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THE EFFECT OF SEX-LINKED DWARF, NAKED NECK AND FRIZZLE GENES ON THE EGG QUALITY TRAITS OF LAYING HENS UNDER TROPICAL CONDITIONS

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SUMMARY: The influence of sex-linked dwarf (*dw*), naked neck (*Na*) and frizzle (*F*) genes and their various combinations on egg quality were investigated. The experimental stock comprised eight genotypes of laying hens; normal (*Dw- ff nana*), naked neck (*Dw- ff Nana*), frizzle (*Dw- Fr nana*), frizzled naked neck (*Dw- Ff Nana*), dwarf (*dw- ff nana*), dwarf naked neck (*dw- ff Nana*), dwarf frizzled (*dw- Ff nana*) and dwarf frizzled naked neck (*dw- Ff Nana*). Results indicated that genotype had no significant (P>0.05) effect on albumen height (at 60 and 76 weeks), yolk weight (at 76 weeks only) and shell breaking strength (at 60 weeks only). The combination of *Na* and *F* appeared to have a positive interaction on several egg quality traits among the non-dwarf population although the *F* had no major effect. However, the *Na* increased shell weight and breaking strength. The *dw* appeared to have detrimental effects on several external and internal egg quality traits despite the incorporation of *Na* and/or *F*.

Keywords: sex-linked genes, egg quality traits

INTRODUCTION

Egg quality embraces both internal and external characteristics including a strong shell of good colour and an albumen that is firm and does not spread when the egg is broken. Large production companies assess egg quality taking into account the factors important to both producer and customer such as shell quality and egg size (Belyavin *et al.*, 1987).

The application of genetic techniques such as introducing a single major gene has proved to be important in improving egg quality traits (Bulfield and McKay, 1987). Under tropical conditions, the major genes of interest to tropical poultry breeders are sex-linked dwarf gene (*dw*) (Merat, 1970, 1972; Selvarajah, 1970; Selvarajah *et al.*, 1970, Hamilton, 1978; Panandam, 1985; Khadijah, 1988), autosomal incomplete dominant naked neck gene (*Na*) (Bordas *et al.*, 1980; Panandam, 1985; Khadijah, 1988) and autosomal incomplete dominant frizzle gene (Fe). A few studies on the effect of *F* on egg production has been conducted (Horst, 1987; Haaren-Kiso *et al.*, 1988; Mathur and Horst, 1990), but none of these are related to egg quality traits.

While some studies indicated that the *dw* only had a slight effect on egg quality (Panandam, 1985; Khadijah, 1988), others (Selvarajah 1970; Selvarajah *et al.*, 1970) found that the *dw* has no influence on egg quality. However, Merat (1972) and Hamilton (1978) showed that eggs from dwarf hens had better shell quality and Haugh unit respectively than those of their normal counterparts.

The heterozygous naked neck hens had heavier yolk and albumen (Bordas *et al.*, 1980; Panandam, 1985), shell breaking strength, shell thickness and shell weight (Panandam, 1985) under high temperatures.

In the present study, the effect of *dw*, *Na*, *F* and their various combinations on the internal and external egg qualities was investigated by analysing eggs from eight different genotypes of laying hens.

MATERIALS AND METHODS

Experimental Stock

A total of 320 day-old chicks was obtained from Lohman Tierzucht, Cuxhaven, Germany. The sire line was of medium heavy feathered birds of naked neck frizzled (*Dw- Ff Nana*) genotype. Dams were from medium heavy feathered birds of normal (*Dw- ff nana*) genotype. The genotypes of female progenies obtained were normal (*Dw- ff nana*), naked neck (*Dw- ff Nana*), frizzle (*Dw- Fr nana*), frizzled naked neck (*Dw- Ff Nana*), dwarf (*dw- ff nana*), dwarf naked neck (*dw- ff Nana*), dwarf frizzled (*dw- Ff nana*) and dwarf frizzled naked neck (*dw-Ff Nana*). Each genotype comprised 40 birds.

Management

All the birds were brooded together (regardless of genotype) under deep litter system. At 18 weeks of age, the birds were housed individually in battery cages. The fowls were fed *ad libitum* with commercial poultry starter mash, poultry grower mash and poultry layer mash from one day to 8 weeks, 8 weeks to 19 weeks and 19 weeks onwards, respectively. Vaccinations against Newcastle disease, fowl pox, Marek's disease and infectious bronchitis were carried out.

Statistical Analysis

All data collected were subjected to analysis of variance (ANOVA) and the least significant differences between means were calculated when the analysis indicated differences to be significant. Statistical Analysis System (SAS) was used.

Traits

Egg quality test were carried out at the ages of 60 and 76 weeks in order to evaluate the quality of eggs at the later stage of laying. Two eggs per hen (first two eggs at 60 and 76 weeks) were used for the measurements. Eggs were stored under a temperature of 20°C for two days before being analyzed.

