Egg and Shell Quality in 2 Strains of Leghorn Hens Selected on High Laying.

Ei und Shallequalität in 2 Leghornlinen selektierten an höhe Legeleistung.

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In most of the flocks of laying hens, selection on the quantitative increase of productivity, disregarding egg and shell quality traits, is being carried out. At the same time it is observed that the greater increase of laying level, the higher number of cracked eggs per flock is/Van Tijen, 1977/. Hamilton and others found that 6-8% of eggs was damaged on the way to the consumer. On some farms the number of cracked eggs deviates from 1 to 2%, sometimes exceeding even 35%.

The actual researches aimed at determining interdependences between formation of egg qualitative traits and selection on the quantitative increase of productivity in two strains of Leghorn hens.

Breeding work, regarding egg quality traits, was done in two investigated strains of Leghorn hens using methods accepted on the pedigree farm of laying hens in Poland /Przyborska and others, 1972; Wężyk, 1978/. 3 eggs were collected from each 9 months old hen, that laid one egg daily for 3 consecutive days. In strain G 88, 1413 eggs laid by 471 hens by 20 cocks and from 305 hens were examined. While in strain G 99, 915 eggs laid by 305 hens by 20 cocks and 139hens were examined.

Egg and shell quality, was evaluated with respect to 11 traits

Table 1. Mean values egg qualitative traits and productivity of Leghorn hens, strains G 88, G 99 from Piaseczno.

Specification	Strain G	$\bar{x}$	$\mp s_{\bar{x}}$	S	V
Egg mass /g/	88 99	64,3 63,0	0,164 0,168	3,56 3,32	5,54 5,27
Shape index /%/	88 99	74,64 74,76	0,126 0,159	2,74 3,15	3,67 4,21
Deformation /μ/	88 99	28,4 -	0,224 -	4,85. -	17,09 -
Specific gravity / g/cm^3/	88 99	1,081 1,079	0,000 0,000	0,00 0,00	0,34 0,39
Shell strength /kg/	88 99	2,758 4,370	0,020 0,038	0,43 0,76	15,70 17,42
Shell mass /g/	88 99	6,17 5,60	0,021 0,024	0,46 0,47	7,42 8,44
Shell percentage/%/	88 99	9,61 8,89	0,029 0,033	0,62 0,66	6,44 7,38
Shell thickness /μ/	88 99	358,53 382,70	0,105 0,009	2,29 0,18	6,38 4,75
Haugh unites /%/	88 99	79,42 85,65	0,329 0,267	7,14 5,30	9,00 6,18
Yolk colour/scale/	88 99	8,40 8,03	0,059 0,056	1,27 1,11	15,19 13,85
Yolk index /%/	88 99	52,81 53,25	0,208 0,164	4,52 3,24	8,56 6,09
Body weight of 20 weeks old hens /kg/	88 99	1,508 -	0,005 -	0,11 -	7,21 -
Maturity /days/	88 99	162,43 160,76	0,341 0,386	7,41 7,62	4,56 4,76
Initial laying rate /%/	88 99	79,33 84,24	0,247 0,276	5,37 5,47	6,76 6,49
Laying up to 64 weeks of life /head/	88 99	208,70 225,07	0,835 0,899	18,16 17,82	8,68 7,92

Table 2. Heritability of egg quality and productivity traits of Leghorn hens, strains G 88, G 99 from Piaseczno.

Specification	Strain G	h^2_S	s.e.h^2_S	h^2_D	s.e.h^2_D	h^2_{SD}	s.e.h^2_{SD}
Egg mass	88	0,224	0,034	0,298	0,046	0,261	0,105
	99	0,338	0,045	0,360	0,059	0,349	0,138
Shape index	88	0,482	0,054	0,398	0,045	0,440	0,133
	99	0,382	0,048	0,343	0,059	0,363	0,141
Deformation	88	0,189	0,027	0,030	0,039	0,080	0,092
	99	-	-	-	-	-	-
Specific gravity	88	0,199	0,036	0,618	0,053	0,408	0,115
	99	0,358	0,048	0,423	0,060	0,391	0,141
Shell strength	88	0,434	0,049	0,282	0,043	0,358	0,124
	99	0,253	0,037	0,134	0,058	0,194	0,127
Shell mass	88	0,433	0,051	0,481	0,048	0,457	0,131
	99	0,160	0,034	0,444	0,065	0,302	0,128
Shell percentage	88	0,614	0,065	0,574	0,048	0,594	0,154
	99	0,309	0,045	0,528	0,062	0,418	0,140
Shell thickness	88	0,357	0,047	0,629	0,052	0,493	0,129
	99	0,114	0,020	0,387	0,055	0,137	0,113
Haugh unites	88	0,365	0,048	0,689	0,053	0,527	0,132
	99	0,551	0,060	0,279	0,055	0,415	0,154
Yolk colour	88	0,166	0,037	0,910	0,060	0,538	0,124
	99	0,212	0,031	0,100	0,056	0,056	0,120
Yolk index	88	0,663	0,068	0,457	0,045	0,560	0,155
	99	0,289	0,039	0,135	0,057	0,212	0,129
Body weight of 20 weeks old hens	88	0,893	0,091	1,037	0,056	0,965	0,204
	99	-	-	-	-	-	-
Maturity	88	0,151	0,031	0,537	0,052	0,344	0,109
	99	0,058	0,030	0,768	0,069	0,413	0,131
Initial laying rate	88	0,157	0,034	0,736	0,056	0,446	0,117
	99	0,151	0,023	0,370	0,054	0,110	0,114
Laying up to 64 weeks of life	88	0,155	0,031	0,487	0,050	0,321	0,107
	99	0,077	0,030	1,561	0,084	0,742	0,147

