ns: $p > 0.05$; *: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$. a–c: means within a column with different letters are significantly different ($p < 0.05$)

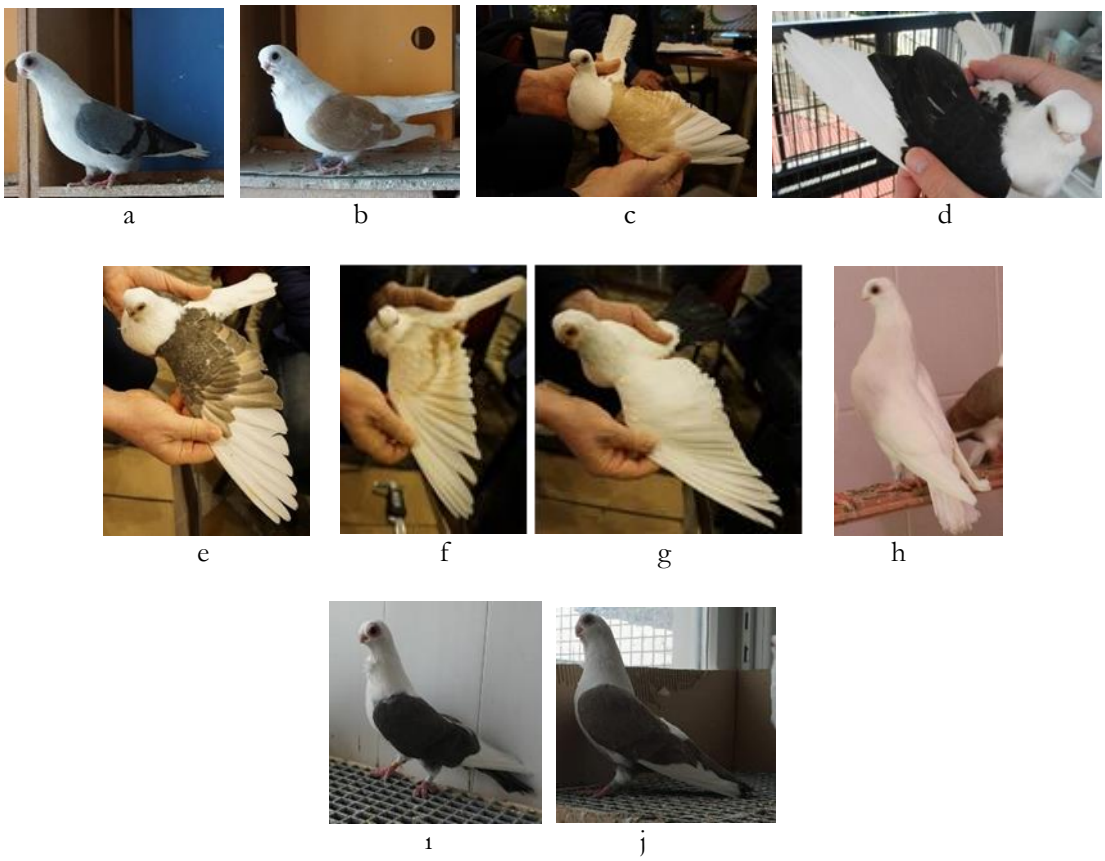

Figure 2: Plumage colors in Mısıri and Bango pigeons. a: Blue wing (Blue), b: Red wing (red), c: Yellow wing (yellow), d: Black wing (Black), e: Chocolate wing (chocolate), f: Lemon-yellow (Limoni) wing, g: Black tail (Black), h: White, ı: Black wing and tail (Black), j: Red wing and tail (red).

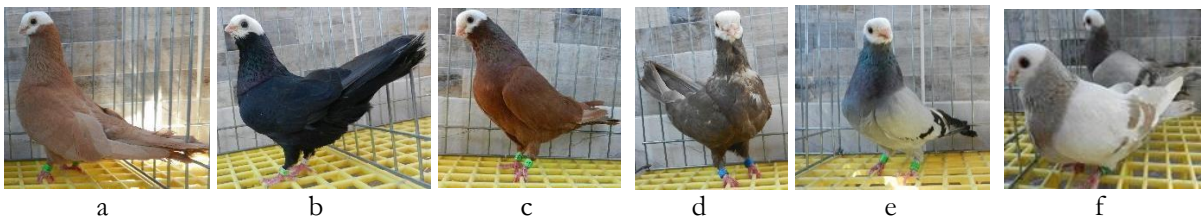

Figure 3: Plumage colors in Baska pigeons. a: Yellow, b: Black, c: Red, d: Chocolate, e: Blue, f: pigeon in front; Lemon-yellow pigeon in the back: Nohudi or chickpea.

