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RESEARCH ARTICLE

Classification Tree Method for Determining Factors that Affecting Hatchability in Chukar Partridge (*Alectoris chukar*) Eggs

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Summary

The study was carried out to investigate the effects of some external egg traits on hatchability using classification tree method (CTM) in Chukar partridge (*Alectoris chukar*). 1193 eggs were collected from 90 female partridges and 671 chicks were obtained from 847 fertile eggs. Overall hatching, fertility and hatchability of fertile eggs were determined as 56.2%, 79.2%, and 71.0%, respectively. Four variables (egg weight=EW, egg volume=EV, egg length=EL and egg breadth=EB) from external egg traits have a significant effect on hatchability was estimated with 75.6% accuracy by using the CTM. Hatchability (H) was occurred as 80.0% at higher eggs than 18.1 g while H was found as 56.0% at lesser eggs than 18.1 g. When EV and EB were higher than 27.2 and 3.14 cm respectively, H was around 82.1%. But, when EV was higher than 27.2 and EB was lower than 3.14 cm (Node 9) respectively, hatchability was lower than desired. EW greater than 18.1 g hatchability was affected significantly by EV, EL and EB. This situation can be regarded as an indicator for hatching from fertilized eggs. The first report on this subject which the external egg traits of Chukar partridges influenced on hatchability were demonstrated by CTM.

Keywords: *Classification tree method, Hatchability, External egg traits, Chukar partridge*

Kınalı Keklik (*Alectoris chukar*) Yumurtalarında Çıkış Gücüne Etki Eden Faktörlerin Sınıflandırma Ağacı Yöntemi ile Belirlenmesi

Özet

Bu çalışma, kınalı kekliklerde *(Alectoris chukar)* sınıflandırma ağacı yöntemi (CTM) kullanılarak çıkış gücüne etki eden bazı dış yumurta özelliklerinin etkilerini araştırmak için yürütülmüştür. 90 dişi keklikten 1193 yumurta toplanmış ve 847 döllü yumurtadan 671 civciv elde edilmiştir. Kuluçkadan çıkış, döllülük ve çıkış gücü sırasıyla %56.2, %79.2 ve %71.0 olarak tespit edilmiştir. Dış yumurta özelliklerinden dört değişkenin (yumurta ağırlığı=EW, yumurta hacmi=EV, yumurta uzunluğu=EL ve yumurta genişliği=EB) çıkış gücü üzerinde önemli etkiye sahip olduğu CTM kullanılarak %75.6 isabetle tahmin edilmiştir. Çıkış gücü 18.1 g'dan hafif yumurtalarda %56.0 olarak gerçekleşirken, 18.1 g'dan ağır yumurtalarda %80.0 olarak gerçekleşmiştir. EV ve EB sırasıyla 27.2 ve 3.14 cm'den büyük olduğunda H yaklaşık %82.1 olmuştur. Ancak, EV 27.2'den büyük ve EB 3.14 cm' den küçük olduğunda istenilen düzeyde çıkış meydana gelmemiştir. EW 18.1 g'dan büyük olduğunda çıkış gücü EV, EL ve EB tarafından önemli derecede etkilenmiştir. Bu durum döllü yumurtalardan çıkış için belirteç olarak değerlendirilebilir. Bu rapor kınalı kekliklerde dış yumurta özelliklerinin çıkış gücüne etkisinin CTM ile gösterildiği ilk rapordur.

Anahtar sözcükler: *Sınıflandırma ağaç yöntemi, Çıkış gücü, Dış yumurta özellikleri, Kınalı keklik*

INTRODUCTION

There are numerous species of partridges in Turkey and around the world, of both the wild and domesticated kinds. The partridge *(Alectoris chukar)* is a wild bird with significantly reduced natural populations in recent years due to excessive hunting and destruction of natural habitats. However, partridge breeding for hunting, egg and meat production is becoming more and more common [1]. Chukar *(Alectoris chukar)* and Rock *(Alectoris*

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greace) partridge belongs to the family Phasinidae and species Alectoris and are more widespread than other partridge species in Turkey. In spite of the fact that there was well documented that overall hatchability, fertility and hatchability of fertile eggs of Rock partridges [2-5], there were a lack of studies concerning the Chukar partridge eggs' fertility and hatchability [6,7].