/table.1/on the base of maen values of 3 eggs collected from laying hens using methods accepted at Random Stample Test Station/Różycka, 1979/.

Statistical characteristics of the two investigated hen strains are indicated in table 1.

Heritability coefficients of egg quality traits /table 2/vary for particular traits and for each strain.

Egg qualitative traits are in most cases genetic and phenotypically correlated significantly/table 3/. Comparison of the two strains did not show any regularity in forming the interdependences. Genetic and phenotypical correlations between productivity and egg quality traits show significant differentiations /tables 5 and 6/.

As far as the productivity is concerned no differences were proved for the strains comparing to other Leghorn hens in Polanu /Dzięciołowska and others, 1977/. Factors of egg qualitative traits are in accordance to values achieved at the International Poultry Random Test Statin in IVANKA on the Danube/Wężyk, Ponińska, 1981/.

Strain G 88 is chracterized by the lower shell strength and shell thickness as well as by the lower values of Haugh's units comparing to strain G99/table 1/. The higher egg mass, lower shell mass and shell percentage of the hens from strain G 88 is due to their achieving sexual maturity later, lower laying rate and total laying in comparison to strain G 99 /tables 5 and 6/.

Heritability coefficients of egg quality traits are similar to those given in the literature. When comparing heritability coefficients defined by Roskosz and others/1979/for the previous generation of hens from strain G 99, their decrease in respect to

Table 3. Coefficients of genetic correlations between measurements of egg qualities – Leghorn hens, strains G 88 and G 99 from Piaseczno

Specification	Strain G	Egg mass	Shape index	Shell deformation	Specific gravity	Shell strength	Haugh unites	Shell mass	Shell percentage	Shell thickness	Yolk colour
Yolk index	88	-0,145^{x}	-0,476^{xx}	-0,322^{xx}	0,719^{xx}	-0,024	0,702^{xx}	0,144^{x}	0,183^{xx}	0,346^{xx}	0,443^{xx}
	99	0,012	0,532^{xx}	-	0,205^{x}	-0,194^{x}	0,846^{xx}	0,251^{x}	0,137	-0,629^{xx}	-0,300
Yolk colour	88	0,720^{xx}	-0,796^{xx}	-0,490^{xx}	0,227	0,003	-0,047	0,369^{x}	-0,023	-0,294^{x}	
	99	-1,132^{xx}	-0,754^{xx}	-	0,253^{x}	0,332^{xx}	-0,551^{xx}	0,004	0,849^{xx}	-0,100	
Shell thickness	88	-0,061	0,654^{xx}	-0,150^{x}	0,017	0,163^{x}	0,575^{xx}	0,266^{xx}	0,301^{xx}		
	99	-0,021	-0,125	-	-0,720^{xx}	-0,015	-0,295^{xx}	-0,610^{xx}	-0,514^{xx}		
Shell percentage	88	-0,341^{xx}	0,020	-0,669^{xx}	0,749^{xx}	0,685^{xx}	0,498^{xx}	0,869^{xx}			
	99	-0,585^{xx}	-0,083	-	0,782^{xx}	0,775^{xx}	0,166^{x}	0,695^{xx}			
Shell mass	88	0,169^{x}	0,090	-0,518^{xx}	0,761^{xx}	0,632^{xx}	0,533^{xx}				
	99	0,193	0,505^{x}	-	0,774^{xx}	0,885^{xx}	0,570^{xx}				
Haugh unites	88	-0,017	0,260^{xx}	-0,530^{xx}	0,466^{xx}	0,533^{xx}					
	99	0,159^{x}	0,728^{xx}	-	0,510^{xx}	0,385^{xx}					
Shell strength	88	-0,166^{x}	-0,085	-0,770^{xx}	0,503^{xx}						
	99	-0,286^{xx}	0,037	-	0,847^{xx}						
Specific gravity	88	-0,097	-0,222^{x}	-0,433^{xx}							
	99	-0,182^{x}	0,132^{x}								
Shell deformation	88	0,297^{x}	0,534^{xx}								
	99	-	-								
Shape index	88	0,094									
	99	0,443^{xx}									

