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An investigation on the determination of factors influencing chick sex prediction in hatching eggs

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This study was aimed at determining the factors influential on the prediction of chick sex in hatching eggs. Data pertaining to quail eggs, from which 478 live chicks hatched after incubation, constituted the material of the study. The binary logistic regression analysis was used for statistical analyses. Four were determined, which influenced the probability of the chick sex being male or female. These predictor variables were determined, which influenced the probability of the chick sex being male or female. These predictor variables were egg weight, egg length, egg width, and egg shape index. The present study demonstrated the mean weight of quail eggs as 12.75±0.89 g and their shape index value range as 75.45±3.02%. The equation of logistic regression model for the four variables was Y=2826.052 + (1.364 egg weight) – (75.007 egg length) + (98.860 egg width) – (37.500 egg shape index). The chi-square value was 563.797 with a P-value of less than 0.0001. The analyses performed demonstrated that, the independent variables included in the model, egg weight and egg width had positive influence on chick sex.

Key words: Logistic regression, quail, sexing, shape index.

INTRODUCTION

The sexing of day-old chicks is of great significance for the poultry industry. Sexing and the separation of male and female animals are performed, based on differences in the nutrient requirements, growth rate, marketing age, management, and nutrition of the two sexes. The sexing of day-old chicks is performed by companies with expertise in animal improvement and grandparent breeding stocks for the purpose of marketing the males of the father line and the females of the mother line, while commercial egg companies perform sexing for the selection of female chicks. Furthermore, in broiler production, sexing is required when males and females are raised separately (Kaleta and Redmann, 2008; Tran et al., 2010; Saatci et al., 2011; Sari et al., 2013; Shafey et al., 2013).

Previously, sex prediction was based on the observation of the shape of the egg (Bönner et al., 2004), and it was predicted that male chicks (cockerels) hatched from pointed or elongated. On the other hand, some other researchers suggested that male chicks hatched from round eggs. In the following years, the hypothesis that egg weight defined chick sex gained popularity. Subsequent research suggested that neither egg shape nor egg weight defined the sex of the chick (Jull, 1934).

In poultry species, the reproductive organs being located inside the body renders sex differentiation, based on physical attributes, difficult. The examination of the cloaca for sex differentiation (vent sexing) in day-old

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chicks was first applied in 1925 by the Japanese, and is based on the observation of the rudimentary male copulatory organ in the cloaca (Lunn, 1948; Phelps et al., 2003; Cerit and Avanus, 2007; Tran et al., 2010). This method has found common use in many poultry species and requires the assessment of expert sexers, who have been trained on sex differentiation. Even if performed by experts, this method has an error margin of 5% (Bramwell, 2003; Cerit and Avanus, 2007).

For sex differentiation, surgical methods based on the assessment of the morphological features of the reproductive organs (Laparoscopy) have also been used. This method requires anaesthesia to be performed and bears the risk of damage to the vital organs and the occurrence of death (Halverson and Dvorak, 1993; Cerit and Avanus, 2007). Sex differentiation by faecal steroid analysis is based on the determination of the oestrogen/testosterone ratio (E/T) in bird faeces. In female birds, the E/T ratio is higher than that of male birds (Hirschenhauser et al., 1999; Washburn et al., 2004). While an E/T ratio of 2.9 or higher was indicated as female owl, an E/T ratio of 1.6 or less was expressed as male owl. The best results are obtained with faecal samples taken from adult birds in the reproduction season (Washburn et al., 2004).

In the sex identification of the poultry sector after hatch were reported methods which are based on sex-linked genetic traits as auto-sexing, colour sexing, feather sexing, shank colour, plumage colour (Warren, 1976; Gawron and Robert, 1980; Kalina et al., 2012). In a study the precision of Manchurian Golden quails sexing by plumage colour (age of 21 days) was found 97% (Genchev et al., 2008).

In parallel with advances in molecular genetics, several methods have been used for sex determination during the incubation period of eggs (Ellegren and Sheldon, 1997; Nandi et al., 2003; Chue and Smith, 2011). The specific W chromosome found in the avian embryo can be detected with the polymerase chain reaction (PCR) technique, yet, in view of the time period required for the PCR results to be obtained and the costs, the application of this method at an industrial scope does not seem feasible (Cerit and Avanus, 2007; Kalina et al., 2012).

Tran et al. (2010) developed a highly accurate, low-cost, rapid and practical method for sex determination, based on the level of oestrogen in the allantoic fluid during embryonic development.

Sex determination methods, which are applied during embryonic development or post-incubation, presenting with certain shortcomings or disadvantages in terms of cost, applicability and accuracy, has required alternative methods to be developed. The aim of this study was to establish a model that would link exterior egg quality traits, such as egg shape index, egg length and egg width, with sex. It was aimed to ascertain the possibility of determining the sex of the chick prior to incubation by means of this model.

