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Investigation of Adaptation Performances of Domestic Chickens with Phenotypic Distribution Model to New Ecology Created by Climate Change

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ABSTRACT

Although commercial chicken genotypes have increased production and quality to a certain extent, it is not possible to completely replace domestic breeds. They need to be protected and brought into production, especially in the regions where they are found as genetic resources. The aim of this study is to determine the reactions of domestic chicken genotypes in the provinces of Bingöl (Bintav), Bitlis (Bittav), Elâzığ (Eltav), Muş (Muştav) and Tunceli (Tunçtav) to environmental change and to determine the environmental variables that affect the change the most. For this purpose, chickens collected from these provinces were distributed to all provinces in a balanced way, and their growth and development were monitored. All measurable climatic variables in the growth and development periods were measured and their effects on the development and maturity periods of the chickens were tried to be determined. Animals were raised in small family businesses with the arrangement made instead of large commercial enterprises. In the study, forty chicks of each breed were given per household and the Ataks commercial genotype was included in the control.

As a result, in the study in which the phenotypic model was used, the average weight of males and females at the growth stages was 15.48 g in males and 16.11 in females. In adulthood, it was determined as 40.24 in males and 41.85 in females. It has been determined that temperature and precipitation are the variables that mostly affect growth and development. Although domestic genotypes showed a good improvement in growth, development, and body weight, they lagged the commercial genotype. However, it was observed that Tunçtav's yield increased as the altitude increased, while Muştav and Eltav were more positively affected by high precipitation and high humidity, Bintav and Bittav genotypes were more resistant to drought and their disease thresholds were higher than others in dry seasons. It was determined that not all these traits were found in the commercial genotype.

INTRODUCTION:

In the changing and developing world, the rapid population growth and the mobility in the population reveal the necessity of making new and much more serious planning. While innovations should be made in every field, it is seen that what needs to be done in the field of food is more important than other fields. It is necessary to provide a balanced diet in order to provide healthy food and improve nutritional conditions. In a balanced diet, it is necessary to ensure the continuity of protein sources. In this, ensuring the continuity in the production of both vegetable and animal protein sources comes to the fore. It is seen that countries that use their resources correctly and realistically have production plans and successfully manage their own resources. The most important protein source is those of animal origin. However, in recent years, an opposition to red meat has begun to emerge in terms of health. Despite the propaganda that there are dangers in terms of health due to unrealistic or overly exaggerated discourses regarding the demand for safe and healthy food, the demand of the Turkish people for red meat continued to increase even though it decreased partially (TÜİK, 2022). There has been a 7.8% decrease in the production of meat, which is expressed as white meat, especially chicken meat (TÜİK, 2020). This situation is thought to have a high impact on the increase in input prices throughout the country.

Developed countries have reached a certain level in the production and supply of animal products and can implement their production programs. However, since developing countries do not fully establish their livestock systems, they cannot make a certain planning and may experience production-related problems (Simopoulos et al., 2012). While domestic breeds are generally at the center of the animal production systems of developing countries, in recent years, concentrations on hybrid and cultural breeds have begun (Gümüş and Çınar, 2016). The fact that native breeds are genetically well adapted to their environment and are more tolerant to changes makes them stand out in their preference (Pym , 2010). Due to this advantage of local breeds, it can be a good source of protein and nutrition especially for businesses and small households that have to produce with low input (Anon, 2012).

Although domestic breeds are criticized for their low productivity, they continue to be raised especially in small businesses (Keskin and Demirbaş, 2012; Haque et al., 2020). Although the studies carried out for the inclusion of high yield hybrid genotypes in the production area were successful on the basis of large enterprises, their effect was limited as they did not find a response in small enterprises (Gangadoo et al., 2016). Because high-yielding genotypes could not adapt to changing environmental conditions, they had to struggle with serious yield losses and diseases that resulted in death (Bekele et al., 2010; Magdelaine et al., 2010). A way must be found to improve and develop local meat and egg production. At the same time, this is a necessary action to prevent possible problems that may be encountered in the future (Dessie et al., 2000; Sultan et al., 2016).

While intensive breeding systems are at the forefront in poultry breeding around the world, semi-intensive and village systems continue to exist even though they are decreasing. The basis for the observed differences between these breeding systems is the difference in management systems (ILRI, 2021). In general, commercially defined hybrid breeds are grown in intensive or semi-intensive breeding, while small businesses raise native breeds in the free system. It would be useful to identify potential areas of suitability for genotypes other than native. Because the determinant of the distribution within the country is not only the environment, but also the knowledge of the producers and the attitude of the state on this issue (Lozano-Jaramillo et al., 2018).