Fertility and physical characteristics of an egg as egg weight, egg breath, shell weight and shell thickness in the poultry play an important role in the hatching success [8,9]. Wilson [10] reported that a higher hatchability for intermediate than small or large eggs. The effects of external egg traits on hatchability were examined using various statistical methods in poultry species by different researchers [11-13], but number of studies conducted in partridges is lower than other poultry species [4,5].

Classification tree method (CTM) is a potentially powerful tool to predict membership of cases in the classes of a categorical dependent variable from their measurements on one or more predictor variables. CTM will be a good choice especially when data set is large, relations between variables are non-linear and when independent variables are mixed (both continuous and categorical). CTM is also structurally very simple and easy to visualize. That is, CTM begins with root node that contains all of the observations in the sample and then branch into mutually exclusive child nodes (sub-groups) which the observations of each sub-group is more homogeneous then the root node. This process goes on until the index of homogeneous meets its requirements [14-17].

The use of classification trees method are not wide-spread in the fields of agriculture but widely used in applied fields as biology and medicine [18-21]. Therefore, firstly this study was aimed at determining the effects of some egg traits on hatchability by CTM in Chukar partridge.

MATERIAL and METHODS

A total of 1193 eggs from 90 female Chukars housed on the Agriculture Faculty's Research and Application Farm of Akdeniz University were used in the study. Random bred parents were housed in individual cages in breeding houses that had windows on both sides with curtains, and they were exposed to 16 h light and 8 h darkness daily. All birds had ad libitum access to a feed containing 200 g crude protein and 11.9 MJ ME/kg [22], and to water during the experimental period. Two females were placed together with one male in all breeding cages. Parent partridges were 40 weeks old when egg collection began. The experimental eggs were collected daily during 20 days, numbered and weighted by digital balance (0.01 gr sensitive). A digital caliper was used to measure the maximum breadth and length of each egg with a sensitivity of 0.001 mm. The measured eggs were stored prior to being set in the incubator in two parties for 10 days. The temperature and relative humidity of storage was approximately 15.0-18.0°C and 65.0-70.0%. Each egg was put into an individual hatching cell on the trays. The setter and hatcher temperature and relative humidity were maintained at 37.7°C, 37.2°C, 60.0% and 70.0%, respectively. The incubation period is 24 days for partridges so at the end of 20th day of incubation the eggs were transferred to the hatcher trays.

Unhatched eggs were checked for fertility after hatching. Eggs were coded as "1" or "0" according to hatching or not, and it was investigated if hatchability connected with the egg traits or not. Overall hatchability, hatchability of fertile eggs and fertility were described as the ratio of total chick number to total egg number set, total chick number to fertile egg number, and total fertile egg number to total egg number set. Egg shape index was calculated as the ratio of egg breadth to egg length. In addition, shell surface area (SSA; cm^2) and shell weight (SW; g), shell ratio (SR; %) and egg volume (EV; cm^3) were estimated using the equations below:

SSA= 4.835 $EW^{0.662}$ [23], (EW= egg weight)

SW= 0.0482 $EW^{1.132}$ [23],

EV= (0.6057-0.0018) x LB^2 [24], (LB= egg length * maximum breadth)

SR= (SW/EW) x 100,

Classification Tree Method (CTM) was used to predict the most important variables of external egg traits affect assessment hatchability in Chukar Partridge *(Alectoris Chukar)* in this study. The purpose of CTM is to produce terminal nodes which are as homogeneous as much as possible with respect to the response variable. Statistical analyses were performed at SPSS for windows version 17.0. CTM is a binary decision tree. The tree is constructed by splitting the whole data into nodes or sub-groups based on yes/no answers about the values of the predictors. On the other hand, some of the predictors may be used more than one times while others may not be used at all. The rule generated at each step maximizes the class purity within each of the two resulting subsets. Each subset is split further based on entirely different relationships. Each split is based on a single predictor variable. It is possible to construct many different tree structures at the end of classification tree analysis. Therefore, model which has high true classification ratio will be better or optimal tree. Each node (even the root node) is assigned a predicted

outcome class. The process of node splitting, followed by the assignment of a predicted class to each node, is repeated for each child node and continued recursively until it is impossible to continue [15].

Criteria for assigning classes to nodes:

C(j/i) is cost of classifying *i* as *j*.

π(i) is prior probability of *i*.

Ni is number of class *i* in dataset

Ni(t) is number of class *i* in node.