MATERIALS AND METHODS

Five hundred and seven hatching eggs laid by 12 to 13-week-old breeder quails raised at the Samandag Vocational School of Mustafa Kemal University in Turkey constituted the material of the study. Eggs, confirmed not to be broken or cracked, were collected daily for a period of one week and were stored in a store room at a temperature range of 15 to 18°C and relative humidity of 70%. Prior to incubation, each egg was weighed and marked with a unique number. Each egg of them were placed onto measurement scale and imaged by camera. These images were analyzed using the *UTHSCSA image tool* software by digital image analysis. Values pertaining to egg width and length were obtained using digital image analysis. The shape index value was calculated using the formulation to read:

Shape index (SI) = (Egg width / Egg length) x 100 (%) (Alkan et al., 2013).

In the first phase of embryonic development (days 0 to 14), the eggs were subjected to a temperature of 37.6°C and a relative humidity of 55 to 60%. During the hatching period, hatching baskets with separate compartments, which were all individually numbered, were used. The eggs, which were individually numbered prior to the incubation process, were placed into the separate individual compartments of the hatcher during transfer. In this phase, the temperature and relative humidity were adjusted to 37.2°C and 65 to 70%, respectively. The number of chicks, which were sexed, was 478. Data obtained from 244 male and 234 female chicks was used in analyses. As the chicks that hatched from the eggs were very small, it was not possible to perform accurate sexing by the observation of the structure of the cloaca (vent sexing). Therefore, the sex of the chicks was determined according to the appearance of the breast feathers (feather sexing). For this purpose, the chicks were examined during the second week of the growing period, and those with plain brown colored breast feathers were considered to be male, whilst those with black dotted grey colored breast feathers were considered to be female.

Statistical analysis

In the present study, the descriptive statistical analysis of external egg quality traits was performed. Chick sex was used as the dependent variable. Therefore, the dependent variable had two options, namely, male and female. Furthermore, egg weight, egg length, egg width and shape index values were included as independent variables in the model. Taken to predict the dependent variable was established separately with each independent variable binary logistic regression equation. The data obtained were assessed using the SPSS (2006) 16.0 software package.

RESULTS

In this study, data pertaining to hatching eggs yielding live chicks, of which the sex was determined, was analysed. The variables, explanations belonging to the variables and descriptive statistical data are presented in Table 1.

The logistic regression analysis was used to determine any differences between the independent variables for sex, and the percentage accrual rate of the probable values of the dependent variable. For this purpose, the sex of the chick that hatched from the egg at the end of

Table 1. The variables used in the model, mean values and standard errors.

Variable / Dependent variable	Groups	n (number)	Explanations
Sex	Female (0) Male (1)	234 244	The sex of the chicks that hatch from the eggs at the end of the incubation period.
Independent variable	**X ± S**	**n (number)**	
Egg weight (g)	12.75±0.89	478	The traits of the eggs from which live chicks hatch.
Egg length (mm)	33.45±1.31	478	
Egg width (mm)	25.21±0.74	478	
Egg shape index (%)	75.45±3.02	478	

Table 2. Logistic regression model for chick sex prediction. Dependent variable (Female=0/Male= 1).

Independent variable	β (Coefficient)	SE (β) (Standard error)	Wald	P	Probability rate (Exp (β))
Constant	2826.052	453.115	38.899	0.647	
Egg weight	1.364	0.692	3.888	0.049	3.912
Egg length	-75.007	12.357	36.845	0.000	0.000
Egg width	98.860	16.287	36.842	0.000	8.596E56
Egg shape index	-37.500	6.020	38.798	0.000	0.000
R^2	0.924				
X^2	563.797 (P=0.000)				

Table 3. Classification results.

Sex (Observed)	Sex (Predicted)		Confirmation rate (%)
	Female (Number)	Male (Number)	
Female	227	7	97.0
Male	4	240	98.4
General classification rate			97.7

the incubation period was set as the dependent variable. Egg weight, egg length, egg width and egg shape index were analysed as the factors influential on the dependent variable. The sex prediction models developed using these variables are shown in Table 2. According to the results presented in Table 2, and based on all Wald values being statistically significant, the common factors influential on sex development were determined as egg weight, egg length, egg width and egg shape index. Accordingly, the equation used for classification was as follows:

$$Y=2826.052 + 1.364_{\text{Egg weight}} - 75.007_{\text{Egg length}} + 98.860_{\text{Egg width}} - 37.500_{\text{Egg shape index}} \quad (1)$$

The chi-square value was determined as 563.797 and the equation was found to be significant according to P<0.05. The coefficient of determination (R^2) of the predicted model was 0.924. The classification table representing this equation is shown in Table 3.

The classification accuracy rate of Equation (1) obtained according to the results shown in Table 3, was determined as 97.7%, and is rather high. This high accuracy rate also demonstrates the significance of the equation. Only 11 chicks were classified erroneously. Of the female chicks 97.0% and of the male chicks 98.4% were predicted correctly.

CONCLUSION AND SUGGESTION

Sex determination bears significance for poultry establishments, in relation to their production purpose. To date, several methods have been used for sex determination in poultry chicks, which are either applied during or after the incubation period. The practicality, cost and potential effect on the viable material of these methods have been effective in their voluntary use by large scale holdings.