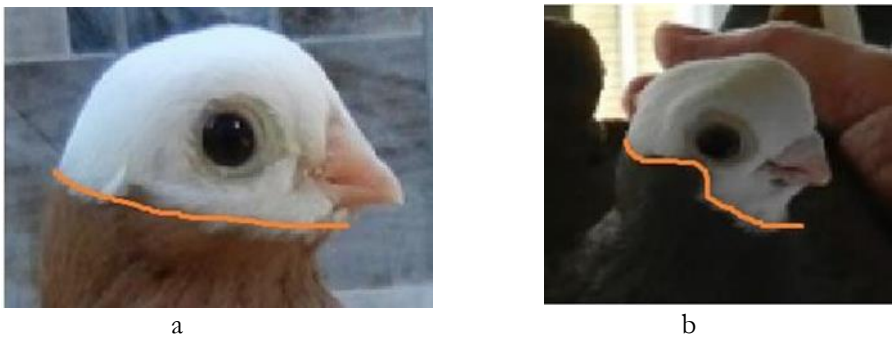

Figure 4: Baska pigeon a: Straight mark line, b: Camber mark line.

DISCUSSION

With the artificial selection applied by pigeon breeders according to behavior and body structure in the World, many pigeon breeds/genotypes have emerged that they are related but have different phenotypic diversity (Pacheco et al. 2020; Young et al. 2017). The genetic mechanism of variation in cranio-facial morphology in pigeons has been explained, and it has been argued that variation in headstructure, and variation in beak structure may be related. The head structure was slightly oval in all three pigeons (Mısırı, Bango, and Baska pigeons), the fore head was wide and angular. This structure of the head resembles the Turbit pigeons. Many authors have argued that there may be kinship between bird genotypes with similar head structures (Bailleul and Horner 2016, Felice and Goswami 2018, Levi 1992, Young et al 2017). The short beak structure seen in some pigeon breeds is one of the cranio-facial differences that enable the distinction between races. It is a feature that occurs as a result of variations in some gene locus and it is seen in many breeds (Adamčík et al 2021, Boer et al. 2021, Pacheco et al. 2020, Stringham et al. 2012).

In the present study, eye cere color (white or pale pink) was determined in three genotypes, and it was different from the yellow-orange, light blue, and red colors reported by Baptista et al. (2009) in different pigeon genotypes (Jambu Fruit-dove, Bare-faced Ground-dove, Diamond dove). The nasal cere, which can be seen among various bird species and breeds, can show differences in terms of texture, appearance, and color (Baptista et al. 2009, Purton 1989). It was determined that the nasal cere color determined in all three genotypes was similar to that domestic racing pigeon reported by Purton (1989), and the appearance of the nasal cere (flat and small in structure) was different from the exaggerated, hypertrophic and cauliflower-shaped appearance reported in Dragon and Carrier pigeons (Baptista 2009). It was determined that all three pigeon genotypes were short-beaked, non-muffled, non-crested and had a small body weight (under 300 g). Darwin (1875) classified pigeons into four groups based primarily on morphological traits, especially beak size. When Anatolian short pigeon genotypes were compared with some short-beaked pigeon breeds used in taxonomic classifications, it was determined that the body weight and non-crested appearance in the head were similar in Old German Owl and Berlin short-faced Tumbler pigeons. Moreover, it was determined that the pigeon genotypes examined in our study were similar to the body weight of Oriental Frill pigeons and similar to body weight, non-crested, non-muffled of African Owl, and Chinese Owl pigeons (Pacheco et al. 2020, Stringham et al. 2012). The frill structure determined in the breast region of Mısırı pigeons is also found in pigeons such as Turbit, Tubiten, Oriental Frill, African Owl, Cheese Owl, and Old German Owl (Pacheco et al. 2020, Levi 1992). However, the frill structure in Mısırı pigeons had less and sparse feathers.

Eye color variation in birds can be shaped by the pattern of melanin pigment or non-melanin pigments (pteridines, purines, carotenoids) in the iris (Edwards et al. 2012, Oliphant 1987). Bull, pearly white and orange iris colors are common in domestic pigeons (Maclary et al. 2021; Si et al. 2021). Blue, white and powder pink eye colors have also been determined in different genotypes of pigeons bred for performance purposes in Turkey (Balcı et al. 2018, Erdem et al. 2021, Özbaşer et al. 2021, Soysal et al. 2011). Hollander and Owen (1939) reported that the bull color is common in pigeons with white feather color. In our study, the fact that the head region of all three genotypes is white and the bull eye color is observed in all pigeons suggests that there may be a relationship between the pigmentation formed in the head and eye color. However, more studies are required on this subject.