Although productivity is important in poultry farming, it is necessary to explain it with the help of mathematical models for the continuity and standardization of production, and the most widely used models in this field are phenotypic distribution models (Smith et al., 2017). Phenotype distribution models are applied to determine the response of phenotypic traits as a function of environmental conditions. Because the environment can accelerate the emergence of some characters, while reducing others and even preventing them from appearing (Topal & Yıldız, 2011). This is considered as a result of the interaction of the genotype and the environment. If the phenotypic differences caused by the environmental conditions change according to the gentypes and give different responses according to the environment, there is an inverse relationship between the environment and the genotype and this is called the Genotype*Environment interaction (Duzguneş et al., 1987). The effects of environmental factors on genotype performances made it necessary to study adaptation in animal husbandry. Due to the high response of commercial breeds to changes in environmental conditions, yield loss can reach large rates. For this, it is recommended to focus on local genotypes. Lozano-Jaramillo et al. 2019) in their study to determine the performance of poultry with the help of the phenotypic distribution model, stated that local genotypes performed much more successfully under adverse conditions. Stayton (2019), on the other hand, examined the performance of hard-shelled turtles with the help of the phenotypic distribution model and stated that the model could successfully explain the phenotypic distributions. Smith et al. (2017) examined species changes in meadows under the pressure of climate change with the help of phenotypic distribution models. As a result, they stated that the species change started and the model was able to explain it successfully.

Our aim in this study is to predict the productivity characteristics of different breeds locally grown in some provinces in the Euphrates basin as a function of the environment in which they live. The

Euphrates air is one of the richest areas in Turkey in terms of diversity. Due to the large number of small farms and their suitability for breeding, it is possible to come across many different chickens. In this study, it was tried to determine the performance of chickens with environmental parameters. In the study, five different types were determined and their relations with environmental parameters were examined with the help of the phenotypic distribution model. The data obtained in the study may be beneficial for the enterprises working on the subject in terms of increasing the success in breeding.

MATERIAL AND METHOD

In the study, domestic chicken genotypes found in the provinces of Bingöl, Bitlis, Elâzığ, Muş and Tunceli, which were selected from the Euphrates basin, which is located in the eastern region of Turkey and has a very important agricultural production potential, were used. The study was carried out between 2017-2019. The entire Euphrates basin was intended to be evaluated within the scope of the study, but the emergence of the Pandemic prevented work in larger areas. The data were obtained through observations. The selected provinces have different agro - ecological structures. This was enough to create sufficient diversity. All applications in the studies were carried out in accordance with the conditions specified in the official regulations. One genotype from each province, which can represent the province and is in good condition in terms of desired characteristics, was defined. They are named as Bintav , Bittav , Eltav , Muştav and Tunçtav in order to make it easier to define them.

These selected genotypes were not selected from large farms, but rather from family farms engaged in small-scale local production. Attention has been paid to the fact that the chickens raised here are genotypes that have been bred for a long time and it is accepted that they show a special adaptation for this region. First of all, the eggs of these reared chickens were taken. They were grown with Atax genotype in local breeding areas. In the study, attention was paid to aquaculture with the lowest input made by local businesses. The five selected breeds were put into breeding in a selected local business in each of the five provinces where the study was conducted. The offspring from the retrieved eggs were distributed to the producers and their development was monitored. 40 chicks of each genotype were given per household. In addition, Ataks commercial genotype was included for control. Thus, all races were tested in the whole area where the study was carried out. Care was taken to raise the young chickens under the same environmental and management conditions as the local breeds owned by the enterprises.