In the present study, factors influential on chick sex prediction in the pre-incubation period have been investigated. The dependent variable, sex, was grouped as male and female and logistic regression analysis was performed. The factors influential on sex were determined.

In the logistic regression model, if the β coefficient is negative, the Exp (β) values will be interpreted as a decrease in view of the negative correlation. The Exp (β) value shown in Table 2 is the ratio of the probability of the sex being female to the probability of the sex being male. On the condition that the other variables remain constant, an increase of one unit in egg width would increase the probability of the sex being female by 8.596×10^{-56} fold. Furthermore, on the condition that the other variables remain constant, an increase of one unit in egg weight would increase the probability of the chick sex being female by 3.912 fold. The probability rate of the embryo sex in an egg was reduced based on the egg shape index variable. The independent variables of the sex prediction model demonstrated that the exterior egg quality traits of the pre-incubation period may facilitate sex prediction. However, new predictive models based on different descriptive variables would enable further comparison.

REFERENCES

Alkan S, Karsli T, Galic A, Karabağ K (2013). Determination of phenotypic correlations between internal and external quality traits of *Guinea Fowl* eggs. J. Faculty Vet. Med. Univ. Kafkas, 19(5):861-867.

Bönner BM, Lutz W, Redmann T, Jäger S, Reinhardt B, Wissing J, Knickmeier W, Kaleta EF (2004). Morphometric and allometric studies on eggshells and embryos of free-living Canada geese (Branta c. Canadensis Linnaeus, 1758). Eur. J. Wildl. Res. 50:179-186.

Bramwell RK (2003). Sexing chicks in the backyard flock. Avian Advice. 5:4-5.

Cerit H, Avanus K (2007). Sex identification in avian species using DNA typing methods. World's Poult. Sci. J. 63(1):91-99.

Chue J, Smith CA (2011). Sex determination and sexual differentiation in the avian model. FEBS J. 278(7):1027-1034.

Ellegren H, Sheldon BC (1997). New tools for sex identification and the study of sex allocation in birds. Trends Ecol. Evol. 12:255-259.

Gawron MF, Robert J (1980). The use of blue-splashed White down in color sexing crosses. Poult. Sci. 59(11):2369-2372.

Genchev A, Kabakchiev M, Mihailov R (2008). Potential of using sexual dimorphism in plumage colour for sexing manchurian golden quails. Trakia J. Sci. 6(2):10-15.

Halverson JL, Dvorak J (1993). Genetic Control of Sex Determination in Birds and the Potential for Its Manipulation. Poult. Sci. 72(5):890-896.

Hirschenhauser K, Möstl E, Kotrschal K (1999). Seasonal patterns of sex steriods determined from feces in different social categories of greylag geese (Anser anser). Gen. Comp. Endocrinol. 114:67-79.

Jull MA (1934). The feasability of sex segregation in day-old chick. Poult Sci. 13(4):205-254.

Kaleta EF, Redmann T (2008). Approaches to determine the sex prior to and after incubation of chicken eggs and of day-old chicks. WPSA: 64:391-399.

Kalina J, Mucksová J, Yan H, Trefil P (2012). Rapid sexing of selected Galliformes by polymerase chain reaction. Czech J. Anim. Sci. 57(4):187-192.

Lunn JH (1948). Chick sexing. Am. Sci. 36(2):280-287.

Nandi S, Mcbride D, Blanco R, Clinton M (2003). Avian sex determination and sex diagnosis. World's Poult. Sci. J. 59(1):5-64.

Phelps P, Bhutada A, Bryan S, Chalker A, Ferrell B, Neuman S, Ricks C, Tran H, Butt T (2003). Automated identification of male layer chicks prior to hatch. World's Poult. Sci. J. 59:33-38.

Saatci M, Arslan C, Unal Y, Tilki M, Aksoy AR (2011). Effect of fattening length, sex and feather color on growth and fattening performance in native Turkish geese. Eurasian J. Vet. Sci. 27(3):183-189.

Sari M, Sari T, Onk K, Isik S (2013). Effects of production system and gender on liveweight and body measurements pekin ducks. Atatürk Univ. J. Vet. Sci. 8(2):112-121.

Shafey TM, Alodan MA, Hussein EOS, Al-Batshan HA (2013). The effect of sex on the accuracy of predicting carcass composition of roos broiler chickens. J. Anim. Plant Sci. 23(4):975-980.

SPSS (2006). SPSS Release 15.0. Statistical packet program, SPSS for Windows. *SPSS Inc*., Chicago, IL.

Tran HT, Ferrell W, Butt TR (2010). An estrogen sensor for poultry sex sorting. J. Anim. Sci. 88:1358-1364.

Warren DC (1976). Renowed poultry geneticist reminisces about feather sexing chicks. Poult. Trib. pp. 31-34.

Washburn BE, Tempel DJ, Millspaugh JJ, Gutierrez RJ, Seamans ME (2004). Factors related to fecal estrogens and fecal testostrone in California spotted owls. The Condor. 106:567-579.