Researchers report that there are many variations in feather pigmentation in pigeons due to artificial selection shaped over many years, mutations in gene loci, and the dominance or recession effects of colors (Domyan et al. 2014, Guernsey et al. 2013). In nature, some bird species can show some sexual dimorphism in terms of their color and color patterns. Generally, females have a monochromatic appearance to stay hidden in the nest, while males have a multicolored appearance for courtship behavior (Madeira 2018). In the present study, no dimorphism was found in terms of the plumage colors seen in males and females in all three genotypes. This situation may be related to the fact that these pigeons were reared under human control for many years and artificial selection. While body color was defined in the genotypes examined in our current study, it was observed that a pigmentation-like structure, which some researchers call 'Bar', was formed on the wings of pigeons with blue, chickpea plumage colors (Haag- WackernageL et al. 2006, Vickrey et al. 2018). T pattern and checker among the primary patterns reported by Haag-Wackernagel et al. (2006) were not found in all three genotypes. Similar body plumage colors were also found in Bango and Mısırı pigeons different from Baska. This suggests that it may be related to the fact that the pigeons were raised in the same region and that the breeders were influenced by each other. In addition, this suggests that these two genotypes may belong to similar subgroups of the same lineage in the phylogenetic tree. However, we think that this situation should be investigated with genetic studies.

It was determined that the average head length (32.58, 32.27 and 35.43 mm, respectively) and beak length (8.09, 8.08 and 9.68, respectively) values in Bango, Mısırı, and Baska pigeons were lower than the Owl (6.00 and 1.50 cm), Satinette (6.00 and 1.50 cm),

Suachandan (5.70 and 1.85 cm), Lakkha (6.00 and 1.95 cm) and Jacobin pigeons (5.00 and 1.85 cm) defined in the short-beak pigeons (Parvez et al. 2016). In addition to feeding, the beak in birds is involved in various functions such as warbling, fighting, thermoregulation, and preening (Van Wassenbergh and Baeckens 2019). Apart from genetic variations, it is thought that these factors may be effective in the differences in beak shape and morphology. Head width values of Bango, Mısıri, and Baska pigeons (25.74; 27.03 and 22.19 mm) were higher than Muradiye Dönek (18.20 mm) and Alabadem (18.51 mm) pigeons, which were defined as diving and ornamental birds (Erdem et al. 2021, Özbaşer et al. 2021). Flight style, optimum flight speed and power, flight distance in birds can vary depending on many factors such as the bird's body weight, chest depth, wingspan, and tail length (Bruderer et al. 2010, Dial 2009, Mercieca et al. 2017, Pennycuick et al. 1996, Shatkovska and Ghazali 2017, Thomas 1996). Average body weight (265.97 g; 270.36 g, and 288.30 g, respectively), wing length (25.37 cm, 26.08 cm and 26.84 cm, respectively), chest depth (54.13 cm, 55.91 cm and 54.79 cm, respectively) and tail length (12.10 cm, 12.10 cm and 12.33 cm, respectively) in Bango, Mısıri, and Baska pigeons in the present study were generally lower than some diver-spinner pigeons [Muradiye Dönek (319.74 g, 35.10 cm, 57.81 cm, and 13.14 cm)], tumbler [Ankara tumbler (321.62 g, 31.55 cm, 62.98 cm, and 13.45 cm)], roller [Mülakat pigeon (328.96 g, 65.43 cm, 59.02 cm, and 13.61 cm)] and ornamental bird [Alabadem (332.0 g, 32.0 cm, 58.12 cm and 12.71 cm)] in the group with a body weight of 250-350 g bred in Turkey (Atasoy et al. 2013, Erdem et al. 2021, Özbaşer et al. 2020, Özbaşer et al. 2021). In addition, the body weight and wingspan values of all three genotypes were found to be lower than the results obtained in Owl (301.80 g and 63.20 cm), Satinette (332.85 g and 60.80cm), Suachandan (336.50 g and 64.70 cm) pigeons raised abroad (Parvez et al. 2016). In birds, the tail is a structure that plays a role in body stability and maintaining balance during the flight (Thomas 1996). It was stated that long-tailed birds fly slower than short-tailed ones to save energy and to compensate for air resistance during flight (Baptista et al. 2009, Norberg 1995). The fact that especially the tail length and wingspan values were lower than the birds bred for performance purposes in the study suggests that these birds are currently bred for form purposes and are subject to selection in this direction. In addition, as a result of the data obtained and a general comparison with different pigeons, it is thought that these birds can be evaluated among low body weight pigeon breeds.

CONCLUSION

As a result of the present study, it was determined that there were statistically significant morphometric differences among the genotypes. Considering the body plumage color of pigeons, Mısıri and Bango pigeons show more similar appearance, however, Baska pigeons have different appearance from both genotypes. Despite these results, we think that it would be appropriate to evaluate morphological data together with genetic analysis. Therefore, we have performed the phylogenetic analysis studies using DNA samples taken from three genotypes. In addition, it can also be interpreted that these genotypes are well preserved by the breeders. However, for safer and guaranteed results, protected and controlled breeding should be carried out as soon as possible in order to protect these genotypes.

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Conflict of Interest: The authors declare no conflict of interest.

Author Contrubution Rate: [1]FTÖB:%50, [2]EE:%25, [3]EKG:%15, [4]MİS:%10

Ethical Approval: This study was approved by the Tekirdağ Namık Kemal University, Animal Experiments Local Ethics Committee (Approval no: 2017-09)

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