VARIABILITY, HERITABILITY AND CORRELATIONS OF EGG SHAPE IN THE ZATORSKA GOOSE

ZMIENNOŚĆ, ODZIEDZICZALNOŚĆ I KORELACJE KSZTAŁTU JAJA U GĘSI ZATORSKIEJ

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ABSTRACT

The experiment was aimed at the evaluation of inheritance of goose egg measurements, egg shape indices and egg weight as well as the relationship between these traits. The research was carried out in the flock of the Zatorska geese, belonging to the FAO registered genetic resources of poultry. Seven hundred sixty-one eggs from pedigree bred geese in their first to fourth reproduction seasons were included in the analysis. Average egg shape index was 68.8%, average shell surface area was 140.6 cm^2. Egg weight of geese in different age was 165 g. Heritabilities and genetic and phenotypic correlations estimated between the analysed traits of goose egg are presented.

Key words: goose egg shape index, heritability, genetic and phenotypic correlation

ABSTRAKT

Praca miała na celu ocenę zmienności i odziedziczalności indeksu kształtu jaja, masy i wymiarów jaja oraz powierzchni skorupy, a także genetycznych i fenotypowych zależności pomiędzy badanymi cechami. Badania prowadzono w stadzie gęsi rasy Zatorskiej, należących do zasobów genetycznych drobiu i objętych rejestrem FAO. Analizą objęto 761 jaj od gęsi w wieku 1 - 4 lat o znanym pochodzeniu. Średni indeks kształtu jaja wynosił 68,8%, średnia powierzchnia skorupy – 140,6 cm^2, a średnia masa jaja gęsi w różnym wieku – 165 g. Przedstawiono współczynniki odziedziczalności oraz korelacji genetycznych i fenotypowych między badanymi cechami.

Słowa kluczowe: indeks kształtu jaja gęsi, odziedziczalność, korelacje genetyczne i fenotypowe

DETAILED ABSTRACT IN POLISH

Celem badań była ocena zmienności i odziedziczalności indeksu kształtu jaja, masy i wymiarów jaja oraz powierzchni skorupy, a także genetycznych i fenotypowych zależności pomiędzy badanymi cechami. Indeks kształtu jaja może mieć związek z wylęgowością jaja. Wielkość powierzchni skorupy stanowi ważny czynnik oceny przepuszczalności skorupy przy wymianie gazowej i ciepła. Powierzchnia skorupy jaja w połączeniu z masą skorupy daje możliwość obliczenia gęstości skorupy.

Badania przeprowadzone były w stadzie gęsi rasy zatorskiej, należących do zasobów genetycznych, będących pod ochroną FAO. Dane do analizy stanowiły pomiary 761 jaj gęsi w wieku 1 – 4 lat, o znanym pochodzeniu. Parametry genetyczne oszacowano metodą analizy wariancji w układzie hierarchicznym. Powierzchnię skorupy obliczano według wzoru 4,67 × $W^{0,6667}$ zalecanego przez Hughesa (W – masa jaja). Średni indeks kształtu jaja wynosił 68,8% (od 57,1 do 78,9%), średnia powierzchnia skorupy wynosiła 140,6 cm^2 (od 113,8 do 175,6 cm^2). Wartość masy jaja gęsi w różnym wieku wahała się od 120 do 219 g (średnia 165 g). Współczynnik zmienności analizowanych pomiarów wynosił od 3,66% (szerokość jaja) do 9,02% (masa jaja). Współczynniki odziedziczalności (h^2_{SD}) cech charakteryzujących kształt jaja były wysokie (0,51 do 0,69). Stwierdzono dodatnią korelację genetyczną między indeksem kształtu a masą jaja (0,28) i powierzchnią skorupy (0,28), natomiast korelacja fenotypowa między tymi cechami była bliska zeru. Korelacja genetyczna i fenotypowa między indeksem kształtu a długością jaja była ujemna (odpowiednio -0,34 i -0,65), a między indeksem kształtu i szerokością jaja – dodatnia (0,73 i 0,53).