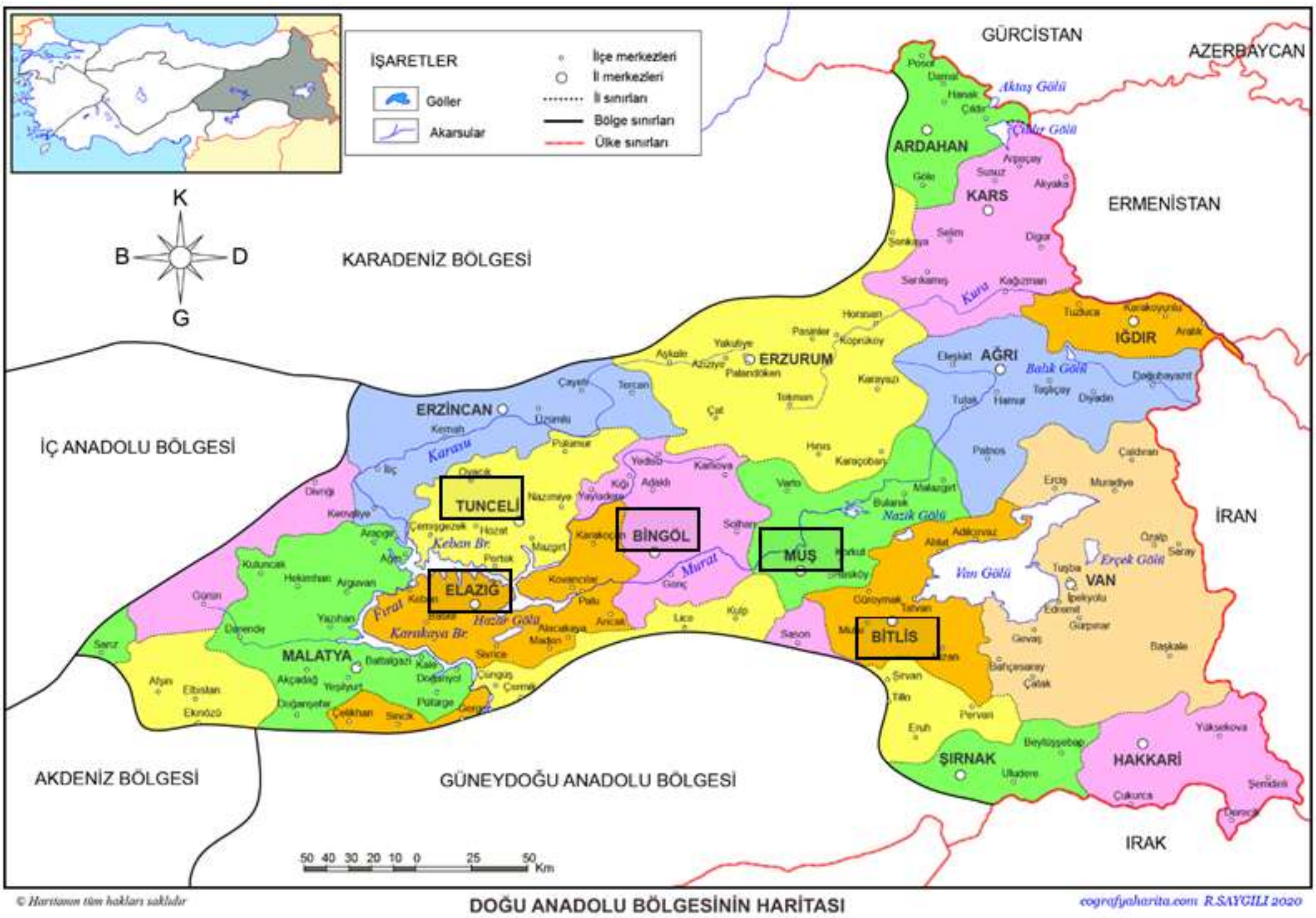

Figure 1. The provinces where the study was conducted and the location of the region in Turkey (cografyaharita.com)

All the genotypes collected were given to local businesses and supported for their cultivation. Chicken fries were grown in a controlled manner until 6 weeks of age and then delivered to the enterprises. While male chickens are kept up to 24 weeks in the region, female chickens can be kept up to 65 weeks. For males, 14-19 weeks are considered as the growth period and 20-24 weeks are considered as the adulthood period and divided into two parts. In females, it remained the same during this growth period, but the adult period was evaluated as 20-65 weeks. But after that it is disposed of. In the study, data continued to be collected during these periods. In the study for men, body weight measurements were made and recorded on a regular basis, primarily once every 15 days. Separate measurements were made for males and females. Thus, gender differences will be seen. While the average weight of males and females at the growth stages was 15.48 g in males, it was 16.11 g in females. In adulthood, it was determined as 40.24 in males and 41.85 in females. It is seen that the growth rates and amounts of females are slightly higher than males, being statistically insignificant. The linear model given below was used in the study;

$Y = S + W + e$

Here *Y;* Average chicken weights, *S;* The number at the time of measurement , *W* ; Measuring week and *e* ; Contains random error. Care was taken to select those with the same body weight during incubation for all chickens included in the study. The Least Squares Mean (LMS) was calculated for chickens of all ages using the Emmeans package in the R program for each age where the measurement was made .

The chickens used in the study were raised under the same conditions as domestic chickens. Producers were not intervened in order to create a special environment for feeding and irrigation, and the conditions continued as always. The producers have continued to give their chickens the same feed and water they have always given. Although they came from different places, they were raised under the same conditions as domestic chickens. Some environment variables were used during the study. These; annual average temperatures of the provinces, average temperature ranges (highest temperature – lowest temperature), standard deviation of seasonal variation of temperature, highest temperature of the hottest month, lowest temperature of the warmest month, highest temperature of the coldest month, lowest temperature of the coldest month temperature, annual range of temperature, humidity status, humidity status of the warmest month, humidity status of the coldest month, annual precipitation, amount of highest precipitation, amount of lowest precipitation, coefficient of variation of precipitation and altitude were carefully recorded. These measured variables are the variables that can directly affect the productivity of chickens.