Node is class i, if

$$\frac{C(j/i)\pi(i)N_i(t)}{C(i/j)\pi(j)N_j(t)} > \frac{N_i}{N_j}$$ for all values of *j*.

RESULTS

Firstly, 1193 were eggs set to incubator and 671 chicks hatched from 847 fertilezed eggs. Hatchability (H), hatchability of fertile eggs (HFE) and fertility (F) were determined as 56.2%, 79.2% and 71.0% respectively. Some descriptive statistics of the studied external egg traits in this research were presented in *Table 1*.

The results showed that SW (CV = 9.00%), EV (CV = 8.07%) and EW (CV = 7.95%) were the most variable egg parameters as compared with less variable SR (CV = 1.07%) and EB (CV = 2.84%). On the average, the external egg traits of Chukar partridge exhibited a low degree of variation in this study *(Table 1),* although the Chukar is a more heterogeneous flock due to semi domestication and because no selection or other artificial applications have been applied yet.

Results of classification tree analyses for determine of external egg traits affecting on hatchability in fertilized Chukar eggs were given in *Fig. 1*. Four studied external egg traits were observed to be significantly associated with hatchability was examined; egg weight (EW), egg volume (EV), egg length (EL) and egg breadth (EB). This classification tree was formed in the 10 nodes. Node-0 contained the proportion of hatchability. According to *Fig. 1,* EW was root terminal node and was divided into

Table 1. *Descriptive statistics of the studied external egg traits*
Tablo 1. *Çalışılan dış yumurta özelliklerini tanımlayıcı istatistikler*

Traits	N	Mean	Min	Max	CV (%)
EW (g)	847	21.5	14.5	26.6	7.95
EB (cm)	847	3.10	2.74	3.40	2.84
EL (cm)	847	4.15	3.46	4.68	3.89
ESI	847	0.75	0.65	0.84	3.69
EV (cm^3)	847	24.1	16.5	29.9	8.07
SW (g)	847	1.56	0.99	1.98	9.00
SSA (cm^2)	847	36.8	28.4	42.4	5.30
SR (%)	847	7.22	6.86	7.43	1.07

EW: *Egg Weight,* ***EB:*** *Egg Breadth,* ***EL:*** *Egg Length,* ***ESI:*** *Egg Shape Index,* ***EV:*** *Egg Volume,* ***SW:*** *Shell Weight,* ***SSA:*** *Shell Surface Area,* ***SR:*** *Shell Ratio,* ***CV:*** *Coefficient of variance.*