Table 4. Coefficients of phenotypical correlations between measurements of egg qualities – Leghorn hens, strains G 88 and G 99 from Piaseczno.

Specification	Strain G	Egg mass	Shape index	Shell deformation	Specific gravity	Shell strength	Haugh unites	Shell mass	Shell percentage	Shell thickness	Yolk colour
Yolk index	88	-0,066	0,050	0,023	0,048	0,029	0,162^{xx}	0,014	0,008	-0,044	0,024
	99	-0,002	0,106	-	0,114^{x}	0,067	0,250^{xx}	0,083	0,103	-0,074	0,079
Yolk colour	88	-0,002	-0,080	-0,162^{xx}	0,149^{xx}	0,095^{x}	0,125	0,042	0,043	0,035	
	99	0,056	0,020	-	0,084	0,042	-0,138^{x}	0,121	0,098	0,021	
Shell thickness	88	0,024	-0,004	-0,423^{xx}	0,643^{xx}	0,416^{xx}	0,026	0,576^{xx}	0,653^{xx}		
	99	0,068	-0,017	-	0,012	-0,008	-0,043	0,048	0,010		
Shell percentage	88	-0,229^{xx}	-0,086	-0,457^{xx}	0,745^{xx}	0,489^{xx}	0,074	0,683^{xx}			
	99	-0,099	-0,031	-	0,778^{xx}	0,397^{xx}	0,028	0,793^{xx}			
Shell mass	88	0,545^{xx}	-0,152^{xx}	-0,385^{xx}	0,588^{xx}	0,447^{xx}	-0,008				
	99	0,517^{xx}	-0,009	-	0,720^{xx}	0,389^{xx}	-0,043				
Haugh unites	88	-0,090^{x}	0,184^{xx}	-0,008	0,138^{xx}	-0,053					
	99	-0,127^{x}	0,142^{x}	-	0,079	0,133^{x}					
Shell strength	88	0,030	-0,082	-0,493^{xx}	0,475^{xx}						
	99	0,081	0,041	-	0,350^{xx}						
Specific gravity	88	-0,071	-0,084	-0,475^{xx}							
	99	0,071	-0,010	-							
Shell deformation	88	0,005	0,289^{xx}								
	99	-	-								
Shape index	88	-0,110^{x}									
	99	0,027									

productivity traits and their increase in respect to egg and shell quality traits was indicated. Shell heritability was the only exception/$h_s^2 = 0{,}487$ in the previous year ; $h_s^2 = 0{,}114$ in the year of investigations/.

The actual introduction of egg quality traits to the selectional program caused the increase of genetic variability which influenced breeding gain positivly. It is observed especcialy in the case of shell strength, which was 3,11 kg in the previous year, and 4,37 kg a year later/data for the previous year-Roskosz and others, 1979/. The selection resulted in the increase of laying by 2,4 eggs from each hen per flock which proved the simultaneous improvement of both traits possible in spita of highly significant negative genetic correlations. This may be due to a positive enviromental influence as well as to the correct choice of mating pairs. Hens of the next generation were chosen from strains of high laying and shell strength traits.

Lack of interdependence between laying rate and egg quality traits in strain G 99 is in accordance to the results achieved by Sarlanov/1974/On the other hand in strain G 88 highly significant and negative genetic correlations between the laying rate and egg mass, egg specific weight, shell strength, mass and thickness of shell , colour were found. Highly significant and positive correlations were found between laying rate and yolk index. In both strains highly significant and negative genetic correlations between laying rate and egg mass were indicated, which is generally known. Accordance of forming genetic interdependences was proved for laying rate and shell percentage/for strain G 88 $r_G=0{,}356^{xx}$; for strain G 99 $r_G=1{,}146^{xx}$/and for yolk colour/$r_G=0{,}488^{xx}$ and $r_G=0{,}693^{xx}$/. Highly significant genetic correlations with opposite signs were determined between laying rate and shape index/$r_G=0{,}376^{xx}$ and $r_G=-0{,}394^{xx}$ respectively/; shell strength /$r_G=-0{,}413^{xx}$ and $r_G=0{,}618^{xx}$/; shell mass /$r_G=-0{,}332^{x}$ and $r_G=0{,}402^{X}$/.