The phenotype is an important feature on which the genotype can manifest itself. There are many characters that affect the formation of the phenotype and they are mostly in relation with each other. Correlation and regression analyzes are used in the analysis of this type of data. Thus, estimation equations are created and evaluations are made by obtaining data with the help of models. However, sometimes these are not enough. In this case, GAMs , which are expressed as generalized additive models, come into play. GAM models can explain relationships in a more flexible and explicable way. However, when a covariate needs to be added, the probability of failure increases. In order to increase the success of regression models, machine algorithms are being developed (Maloney et al., 2012). In order to explain the effects of the environmental variables examined in the study on the phenotype, these variables were used as predictive variables, while the live weight values for each growth period were taken as the response variable. In this, the gradient increasing method, which is one of the machine teaching methods, was applied. Gradient boosting involves an iterative process created for predictive models that poorly fit the data. Gradual adaptation can lead to improvement. Reinforcement algorithms were used as tuning parameters and stop refresh was used to stop the algorithm at the most appropriate point. The stopping point prevents data from cluttering up and can increase accuracy. The study was carried out separately for each genotype. The stopping process was made with the actions specified by Huber (2018). The variable making the highest contribution was determined in the models. The contribution of each variable to risk reduction was measured and the significance of the variable was determined. The least squares mean was used to determine the success of the predictions. The mboost program in the R program was used for modeling phenotypic variation and variable selection (Hothorn et al., 2017).

RESULTS AND DİSCUSSİON

The lowest, highest and average live weights observed for chicken genotypes in the study area were determined. The results obtained are given in Table 1. When the table is examined, the highest value observed in terms of live weight was observed in Tunçtav with 702.5 g, followed by Eltav with 693.4 g. Although Tunçtav is slightly heavier than Eltav, it has been determined that the statistical difference is insignificant. The lowest value was observed in Muştav with 586.7.

Considering the situation between observed and expected values, the most successful prediction was observed in Mustav genotypes. The coefficient of determination was quite high with 0.98. Tunçtav genotype followed this with 0.97. As a result of the statistical comparison, it was determined that the difference between the determination coefficients was statistically significant. The determination coefficient of the Eltav genotype had the lowest value with 0.92 and it was statistically significantly separated. In general, the average determination coefficient over the whole genotype was found to be 0.95. Since a high coefficient of determination also means a decrease in the uncertainty coefficient, a high coefficient of determination is considered important (Draper and Smith, 1998). The decrease in the uncertainty coefficient is a desirable feature as it will indicate the high level of identification success.

Table 1. Descriptive statistics for live weights of chicken genotypes

First Name	GCAO (g)	BAO (g)	R2	GEDCA (g)	GEYCA (g)	DG
Bintav	598.2b	602.6 cds	0.96 a	417.6	984.7	567.1
Bittaw	614.6b	627.9c	0.93 ab	408.3	1017.5	609.2
Eltav	693.4 a	671.4b	0.92b	421.2	1086.2	665.0
Mustache	586.7 c	581.2 d	0.98 a	435.4	1102.1	666.7
Tunctav	702.7 a	718.5 a	0.97 a	456.3	1181.8	725.5
Average	**637.9**	**640.32**	**0.95**	**427.2**	**1074.4**	**646.7**

GCAO; Observed Body Weight Average, BAO; Expected Weight Average, GEDCA; Lowest Observed Body Weight, GEYCA; Maximum Observed Body Weight, DG; Change Width

Tunçtav and Eltav have generally adapted better to all environments and their productivity has not changed. Considering the observed variation widths, it is seen that the variation width in chickens of Tunceli region has the highest value. The lowest variation was observed in Bintav genotypes. According to this, it can be said that chickens in Bingöl region have higher tolerance to changing environmental conditions, whereas those in Tunceli region have lower tolerance levels. Mashaly et al. (2004) stated that environmental factors, especially temperature, have a serious effect on chicken development and production. Zhu et al. (2015) stated that environmental conditions should allow this in terms of growth and development of chickens and product quality. However, Kumar et al. (2007) stated that if there is a genetic similarity between chicken genotypes, the change would be much lower than those without a relationship. The study shows that the high variation width in Tunçtav is not stable in the face of changes in environmental conditions.