INTRODUCTION

Genetic variability in the shape of egg in domestic birds has been long known [3] and its effect on egg hatchability and other traits was indicated [10]. Egg shell surface combined with shell weight might be a useful indication of shell strength of eggs [1]. Heritability estimates of the egg shape characteristics are scarce [10, 13, 15]. Characteristics of heritability of egg weight and other performance traits, as well as the origin of the Zatorska breed of geese, the concept of breeding work and the analysis of the body phenotype and performance of the population over many years were presented by Rabsztyn [11]. The objective of this study was to estimate the heritability coefficients of some egg measurements and the correlations between them in the eggs of the Zatorska geese being part of the Polish genetic resources of waterfowl.

MATERIAL AND METHODS

Observations were made in the preserved stock of the Zatorska geese maintained at the research station of the Agricultural University of Kraków. Seven hundred sixty-one eggs from geese in their first to fourth laying seasons were under investigation. Measurements of egg weight, length of the longer and shorter diameters and the egg shape index (100 * maximum width/egg length) were taken to analysis. Abnormally shaped eggs were not considered. Egg shell surface area was determined by the formula of Mueller and Scott as recommended by Hughes [2]: 4.67 × $W^{0.6667}$. Coefficients of heritability and genetic and phenotypic correlations were estimated according to the model [16]:

$$Y = \mu + a_i + s_{ij} + d_{ijk} + e_{ijkl}$$

where μ – arithmetic mean, a – effect of the age of layer, s – sire effect, d – effect of a dam within sire, e – random error effect. Significance of the phenotypic correlation coefficients were estimated after Snedecor and Cochran [14].

RESULTS

Egg weight laid by geese in different age (1-4 years) ranged from 120 to 219 g with the average 165 g, and the average egg shape index was 68.8%. Average shell surface area was 140.6 cm^2 (table 1). Variability coefficients of egg shape index and egg dimensions (3.66 to 4.34%) were about twice as smaller than that for egg weight. Heritability coefficients estimated from the sire component were rather low for egg measurements and medium for egg weight and shell surface area. However, h^2_{SD} estimates were high for all analysed traits and ranged from 0.51 to 0.69 indicating to possible significant maternal effects (table 2).

The biggest positive genetic correlation (0.73) was noted between egg shape index and maximum egg width, while the genetic correlation of egg shape index and the maximum egg length was found to be negative (-0.34) (table 3). The phenotypic correlation (-0.65) emphasizes observed negative relationship of both traits. Genetic correlations between egg shape characteristics and egg weight ranged from 0.28 to 0.53, while phenotypic relationship of egg shape index and egg weight was close to zero. Parameters estimated for egg shell surface area resembled closely those for egg weight as shell surface area is a function of egg weight.

Table 1. Egg weight, length, width, shape index and shell surface.
Tabela 1. Masa jaja, długość, szerokość, indeks kształtu i powierzchnia skorupy jaja.

Parameter Parametr	Egg weight Masa jaja [g]	Longer axis Oś długa jaja [mm]	Shorter axis Oś krótka jaja [mm]	Egg shape index Indeks kształtu [%]	Shell surface area Powierzchnia skorupy [cm^2]
Arithmethic mean Średnia arytmetyczna	164.97 ± 0.65	85.71 ± 1.43	58.93 ± 0.94	68.82 ± 0.13	140.60 ± 0.36
V [%]	9.04	3.84	3.66	4.34	6.02
Range Rozstęp	120 – 219	77.5 – 98.5	49.4 – 69.7	57.1 – 78.9	113.8 – 175.6

Table 2. Heritability of egg weight, dimensions, shape index and shell surface area.
Tabela 2. Odziedziczalność masy jaja, wymiarów, indeksu kształtu oraz powierzchni skorupy.

