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TWO–WAY SELECTION FOR EGG ALBUMEN QUALITY

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OPSOMMING: TWEE-RIGTING SELEKSIE VIR EIER–ALBUMENKWALITEIT

Twee Wit Leghornlyne is geselekteer vir verhoogde en verlaagde Haugh-eenhede. Na 6 generasies was daar 'n betekenisvolle verskil van 17,1 Haugh-eenhede tussen die lyne, maar responsie in die hoë lyn was 4,5 maal meer as in die lae lyn.

SUMMARY:

Two White Leghorn lines were selected for increased and decreased Haugh units. After 6 generations there was a significant difference of 17,1 Haugh units between lines, but response in the high line was 4,5 times more than in the low line.

It is generally assumed that for frying and poaching, consumers prefer an egg with a large proportion of its albumen in the firm or jelly-like condition. For a desirable appearance when broken-out the albumen should therefore stand up high around the yolk (Wells, 1968). A large proportion of thick egg white is also desirable for satisfactory performance in functions demanding foaming and heat coagulation of the white proteins, as in cake making (Shenstone, 1968). The thick white forms about 57 percent of the total egg white (Whenstone, 1968). Wells (1968) concluded that of all the different methods used in measuring albumen quality the Haugh unit (Haugh, 1937), based on albumen height corrected for egg weight, is widely accepted as the best objective measurement.

In a review of the literature van Tijen & Kuit (1970) estimated an average heritability of 0,38 for internal quality. About half of the values included were based on Haugh units. With a heritability of this magnitude a change of albumen quality with selection would be regarded as possible.

Few papers have been published on selection for albumen quality. Lorenz, Taylor & Almquist (1934) selected birds for high and low percentage of firm albumen. With one generation of selection they significantly increased the percentage firm albumen to 66,7% . The mean of 57,2% in the low line, did not show any decrease when compared to a mean of 56,4% for a random sample of pullets. Lorenz & Taylor (1940) reported on further response in these lines. After five generations of selection from 1932 tot 1936 there was no further increase in the high line. There was a slight decrease in percentage firm albumen in the low line till generation 5 and then a sharp decrease in generation 6. Over generations 1 to 5 the average number of pullets per year was 59 in the high line and 40 in the low line.

Knox & Godfrey (1940) gave the results of selection for high and low percentages of thick albumen in two Rhode Island Red lines, with a common origin. The screen method of determining the amounts of thin and thick albumen was used. A total of 171 breeders and 316 female progeny were used from 1933 to 1939. The mean of the flock at the start of the experiment was 50,2%. Considerable progress was made in the high line to reach a mean value of 66,2% after 5 generations of selection. In the low line, however, less progress was made and a mean of only 46,4% was reached. The present study was undertaken to investigate the possibility of changing albumen quality, as measured in Haugh units, with selection.

Materials and Methods

A closed White Leghorn flock under long-term selection for increased egg production served as the base population for the 2 selection lines (Poggenpoel & Erasmus, 1978). From a total of 400 hens, three eggs per hen were measured for Haugh units at an age of 35 weeks. Forty six hens were selected on individual mean performances as parents of the high line and, similarly, 39 hens for the low line. Eight males were selected for each line on the average Haugh unit performance of an average of 3,8 full sisters each. From generation one to 6 the average numbers in the 2 lines were 7 sires, 35 dams and 90 measured daughters. Measurements on an average of 2,8 eggs per pullet were taken yearly at an age of between 30 and 40 weeks. Other measurements in generations 5 and 6 were taken on smaller numbers as indicated in Table 1. Males were selected during each generation on the performance

of an average of 2,6 full sisters with the restriction of not selecting more than 2 males from a full sib family.

All eggs were measured on the day after being laid. Albumen height was measured with a tripod screw micrometer to 0,1 mm immediately after breaking, at a point halfway between the edge of the yolk and the outer edge of the thick white. Haught units for each egg was determined with the internal quality calculator as proposed by Brant, Otte & Norris (1951).