During the growth period, the growth of female chickens especially, is more important. The lowest, highest and average body weights observed for female chicken genotypes were determined and given in Table 2. The highest live weight average observed for female chickens was observed in Muştav with 565 g. Tunçtav followed this with 559.4 g. It was determined that the observed difference was not statistically significant. The lowest value was observed in Eltav with 512.7 g. However, similarities were found between the value of Eltav and the values of Bintav and Bittav . There was no statistically significant difference between the average of the observed live weight and the average of the expected values. The coefficients of determination ranged from 0.92 to 0.96. However, the difference between the coefficients of determination was not significant. This shows that the responses of the female chickens are similar. The determination of the average determination coefficient as 0.94 indicates that the uncertainty ratio is also very low, such as 0.06. Accordingly, it can be said that the responses of females of these genotypes are more successfully described.

Table 2. The lowest, highest and average body weights observed for female chicken genotypes during growth periods

First Name	GCAO (g)	BAO (g)	R2	GEDCA (g)	GEYCA (g)	DG
Bintav	544.7 eu	551.9 a	0.93 a	655.8	956.8	301.0
Bittaw	538.1b	542.4 eu	0.95 a	718.2	1177.6	459.4
Eltav	512.7bc _	502.8b	0.95 a	805.5	1216.5	411.0
Mustache	565.0 a	556.1 a	0.96 a	1017.6	1356.7	339.1
Tunctav	559.4 a	545.7 a	0.92 a	1054.9	1417.0	352.1
Average	**543.9**	**539.8**	**0.94**	**850.4**	**1224.9**	**372.1**

GCAO; Observed Body Weight Average, BAO; Expected Weight Average, GEDCA; Lowest Observed Body Weight, GEYCA; Maximum Observed Body Weight, DG; Change Width

Unless there is a large and continuous change in the environmental conditions of the animals in the growth and development age, the rate of being affected by the environment remains limited. Durmuş and Koluman (2019) stated that depending on the change in environmental conditions, animals firstly start hormonal changes and then other changes begin. Jolly et al (1995), on the other hand, stated that nutritional conditions are the most important factor triggering change and stated that improving nutritional conditions can increase tolerance to the environment in animals. Karadavut et al. (2014) determined with mathematical models that the changes seen during growth in birds show themselves more clearly in females and that growth and development occur faster in females. In the study, it was observed that the Bittav genotypes with the highest variation width were more tolerant in terms of adaptation to environmental conditions, while the Bintav genotype had low tolerance but high stability. Bittav in terms of females and in terms of adaptation to different environmental conditions, It has been determined that the genotype is more suitable, but the Bintav genotype is not very suitable. It may be useful to consider this feature, especially when laying hens is planned.

The lowest, highest and average body weights observed in the families during the maturity period of the animals were determined. The results obtained are shown in Table 3. The lowest value in terms of live weight was obtained in the Bintav genotype with a value of 1258.1 g, while the lowest value was observed in the Eltav genotype with a value of 1588.3 g. The observed live weight average was determined as 1412.2 g. While the lowest weight was observed in the Bintav genotype with 1618.3 g, the highest live weight value was observed in the Eltav genotype with a value of 2496.9 g. The width of variation can be a measure of the adaptability of genotypes (Hinkelman, 1971). The genotype with the highest variation width was Bittav genotype with 666.4 g. This was followed by the Eltav genotype with 605.1 g. The lowest change width value was observed in Tunçtav genotype with 396.8 g. The fact that the Tunçtav genotype has a lower variation width than the others indicates the existence of a familial rather than individual resistance to change. It is understood that especially males' resistance to change is higher in Tunçtav genotypes. Maruyame et al (2001) stated that males are more resistant to change in their study on ducks. Hijmans et al. (2005), on the other hand, stated that it decreased slightly in females, especially with climate change, but the resistance continued in males. Dere and Tekeş (1996) studied growth and development in broilers and tried to reveal the differences between males and females and showed that females are physiologically more open to environmental changes.

Families were evaluated together during the maturity period and the determination coefficients were found to be above 0.90 in general. The lowest determination coefficient was obtained from the Bittav genotype with 0.90, followed by the Eltav genotype with 0.92. The highest determination coefficient was found in Bintav genotype with 0.96. When the Bintav genotype is defined as a family, it is defined more successfully. The uncertainty value is quite low. While the average determination coefficient was determined as 0.93, the uncertainty coefficient was 0.07. It was observed that the observed difference between the coefficients of determination was statistically significant. Tunçtav and Bintav were statistically in the same group. However, Bittav and Eltav were in a different group. Mustav, on the other hand, was somewhere between the two genotypes. In other words, the response of this genotype may resemble a subgroup depending on environmental changes, or it may rise to the upper group under good environmental conditions.