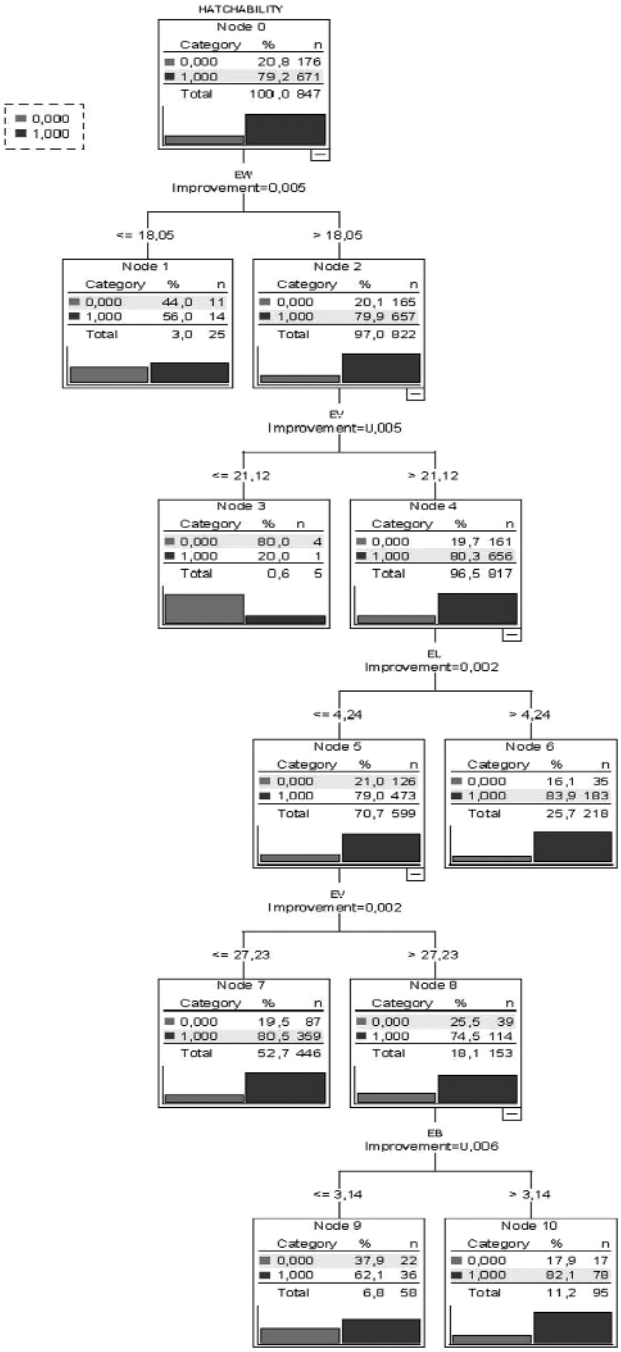

Fig 1. Classification tree of external egg traits that influence on hatchability

Şekil 1. Çıkış gücüne etki eden dış yumurta özelliklerinin sınıflandırma ağacı

EW: Egg Weight, **EV:** Egg Volume, **EL:** Egg Length, **EB:** Egg Breath, Category 0.000: no hatching, 1.000: hatching

two arms (Node 1 and Node 2). Hatchability (H) was occurred as 80.0% at higher eggs than 18.1 g while H was found as 56.0% at lesser eggs than 18.1 g (Node 2). Also, H was significantly low (20%) although the EW was more than 18.1 g when the EV was less than 21.1 (Node 3). On the other hand, when the EW and EV were higher than 18.1 g and 21.1 respectively; H was happened probably 96.5% (Node 4). H was occurred very high (83.9%) when the weight, volume and length of an egg were more than 18.1 g, 21.1 and 4.24 cm, respectively (Node 6).

Also, it was observed that when the EL and EV were equal and/or lesser than 4.24 cm (Node 5) and 27.2 (Node 7) respectively, H was occurred around 80.0%. When EV and EB were higher than 27.2 and 3.14 cm (Node 10) respectively, H was around 82.1%. But, when EV was higher than 27.2 and EB was lower than 3.14 cm (Node 9) respectively, hatchability was lower than desired.

DISCUSSION

When *Fig. 1* was examined it can be said that, if EW greater than 18.1 g, hatchability was affected significantly by EV, EL and EB in this study. This situation can be regarded as an indicator for hatching from fertilized eggs and H will not be at desired level if eggs lighter than 18.1 g (Node 1). Therefore, length, volume and breadth of an egg must be taken into account for reliable estimates about hatchability at the egg weight of more than 18.1 gr. Besides, if EL lesser than 4.24 cm, hatchability was affected by EV and EB. It was estimated to hit 75.6% by CTM that EW, EV, EL, and EB primarily affected on hatchability in Chukar partridge.

Çetin et al.[6] reported lower H (53.6%) but higher HFE (81.3%) for flock Chukar and also higher H (91.1%) and HFE (93.8%) for cage Chukar than our founds. H, HFE and F were reported as 78.7-84.6, 88.7-97.3 and 82.8-90.1% for different storage groups in rock partridge, respectively [5]. Gonzalez-Redondo [25] observed that H, HFE and F as 67.5%, 83.3% and 81.0% in Red-Legged partridge. Differences between results of present study and literatures may be related with different genotype, care, egg storage, hatching and nutrition conditions.

Several researchers reported the egg weight (EW) values between 19.2-21.4g [6,26,27] for Chukar partridge, which were consistent with our result (21.5 g). In general, many researchers agree that average egg weight preferable to achieve successful hatching. Alkan et al.[27], reported that egg width and egg length as 3.90 cm and 4.50 cm, respectively. These values were similar to our findings.

Fertile eggs have the highest probability of hatching successfully when their physical characteristics are average. The effects of external egg quality factors namely egg weight, length, width on hatchability was found significant [8,10]. Classification tree method is a powerful technique with significant potential which used in this study and highly detailed information was presented visually. The first report on this subject which the external egg traits of Chukar partridges influenced on hatchability were demonstrated by CTM. The approach to the analyses of a larger sample here described might serve to validate the technique. This research has provided valuable data that could be used when designing future studies on this area, and that can be applied to improving hatchability of partridges through selective breeding. Finally, the results of this study were showed this method can be used in the fields of agriculture.

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