	Egg weight Masa jaja	Longer axis Oś długa jaja	Shorter axis Oś krótka jaja	Egg shape index Indeks kształtu	Shell surface area Powierzchnia skorupy
h^2_S	0.34 ± 0.08	0.12 ± 0.06	0.25 ± 0.08	0.16 ± 0.06	0.31 ± 0.08
h^2_{SD}	0.66 ± 0.16	0.51 ± 0.12	0.69 ± 0.17	0.54 ± 0.12	0.62 ± 0.16

Table 3. Genetic (r_G) and phenotypic (r_P) correlations between egg dimensions, egg shape index, egg weight and shell surface area.
Tabela 3. Korelacje genetyczne (r_G)) i fenotypowe(r_P) pomiędzy indeksem kształtu, wymiarami jaja, masą jaja i powierzchnią skorupy.

		Longer axis Oś długa	Shorter axis Oś krótka	Egg shape index Indeks kształtu	Shell surface area Powierzchnia skorupy
Egg weight Masa jaja	r_G	0.34 ±0.82	0.53 ±0.50	0.28 ± 0.81	1.00 ± 0.01
	r_P	0.68**	0.70**	-0.04	1.00**
Longer axis	r_G		0.39 ± 1.00	-0.34 ±1.05	0.30 ±0.90
Oś długa	r_P		0.30**	-0.65**	0.68**
Shorter axis	r_G			0.73 ± 0.57	0.51 ±0.54
Oś krótka	r_P			0.53**	0.70**
Egg shape	r_G				0.28 ±0.84
index Indeks kształtu	r_P				-0.04

** – phenotypic correlation statistically significant ($P \leq 0.01$)
** – korelacja fenotypowa statystycznie istotna ($P \leq 0{,}01$)

DISCUSSION AND CONCLUSIONS

Repeatability of some traits of egg like egg weight or volume is high in some species. Methods to quantify differences in egg shape is of particular interest in ornithology where known high repeatability among females makes it possible to identify eggs laid in nests by other females of the same species, and a wide range of parameters to describe subtle details in egg shape can be used to identify intraspecific parasitic eggs [8]. The significance of parentage effect on egg size and shape was underlined by Preston [9]. The surface area of the avian egg is a variable of prime importance for quantification of the permeability properties of the shell [7].

Egg shape index in chickens varies usually between 71 and 80% [17] and several authors noted inconsistent dependencies with fertility and hatchability. Egg shape index in ducks estimated by Sochocka and Różycka [15] and by Mazanowski [5] was 70.7 to 73.3% . Egg shape of Biłgorajska geese was estimated to be 63 – 67% [10] and in different crossbred geese the index was 65 – 67.5% [4, 6], confirming a tendency to slight elongation of egg shape in the investigated material as compared to the Zatorska geese. Similarly low values of variability coefficient of goose egg dimensions were noted by Paganelli et al. [7], Puchajda [10], Petersen [8]. Egg shell area calculated in several crossbred geese with Graylag ancestry (Anser anser) [6] was greater than in the Zatorska geese and ranged from 146 to 151.7 cm^2. However, the authors used different shell surface algorithm after Paganelli et al. [7].

Heritability estimates of egg shape and egg measurements in Biłgorajska geese [10] were lower than noted in the Zatorska geese. In ducks the h^2_S coefficient estimated by Sochocka and Różycka [15] was as high as 0.96 for egg shape index and 0.82 for the longer egg axis. Schultz [13] proved that heritability of egg shape index in chickens was significantly higher for the first egg in a clutch than that for the second position and the h^2 estimates were moderately low (0.11 to 0.19). Lack of phenotypic relationship observed in Zatorska geese between egg shape and egg weight was in good agreement with the results of Różycka and Wężyk [12] for chicken eggs and of Sochocka and Różycka [15] for Pekin ducks. But negative genetic correlations of these traits in ducks do not confirm that relationship found in the Zatorska geese.

In conclusion, variability of the Zatorska goose egg measurements, egg shape and egg surface area was very small, and was smaller than those for egg weight. Heritability estimates for egg weight and egg dimensions indicate possible maternal effects.

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