Table 3. The lowest, highest and average live weights observed for families in maturity periods

First Name	GCAO (g)	BAO (g)	R2	GEDCA (g)	GEYCA (g)	DG
Bintav	1258.1 d	1267.8 d	0.96 a	1618.3	2168.3	550.0
Bittaw	1376.4 c	1318.6 c	0.90b	1677.7	2344.1	666.4
Eltav	1588.3 a	1562.0 a	0.92b	1891,8	2496.9	605.1
Mustache	1411,9 bc	1455.7 b	0.93 ab	1855.3	2381.7	526.4
Tunctav	1451.2b	1438,2b	0.94 a	1890,6	2377.4	396.8
Average	**1412.2**	**1408.5**	**0.93**	**1786.8**	**2353.7**	**566.9**

GCAO; Observed Body Weight Average, BAO; Expected Weight Average, GEDCA; Lowest Observed Body Weight, GEYCA; Maximum Observed Body Weight, DG; Change Width

Different environmental conditions are effective on the growth periods of chickens belonging to each genotype used in the study. On this difference, the response of genotypes to environmental factors is important. For each genotype, environmental factors affecting the lowest and highest body weights measured during the growth period of males were determined. The results obtained are shown in Table 4. Each environmental factor has a positive or negative effect on the growth and development of animals. However, some effects may be more pronounced than others. The highest temperature in the hottest month was effective on Bintav genotypes in Bingöl province . The change width was quite high as 1070.2 g. It is noteworthy that although there are domestic chickens of the province, they are the genotype most affected by high temperatures. In Elazig, the Bintav genotypes came to the fore again and the average daytime temperature made the biggest impact.

Considering the observed average values, the highest value was obtained from Tunçtav genotypes in Bingöl province with 817.9 g. The lowest value was observed in Bingöl province and Bittav genotypes with 673.2 g. However, the difference between Tunçtav and Bityav genotypes grown in Bingöl was not statistically significant. At the same time, the difference between the mean values of Bintav genotypes grown in Bingöl and Elâzığ provinces and Tunçtav genotypes grown in Muş province was found to be insignificant. Considering the determination coefficient showing the success of the estimation, the highest coefficient of determination with 0.96 was obtained from the Bintav genotypes in the province of

Bingöl, where the highest temperature in the hottest month was affected, while the lowest value was obtained from the Bittav genotypes in the province of Bingöl, which was affected by the daily temperature in the environment . .

Table 4. Environmental factors affecting the lowest and highest body weights observed and estimated during the growth period of males for each genotype

ECF	EYCAGI	GA	GOD	TEOD	R2 ⁻	GEDA (g)	GEYA (g)	DG (g)
ESAEYS	Bingol	Bintav	673.2b	665.2	0.96 a	347.6	1417.8	1070.2
OGS	Elazig	Bintav	701.8b	678.4	0.91b	405.8	1343.7	937.9
ESAY	Mus	Tunctav	677.8b	712.8	0.91b	417.0	1309.9	1305.7
OGS	Bingol	Bittaw	788.3 a	725.5	0.90b	371.9	1484.1	112.2
VOTE	Bingol	Tunctav	817.9 a	799.6	0.94 a	443.7	1552.0	428.2

ESAEYS: Highest temperature in the warmest month, OGS: Average daytime temperature, ESAY: Precipitation in the coldest month, OY: Average precipitation, ECP: Effective Environmental Factor, EYCAGİ: Province with the Highest Body Weight Observed, GA: Genotype Name, GOD: Observed mean value, TEOD: Predicted mean value, GEDA: Lowest Observed Weight, GEYA: Highest Observed Weight, DG: Change width,

Koç and Gökkuş (1993) stated that daytime temperatures have a direct effect on the nutrient utilization of animals and that very high temperatures can cause growth retardation. Sahin et al. (2013) stated that daytime temperature can cause a serious heat stress and this will reduce feed efficiency and productivity. Türkel (2020) stated that climate change will negatively affect the growth and development of animals and stated that necessary precautions should be taken. It is known that the growth and development of animals will decrease with heat stress. However, since climate change and global temperature increases are expected to have a negative effect on poultry, it will be necessary to concentrate the studies on the genotypes with the highest temperature tolerance. Thus, the genotypes that show the highest tolerance to temperature can be determined and these can be given priority in future studies.

Monitoring the growth of females is particularly important. Environmental factors affecting the lowest and highest body weights in the growth periods of the females of the gher chicken genotype in the study were determined. The results obtained are given in Table 5. The lowest values ranged from 297.6 g to 412.8 g, while the highest values ranged from 1393.2 to 1604.3 g. In the study conducted in Bitlis province, the main determinant was the annual total temperature and its effect on Bintav was higher than the others. The lowest value obtained with the effect of high temperature was 388.3 g, while the highest value was observed as 1556.8 g. It has been observed that the amount of precipitation in the most humid month in Tunceli province is more effective and the most affected genotype is Muştav. While the lowest value was 297.6 g in the Mustard genotype , the highest value was 1393.2 g. It is seen that total precipitation is effective in Elazig province. Eltav has been affected by the total precipitation here. The lowest value of this genotype ranged from 412.4 g to 1407.1 g. However, in the study conducted here on why the local genotype is affected by annual growth, it has been seen that the precipitation is very uneven due to the deterioration of the precipitation regime, and this causes undesirable developments. For this reason, it is thought that it would be much more accurate to leave the concept of annual precipitation in time and evaluate seasonal precipitation as a priority.