Shell Breaking Strength, Weight and Thickness

Shell breaking strength was determined by applying a horizontal force with the aid of an egg cracking machine and the force was recorded to the nearest 0.1 kg. A Mettler balance was used to weigh the air dried shell (including shell membrane) to the nearest 0.01 g. Measurement of shell thickness was conducted by measuring the shell equator

Shell Thickness

Shell thickness was observed to deteriorate by approximately 9.5% from 60 to 76 weeks in all the eight genotypes. The mean values attained by *Dw- ff Nana* and *Dw- Ff Nana* were not significantly different (P>0.05) from *Dw-ff nana* at both 60 and 76 weeks although Panandam (1985) reported that *Na* increased shell thickness. At 60 weeks, the *Dw- Ff Nana* hens laid eggs with thicker shell (3.81 mm) compared to those of *Dw- ff Nana* (3.68 mm), suggesting a positive interaction between *Na* and *S* for shell thickness. The *dw* appears to have a detrimental effect on shell thickness at both 60 and 76 weeks. This is in agreement with the findings of Bernier and Arscott (1960), Gleichauf (1973), Panadam (1985) and Khadijah (1988). At 60 weeks, all the four genotypes incorporated with the *dw* had lower values compared to those of *dw- ff nana* (3.70 mm) but differences were not significant (P>0.05). At 76 weeks, the egg shells of *dw- ff nana* (3.11 mm) and *dw- ff Nana* were significantly thinner (P<0.05) than those of other genotypes. On the other hand, the shell thickness of *dw- ff Nana* (3.34 mm) and *dw- ff Nana* (3.33 mm) were observed to be not significantly different (P>0.05) from the measurements of the non-dwarf population although they were significantly greater (P<0.05) than the values observed with *dw- ff nana* and *dw- Ff nana*. Panandam (1985) also reported the superiority of dwarf naked neck layers in egg shell thickness compared to dwarf birds, suggesting that the *Na* improves shell thickness only in the dwarf population.

Shell Weight

All genotypes showed a decrease in shell weight from 60 to 76 weeks. At 60 weeks, an obvious difference was observed between genotypes carrying *dw* and *Dw*. This has also been reported by Panandam (1985) and Khadijah (1988). However, the difference in shell weight between *Dw- Ff nana* (6.04g) and *dw- Ef Nana* (5.87 g) was not significant (P>0.05). On the contrary, at 76 weeks only the shell weight of *dw- ff nana* (5.10 g) and *dw- Ff nana* (5.20 g) was significantly lower (P<0.05) than genotypes incorporated with *Dw*. The lower shell weight (*dw- ff nana* and *dw-Ff nana*) could be attributed to the significantly lower (P<0.05) shell thickness values attained by the two genotypes. Earlier studies showed that *Na* has a positive influence on shell weight (Panandam, 1985). However, in the present study, this was clearly observed only at 76 weeks. The *Dw- ff Nana* (6.00 g) and *Dw- Ff Nana* (6.01 g) had significantly heavier (P<0.05) shells as compared to *Dw- ff nana* (5.66 g) and *Dw- Ff nana* (5.62 g).

Yolk Weight

There was a drop in yolk weight among all genotypes from 60 to 76 weeks of age except for *dw- Ff nana*. Among the various genotypes, the *Dw- Ff Nana* layers attained the heaviest yolk weight; at 60 and 76 weeks, recorded values were 19.26 g and 18.56 g respectively. However, at 60 weeks, the value was significantly greater (P<0.05) than those of *dw- ff nana* (16.84 g) *dw- Ff Nana* (17.67 g) and *dw- ff Nana* (17.76 g) whereas at 76 weeks, the yolk weight of *Dw- Ff Nana* was significantly heavier (P<0.05) than the values attained by *Dw- FF nana* (17.64 g) and all the genotypes with *dw*. The *dw- ff nana* and *dw- Ff Nana* (16.72 g) birds had the lowest yolk weight at 60 and 76 weeks respectively. From the results obtained, the *Na* and *F* had no clear effect on yolk weight although it was reported that the *Na* improved yolk weight (Bordas *et al*., 1980; Panandam, 1985). The *dw* appears to have a depressive effect on yolk weight.

Table 2. Means and standard deviations of egg quality traits of eight genotypes of layers at 76 weeks.