Egg shape index was obtained by dividing the breadth of the egg by the length and multiplying the result by 100 (Romanoff & Romanoff, 1949). Yolk index was defined as the ratio of the height to the width of the yolk, measured in its natural position when the egg was broken-out on a flat surface. Yolk height was measured by means of a tripod screw micrometer and the width by taking 2 measurements at right angles with calipers (Wells, 1968). Funk (1948) found that the index calculated with the yolk in its natural position must be decreased by 10% to correspond to the index calculated after the yolk had been separated from the albumen.

Hatchability of fertile eggs was measured after inseminating hens of the selection lines with semen from unrelated Black Australorp cocks, to eliminate any possible effect of inbreeding in the selection lines.

Results and Discussion

The response in Haugh units in the 2 selection lines is presented in Fig. 1. From a mean 74,3 Haugh units in the base population the high line increased to a mean of 88,4 Haugh units in generation 6 while the low line decreased to 71,3, giving a difference of 17,1 Haugh units, or 24% . The differences between the two lines from generations 1 to 5 were 6,7; 9,8; 10.5; 13,0 and 12,2. A significant linear regression coefficient of 2,33 Haugh units per generation ($P \leq 0{,}001$) was estimated for the difference between the two lines.

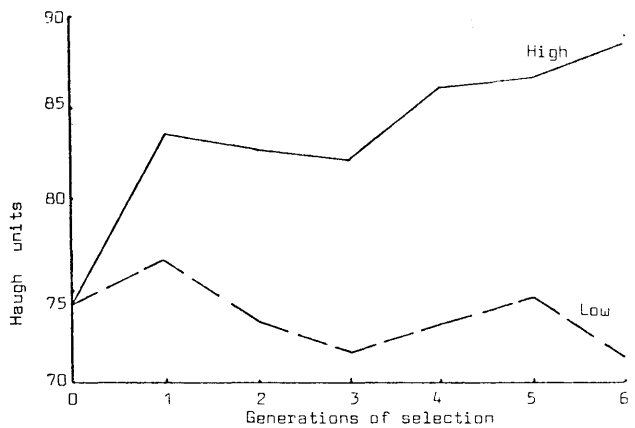

Fig. 1 *Mean Haugh units of selection lines*

These results show much more response in the up than in the down direction. The selection differential of the selected female parents in the base population was 6,37 Haugh units for th high line and −7,51 for the low line. Over generations 1 to 5 the average selection differential of selected pullets was 2,47 for the high line and −3,94 for the low line. The apparent asymmetry in response can therefore not be ascribed to differences in selection pressure in the two lines.

Similar results of more response in the high percentage firm albumen lines were obtained by Knox & Godfrey (1940) and by Lorenz and Taylor (1940). In the first study total response in the high line was 3,7 times more than in the low line and in the latter this ratio was 4,8 times in the 5th generation of selection. In the present study, total response in the high Haugh unit line was 4,5 times more than in the low line in the 6th generation. All three available studies show more response when selecting for increased albumen quality than for decreased quality, expressed in the original measurements. This phenomenon is probably the result of a scale effect.

The heritability of Haugh units in the base population (based on sire and dam components) was estimated at 0,44 ± 0,13. The pooled heritability over generations 1 to 5 was 0,28 ± 0,12 in the high line and 0,40 ± 0,12 in the low line. These values do not differ significantly.

In the review by van Tijen & Kuit (1970) a mean genetic correlation of −0,355 between egg shape and internal quality was estimated, from 2 published values (Kinney *et al.*, 1968; Kinney & Lowe, 1968). In these 2 publications albumen quality was determined according to a visual score ranging from one to 9 and based on the USDA egg quality chart. This chart credits best albumen quality with a score of one, followed by increased scores for decreasing qualities. As Haugh unit scores increase from low to high values for increasing albumen qualities, a positive genetic correlation is expected between egg shape index and Haugh units. A number of eggs was measured in the high and low lines in generations 5 and 6 to compare egg shell index. The higher value of the high line (72,5 against 70,5) in generation 5 was significant ($p < 0{,}01$), but not in generation 6 when fewer eggs were used (Table 1). These results give evidence for a positive genetic correlation between Haugh units and egg shape index.