In case of rapid and continuous temperature changes, difficulties may arise in the adaptability of animals. The province with the highest temperature changes was Bingöl and the genotype most affected by the change here was Bittav genotype. The lowest value in the Bittav genotype ranged from 379.5 g to 1604.3 g. The coldest day of the coldest month was effective on the Eltav genotype in Muş province. The highest value of this genotype was 356.4, while the highest value was 1573.4. Considering the widths of variation, it was observed that the temperature changes in Bittav genotypes in Bingöl were ahead with a variation width of 1224.8 g.

In terms of average values observed, 836.1 g was observed in Bittav genotype in Bingöl province where temperature change was effective, while the lowest value was 669.0 g in Muştav genotypes in Tunceli province, where precipitation in the most humid month was effective. When the coefficient of determination is examined, it is seen that there is no statistical difference between the coefficients. A high coefficient of determination is important because it emphasizes the high level of predictive success of the model. The uncertainty coefficient decreases and this shows that the variables used in the study were chosen correctly (Draper & Smith, 1998).

Table 5. Environmental factors affecting the lowest and highest body weights observed during the growth period of females for each genotype

ECF	EYCAGI	GA	GOD	TEOD	R2 ⁻	GEDA (g)	GEYA (g)	DG (g)
YTS	Bitlis	Bintav	715.9c	692.8	0.93 a	388.3	1556.8	1168.5
ENAY	Tunceli	Mustache	669.0c	722.8	0.93 a	297.6	1393.2	1095.6
TY	Elazig	Eltav	822.7 a	799.3	0.92 a	412.8	1407.1	994.3
SD	Bingol	Bittaw	836.1 a	810.4	0.94 a	379.5	1604.3	1224.8
ESAESG	Mus	Eltav	794.2b	812.2	0.94 a	356.4	1573,8	1217.4

YTS: Annual total temperature, ENAY: Precipitation in the wettest month, TY: Total precipitation, SD: Temperature change, ESAESG; Coldest day of the coldest month, ECP: Effective Environment Factor, EYCAGI: City with Highest Body Weight Observed, CI: Genotype Name, GOD: Observed mean value, TEOD: Predicted mean value, GEDA: Lowest Observed Weight, GEYA: Observed Maximum Weight, DG: Width of change

In his study, Model (2017) stated that environmental changes will be the sector that will be most affected by climate change in global animal production, and especially the annual total temperature, temperature changes for the year and total precipitation will be determinants. Bayraç and Doğan (2016), on the other hand, emphasized that sudden changes can occur with the total precipitation and temperature being effective, which can greatly reduce productivity. Erlat and Türkeş (2012) stated in their study that the change in the number of coldest days would affect other climatic factors as well, and they also stated that this could increase as well as decrease the effects of other climatic factors. Musharaf and Latshaw (1999) stated that high temperature and rapid temperature changes may disrupt protein metabolism in chickens, and for this, necessary treatments should be taken against temperature increase and change in the rearing areas. Fidan (2012) stated in his study on animal welfare that females are more sensitive in this regard and give better results in positive conditions. Accordingly, it has become important to determine the effects of environmental factors, especially on females.

After obtaining the data in the growth periods of the females, the data in the maturity periods were obtained. Accordingly, the environmental factors affecting the lowest and highest body weights determined in the maturity period of females for each genotype are given in Table 6. According to the locations, the lowest measurement values ranged from 356.6 g to 444.3 g, while the highest values ranged from 1505.2 to 1616.4 g. In Tunceli province, precipitation in the driest month was determined as the most effective environmental factor. The change width was 1255.3 g. While precipitation in the hottest month was effective in Elazig and Muş provinces, there were differences in the most affected genotype. Bittav in Elazig and Bintav in Muş were the most affected genotypes. In Muş province, the variation width of Bintav reached the highest value with 1281.3 g. While the annual total precipitation has the highest effect on Eltav in Bingöl, altitude has an effect on Bitlis.