Table 5. Coefficients of genetic correlations between measurments of egg quality and productivity of Leghorn hens - strains G 88, G 99 from Piaseczno.

Specification	Strain G	Egg mass	Body weight of 20weeks old hens	Maturity	Initial laying rate	Laying up to 64 weeks of live
Egg mass	88	-	0,190^{x}	-0,362^{x}	-1,336^{xx}	-0,944^{xx}
	99	-	-	-0,694	-1,102^{xx}	-0,286
Shape index	88	0,094	-0,609^{xx}	1,123^{xx}	0,376^{xx}	0,025
	99	0,443^{xx}	-	0,114	-0,394^{xx}	0,076
Deformation	88	0,297^{x}	0,059	-0,004	0,095	0,047
	99	-	-	-	-	-
Specific gravity	88	-0,097	-0,686^{xx}	-0,124	0,263	0,231
	99	-0,182^{x}	-	0,460	0,617^{xx}	-0,509^{xx}
Shell strength	88	-0,166^{x}	-0,168^{x}	-0,229^{x}	-0,413^{xx}	0,063
	99	-0,286^{xx}	-	-0,553	0,618^{xx}	-0,413^{xx}
Haugh unites	88	-0,017	-0,537^{xx}	0,483^{xx}	0,479^{xx}	0,788^{xx}
	99	0,159^{x}	-	0,081	0,109	-0,156^{xx}
Shell mass	88	0,169^{x}	-0,641^{xx}	0,033	-0,332^{x}	-0,038
	99	0,193	-	0,090	0,402^{x}	-0,524^{xx}
Shell percentage	88	-0,341^{xx}	-0,693^{xx}	0,209^{x}	0,356^{xx}	0,428^{xx}
	99	-0,585^{xx}	-	0,564	1,146^{xx}	-0,325^{xx}
Shell thickness	88	-0,061	-0,920^{xx}	0,995^{xx}	-0,041	-0,226^{x}
	99	-0,021	-	0,379	0,153	-
Yolk colour	88	0,720^{xx}	0,257^{x}	-0,221	0,488^{x}	0,775^{x}
	99	-1,132^{xx}	-	0,765^{x}	0,693^{xx}	-1,484^{xx}
Yolk index	88	-0,145^{x}	-0,282^{xx}	-0,022	0,157^{x}	0,318^{xx}
	99	0,012	-	0,623^{x}	-0,008	-0,197^{xx}

x - P = 0,05

xx - P = 0,01

Analyzing significant differences between strains,which concerned heritability coefficients of egg quality traits,it may be assumed that these populations could differentiate basically genetic conditioning of these traits which resulted from the present breeding work/table 2/.Similar differences among four examined populations of Leghorn hens were obtained by Hamilton and others/1979/.

The obtained highly significant and negative genetic correlations between egg mass and its qualitative traits suggest that this trait cannot be treated unlimitedly as the selectional factor.As,while aiming at increasing of egg mass,the following traits may be decreased in both strains:egg specific weight,shell strength, Haugh units/G 88 only/,percentage and shell thickness, yolk colour/G 99 only/.Only shape index,and shell mass in both strains,Haugh's units in strain G 99 and yoke colour in strain G 88 may improve.

In both investigated strainsthe egg mass heritability was determined on the exceptionally low level /h^2_S=o,224 and 0,388/. Halaj/1977/and Jain and others/1978/do not agree at this point. They suggest,on the basis of high egg mass heritability and positive genetic correlations between egg mass and its qualitative traits,that this factor can serve as a selectional criterium in the breeding programs that aim at egg quality improvement.

The obtained results show such a differentiation of genetic conditions of egg quality traits,that identical selectional programs cannot be applied to them.

Breeding programs require both consideration of egg quality traits and appliance of correct mating systems which in turn will guarantee proper breeding gain próper breeding gain as far as productivity and egg quality traits are concerned.

Table 6 . Coefficients of phenotypical correlations between measurments of quality and productivity of Leghorn hens, G 88, G 99 from Piaseczno.