Wesley & Stadelman (1959) found a phenotypic correlation of 0,39 between Haugh units and yolk index. To test for a possible genetic relation between these 2 traits, eggs of the high and low lines were compared for yolk index in generations 5 and 6. As indicated in Table 1 there was no difference between the 2 lines. Hatchability of fertile eggs of the 2 lines compared in generations 5 and 6 did not differ (Table 1).

Table 1

Comparison of traints of the high and low Haugh unit selection lines in generations 5 and 6

Generation	Line	Egg shape index		Yolk index		Hatchability %	
5	High	72,5	(35)	0,486	(30)	94,0	(83)
	Low	70,5	(35)	0,478	(29)	91,3	(80)
		**		ns		ns	
6	High	72,4	(13)	0,454	(13)	86,2	(153)
	Low	71,9	(38)	0,454	(36)	87,8	(361)
		ns		ns		ns	

** $p < 0,01$
ns not significant
( ) number of eggs tested

The results of the present study show that there was additive genetic variance for albumen quality, measured as Haugh units, in the base population and that greater response was obtained in the upward direction. Increased Haugh unit score was accompanied by a correlated positive response in egg shape index but there was no change in yolk index.

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References

BRANT, A.W., OTTE, A.W. & NORRIS, K.H., 1951. Recommended standards for scoring and measuring open egg quality. *Food Technology*, 5, 356.

FUNK, E.M., 1948. The relation of yolk index determined in natural position to the yolk index as determined after separating the yolk from the albumen. *Poultry Sci.*, 27, 367.

HAUGH, R.R., 1937. The Haugh unit for measuring egg quality. *U.S. Egg and Poultry Magazine*, 43, 552 - 555 and 572.

KINNEY, T.B. & LOWE, P.C., 1968. Genetic and phenotypic variation in the regional red controls over nine years. *Poultry Sci.* 47, 1105.

KINNEY, T.B., LOWE, P.C., BOHREN, B.B. & WILSON, S.P., 1968. Genetic and phenotypic variation in randombred White Leghorn controls over several generations. *Poultry Sci.* 47, 113.

KNOX, C.W. & GODFREY, A.B., 1940. Five years of breeding for high and low percentage of thick albumen in the eggs of Rhode Island Reds. *Poultry Sci.* 19, 291.

LORENZ, F.W. & TAYLOR, L.W., 1940. The inheritance of an albumen quality characteristic of chicken eggs. *Journal of Agric. Res.* 61; 293.

LORENZ, F.W., TAYLOR, L.W. & ALMQUIST, H.J., 1934. Firmness of albumen as an inherited characteristic. *Poultry Sci.* 13, 14.

POGGENPOEL, D.G. & ERASMUS, J.E., 1978. Long-term selection for increased egg production. *Brit. Poultry Sci.* 19, 11.

ROMANOFF, A.L. & ROMANOFF, A.J., 1949. The Avian Egg. John Wiley and Sons, Inc., New York.

SHENSTONE, F.S., 1968. The gross composition, chemistry and physico-chemical basis of organization of the yolk and white. *In:* Egg Quality, Edit. Carter, T.C., Oliver and Boyd, Edinburgh.

VAN TIJEN, W.F. & KUIT, A.R., 1970. The heritability of characteristics of egg quality, their mutual correlation and the relationship with productivity. *Arch. Geflügelk.*, 34, 201.

WELLS, R.G., 1968. The measurement of certain egg quality characteristics: A Review. *In:* Egg Quality, Edit. Carter, T.C., Oliver and Boyd, Edinburgh.

WESLEY, R.L. & STADELMAN, W.J., 1959. Measurements of interior egg quality. *Poultry Sci.* 38, 474 - 481.