Considering the average values observed, the highest value with 817.3 g was determined in the Eltav genotypes in Bitlis province, where altitude is effective. The lowest value was 738.6 g in the Muştav genotype in Tunceli province, where the rainfall in the driest month was effective. It was determined that the observed differences between the observed mean values were statistically significant. The values of Eltav and Bintav genotypes grown in Bitlis and Muş provinces were found to be in the same group statistically. The difference between the observed mean values of chickens reared in Tunceli, Elazığ and Bingöl provinces was found to be insignificant. Considering the determination coefficients, the highest value was 0.96 in the Mustav genotypes in Tunceli province, where the rainfall in the driest month was effective. The lowest value was seen in Eltav genotypes in Bingöl province, where the annual total precipitation was effective. The determination coefficients above 090 were considered as success in terms of the study.

Table 6. Environmental factors affecting the lowest and highest body weights estimated at maturity of females for each genotype

ECF	EYCAGI	GA	GOD	TEOD	R2 ⁻	GEDA (g)	GEYA (g)	DG (g)
ICC	Tunceli	Mustache	738.6b	726.8	0.96 a	361.1	1616.4	1255.3
ESAY	Elazig	Bittaw	744.2b	711.3	0.91b	356.7	1505.2	1148.5
ESAY	Mus	Bintav	802.8a	837.9	0.93 ab	418.6	1699.9	1281.3
YTY	Bingol	Eltav	766.9b	791.0	0.90b	444.3	1543.6	1099.3
R	Bitlis	Eltav	817.3 a	796.6	0.94 a	391.1	1516.7	1125.6

ICC: Precipitation in the driest month ESAY: Precipitation in the warmest month, Y TY: Annual total precipitation, R: Altitude, ECF: Effective Environmental Factor, EYCAGI: Province with the Highest Body Weight, GA: Genotype Name, GOD: Observed average value, TEOD: Predicted mean value, GEDA: Lowest Observed Weight, GEYA: Highest Observed Weight, DG: Width of change,

CONCLUSION

Significant variations were observed between observed and predicted weights according to genotypes. In addition to the ecological conditions of this region, it may vary depending on the knowledge and culture of the breeders. There are significant differences in the performances of the early and females in the growth and maturity stages. Determination coefficients were calculated to determine the success of the predictions made. In addition, to evaluate the sensitivity, the correlations between the estimated values with the help of phenotypic variation models and the household averages of the breeding families, significant differences were determined for all genotypes and growth stages.

The correlations also showed changes according to the provinces and this was found to be significant. Correlation values were determined as r=0.561** for household*region, r=0.109 for household*genotype, and 0.499** for region*genotype interactions. Accordingly, changes in households according to regions affect productivity, as well as the effectiveness of genotypes according to regions, and genotype values vary according to regions. However, positive but insignificant relationships were found between household and genotype. Correlations ranged from 0.21 to 0.88. The estimation of the most suitable region per genotype and the results of the applied model gave similar results according to gender. However, it was observed that females had slightly higher values. To determine the most successful model, it is always necessary to know the effects of environmental factors. As the effect of environmental factors increases, the success rate in estimating model variables may change. Determining the individual impact amounts of environmental variables directly affects success. In the study, the distribution of male weights was seen as the variable most affected by environmental factors. From here, it can be said that men are much more sensitive to the environment, although it varies according to genotypes and region. Temperature-related factors were decisive in the estimation of live weights.

Phenotypic distribution models using gradient reinforcement, one of the machine learning methods, were used to increase the prediction ability of the GAM procedure and accordingly to increase the chance of success. When the results obtained are examined, it is possible to show how different genotypes respond to changing environmental conditions. Breeding studies have reached a certain stage in the poultry industry and successful results have been obtained. However, the necessity of conducting studies for native genotypes has emerged. With this study, the responses of local genotypes to changing environmental conditions were determined.

Although the local genotypes showed a good development in terms of growth, development and live weight, they remained behind compared to the commercial genotype, whereas the Bintav and Bittav genotypes were more resistant to drought and the disease thresholds were higher than the others in the dry seasons. Growth and development performance of our commercial genotype has been much faster. Although the Tunçtav genotype increases its durability as the height increases, it has been observed that Muştav and Eltav are more positively affected by high precipitation and high humidity. It was determined that Bintav and Bittav genotypes were more resistant to drought and their disease thresholds were higher than the others in dry seasons. It has been estimated that the low performance of domestic genotypes compared to the commercial genotype depends on the temperature and humidity in the environment. It was determined that each degree increase in temperature had a negative effect on live weight. However, the ambient temperature being up to 30 degrees did not make a serious change, while each degree of 31 and above caused a 2-3 % decrease in live weight. In addition, it was determined that the age factor was significantly effective in the response of genotypes to the environment. It has been determined that tolerance decreases with age, but if the temperature rises above 35 degrees, they perform better than the commercial genotype.

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