Genotype	Traits						
	EW (g)	BS (kg)	YH (mm)	AH (mm)	YW (g)	SW (g)	ST (m)
Dw- ff nana n=32	62.53^{ab} ±5.49	3.13^{ac} ±0.94	17.22^{a} ±1.45	4.98^{a} ±1.33	17.64^{ac} ±1.85	5.66^{a} ±0.58	3.38^{a} ±0.31
Dw- ff Nana n=35	64.17^{bc} ±4.71	3.35^{ac} ±0.81	17.33^{a} ±1.03	4.86^{a} ±1.45	18.45.^{b} ±2.08	6.00^{c} ±0.55	3.42^{a} ±0.29
Dw- Ff nana n=34	61.80^{a} ±4.83	3.29^{ac} ±1.26	17.21^{a} ±0.96	4.84^{a} ±1.34	17.87^{ab} ±1.47	5.62^{a} ±0.70	3.34^{a} ±0.34
Dw- Ff Nana n=30	65.98^{c} ±5.07	3.34^{ac} ±0.95	17.30^{a} ±1.78	4.52^{a} ±1.81	18.56^{b} ±1.59	6.01^{bc} ±0.61	3.41^{a} ±0.34
dw- ff nana n=33	59.01^{d} ±6.04	2.74^{b} ±1.09	17.00^{a} ±1.15	5.00^{a} ±1.95	17.13^{ae} ±1.72	5.10^{d} ±0.85	3.11^{b} ±0.43
dw- ff Nana n=30	59.87^{d} ±4.69	3.49^{c} ±1.14	16.92^{a} ±1.23	5.06^{a} ±1.26	17.01^{ce} ±2.06	5.51^{a} ±0.70	3.34^{a} ±0.43
dw- Ff nana n=34	58.77^{d} ±7.56	2.98^{ab} ±1.03	17.88^{a} ±5.08	5.28^{a} ±1.40	17.00^{cde} ±2.35	5.20^{de} ±0.82	3.16^{b} ±0.40
dw- Ff Nana n=29	59.49^{d} ±4.39	3.43^{ac} ±1.08	17.01^{a} ±1.26	5.06^{a} ±1.68	16.72^{e} ±1.32	5.45^{ae} ±0.61	3.33^{a} ±0.42

EW (egg weight) BS (shell breaking strength) YH (yolk height) AH (albumen height)
YW (yolk weight) SW (shell weight) ST (shell thickness)

Two eggs per bird were utilised for measuring egg quality traits
Means with different superscripts within a column are significantly different (P<0.05)

Yolk Height

All genotypes exhibited a lower yolk height at 76 weeks as compared to 60 weeks except for *dw- Ff nana*. Genotype had a significant influence (P<0.05) on yolk height only at 60 weeks. No significant difference (P>0.05) in mean yolk height was observed within the dwarf and non-dwarf populations. On the other hand, Khadijah (1988) demonstrated that the *Na* increased yolk height. There were significant differences (P<0.05) in the yolk height between several genotypes incorporated with *dw* and *Dw*. The *Dw- Ff Nana* (18.25 mm) hens yielded eggs with greater yolk height as compared to those of genotypes carrying *dw*.

Shell Breaking Strength

Although the eggs of *Dw- ff Nana* had greater breaking strength (3.35 kg) than other genotypes, it was not significantly different (P>0.05) within the non dwarf population. In comparison to genotypes with *dw*, only *dw- Ff nana* had a significantly lower (P<0.05) breaking strength (2.74 kg). Thus, the incorporation of *F* and/or *Na* into the dwarf population improved shell breaking strength at 76 weeks. However, the *Na* appears to play a greater role in improving breaking strength compared to *F*. The shell breaking strength of *dw- ff Nana* (3.49 kg) was greater compared to that of *dw- Ff nana* (2.98 kg). The beneficial effect of the incorporation of the *Na* on shell breaking strength has also been reported by Panadam (1985) but the findings of Merat (1972) and Hamilton (1978) that the *dw* increases shell quality were contradictory to the observation made in the present study.

Generally, the *dw* had adverse effects on most external and internal egg quality traits despite the incorporation of *Na* and/or *F*. However, the *Na* increased shell weight in both dwarf and non-dwarf populations while improvement in shell breaking strength was only observed among genotypes carrying *dw*. Except for an increase in yolk weight among the dwarf populations, the *F* had no major influence on egg quality traits and the combination of the *F* and *Na* appears to have the same effect as the influence of the single *Na*.

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RINGKASAN

KESAN GEN-GEN KERDIL TERANGKAI SEKS, LEHER BOGEL DAN BULU TERBALIK TERHADAP TRAIT KUALITI TELUR AYAM PENELUR DI BAWAH KEADAAN TROPIKA

Kesan gen-gen kerdil terangkai seks (dw)*, leher bogel (*Na*) and bulu terbalik (*F*) dan pelbagai gabungannya terhadap trait kualiti telur telah dikaji. Stok ujikaji terdiri daripada lapan genotip ayam penelur; normal (*Dw- ff nana*), leher bogel (*Dw- ff Nana*), bulu terbalik (*Dw- Fr nana*), leher bogel bulu terbalik (*Dw- Ff Nana*), kerdil (*dw- ff nana*), leher bogel kerdil (*dw- ff Nana*), bulu terbalik kerdil (*dw- Ff nana*) dan leher bogel bulu terbalik kerdil (*dw- Ff Nana*). Hasil yang diperolehi menjunjukkan bahawa genotip tidak memberi kesan tererti (P<0.05) terhadap ketinggian albumen (pada minggu 60 dan 76), berat yolka (pada minggu 76 sahaja) dan daya pecah cangkerang (pada minggu 60 sahaja). Gabungan* Na *dan* F *didapati mempunyai saling tindakan positif terhadap beberapa trait kualiti telur di kalangan populasi bukan kerdil sungguhpun* F *itu tidak memberi sebarang kesan penting. Bagaimanapun,* Na *meningkatkan berat dan daya pecah cangkerang.* dw *nampaknya menunjukkan kesan buruk terhadap beberapa trait kualiti telur dalaman dan luaran walaupun dengan kemasukan* Na *dan/atau* F.