Specification	Strain G	Egg mass	Body weight of 20 weeks old hens	Maturity	Initial laying rate	Laying up to 64 weeks of life
Egg mass	88		0,089^{x}	0,035	-0,165^{xx}	-0,091^{x}
	99	-	-	0,028	-0,097	-0,177^{xx}
Shape index	88	-0,110^{x}	-0,132^{xx}	0,163^{xx}	0,126^{xx}	0,136^{xx}
	99	0,027	-	0,077	-0,082	0,039
Deformation	88	0,005	-0,028	-0,007	0,051	0,113^{x}
	99	-	-	-	-	-
Specific gravity	88	-0,071	-0,032	0,079	0,134^{xx}	-0,141^{xx}
	99	0,071	-	0,018	-0,094	-0,182^{xx}
Haugh unites	88	-0,090^{x}	-0,102^{x}	0,087	-0,049	-0,012
	99	-0,127^{x}	-	0,009	-0,050	-0,004
Shell strength	88	0,030	-0,026	0,071	-0,091^{xx}	-0,087
	99	0,081	-	0,024	0,059	-0,088
Shell mass	88	0,545^{xx}	-0,013	0,070	-0,138^{xx}	-0,108^{x}
	99	0,517^{xx}	-	-0,019	-0,157^{xx}	-0,192^{xx}
Shell percentage	88	-0,229^{xx}	-0,099^{x}	0,055	-0,020	-0,056
	99	-0,099	-	-0,046	-0,102	-0,092
Shell thickness	88	0,024	-0,050	0,132^{xx}	-0,117^{xx}	-0,157^{xx}
	99	0,068	-	-0,006	0,042	0,074
Yolk colour	88	-0,002	0,074	-0,013	-0,166^{xx}	-0,105^{x}
	99	0,056	-	0,006	0,015	-0,196^{xx}
Yolk index	88	-0,066	-0,104^{x}	-0,011	0,177^{xx}	0,065
	99	-0,002	-	0,015	-0,009	-0,004

x - P = 0,05

xx - P = 0,01

SUMMARY

Investigations were carried out on 2 Leghorn strains /G_{88} and G_{99}/ selected during many generations on early sexual maturity and high egg production. The breeding program aimed at keeping the hen live weight and egg weight on the constant level. Moreover, in the selection work the improvement of the egg and shell quality was taken into consideration.

To estimate quality parameters 3 eggs were taken from each, 9 month old hen, during 3 consecutive days. 1413 eggs were collected from strain G_{88}, and 915 eggs from strain G_{99}.

The results of individual production control indicated that strain G_{99} was characterized by both better production and higher quality parameters. On the other hand, strain G_{88} had the highest heritability coefficients of all investigated egg and shell quality traits. In both populations the heritability of egg weight was on extremly low level /h^2_S = 0,224 and 0,388/.

The traits of egg and shell quality in both strains were almost always genetically and phenotipically correlated.

Highly significant and negative genetic correlations between the egg weight and its quality traits suggested, that this factor could not be used without restrictions as the selection coefficient. Aiming at increasing the egg weight, we could decrease in both populations their specific weights, shell strenght, percentage and thickness of shell. It is possible to improve egg shape and shell weight only.

R E S U M E N

Se han llevado a efecto investigaciones sobre dos líneas Leghorn (G_{88} y G_{99}) seleccionadas durante muchas generaciones para la madurez sexual temprana y para la alta producción de huevos. El programa de mejora trataba de mantener el peso vivo de las gallinas y el peso del huevo en un nivel constante.

Además, en el trabajo de selección la mejora del huevo y de la calidad de la cáscara se tuvieron tambien en consideración. Para valorar los parámetros de calidad se tomaron 3 huevos de cada gallina de 9 meses de edad, durante 3 días consecutivos. Se recolectaron 1.413 huevos de la línea G_{88} y 915 de la G_{99}. Los resultados del control de producción individual indicaron que la línea G_{99} se caracterizó tanto por una mayor producción como por una más elevada cantidad en sus parámetros. Por otro lado, la línea G_{88} tuvo los mayores coeficientes de heredabilidad en todos los caracteres investigados en los huevos y en la calidad de la cáscara. En ambas poblaciones la heredabilidad del peso del huevo fué extremadamente baja (h^2_S = 0,224 y 0,388). Los caracteres del huevo y de la calidad de la cáscara en ambas líneas estuvieron casi siempre genética y fenotípicamente correlacionados. Las correlaciones genéticas altamente significativas y negativas entre el peso del huevo y sus caracteres de calidad sugieren que este factor no podría ser utilizado sin restricciones como coeficiente de selección. Deseandose un aumento del peso del huevo, se debería disminuir en ambas poblaciones sus pesos específicos, la consistencia de la cáscara, el porcentaje y grosor de ella, siendo posible mejorar solamente la forma del huevo y el peso de la cáscara.