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MINIMIZING RESIDUAL FEED CONSUMPTION BY INTRODUCING DWARF AND NAKED NECK GENES IN LAYING CHICKEN

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Abstract: *An experiment was conducted to evaluate the effect of dwarf (dw) and naked neck (Na) genes in a single state or combination on feed efficiency and egg production parameters of laying hens under summer season of Egypt. Measurements related to efficiency of feed utilization for egg production were recorded between ages 20 and 40 weeks. Residual feed consumption (RFC) was estimated as the difference between observed feed consumption (OFC) and expected feed consumption (EFC) given by a multiple regression equation within feed consumption as dependent variable and egg mass, metabolic body weight ($BW^{0.75}$) and weight gain as independent variables. The current results revealed that the dw gene significantly reduced body weight, total egg number, egg mass and feed intake in either normal or naked neck genotype. With respect to Na gene, the results showed that the presence of Na gene increased total egg number, egg mass and egg weight compared to normally feathered sibs, but the differences were not statistically significant. Moreover, the incorporated Na gene into dwarfed birds compensated the negative effect associated with dw gene on egg production parameters. The presence of dw gene in a single state or combined with Na gene significantly improved feed conversion ratio compared to normal type. Similar trend was observed for Na gene, but the difference was not statistically significant. Concerning eggshell quality, the presence of dwarf (dw) and naked neck (Na) genes improved eggshell quality.*

The results revealed that the equation calculated for Nanadw- genotype had a better rate of determination (R^2=0.69) followed by nanadw- (R^2=0.46), NanaDw- (R^2=0.35) genotypes compared to nanaDw- sibs (R^2=0.28). It was generally noticed that the observed *values of feed intake were closely to expected values in Nanadw-, nanadw- and NanaDw- genotypes compared to nanaDw- sibs. This adjacency was reflected on RFC, where it was more consistent to zero line. Positive relationships between RFC and egg mass were observed in nanadw- and NanaDw- genotypes. However, these relationship were inverse in nanadw- and Nanadw- genotypes. Both observed feed consumption and feed conversion ratio was highly significant positive correlations with RFC in all genotypes. The relationships between RFC and yolk percentage were positive in all genotypes.*

In conclusion*, the current results suggest the incorporation of dw and Na genes into laying chickens led to improved feed efficiency by minimizing residual feed consumption. The results also suggested that more consideration should be given the difference among various genetic stocks in their requirements for maintenance and egg production. Moreover, it is possible to use of residual feed consumption as selection criteria for improve feed efficiency.*

INTRODUCTION

In poultry production, two thirds of the total cost is accounted for by feed cost. Efficient laying hens production at low costs is the most important goal of breeders and geneticists. Therefore, laying hens are selected for generations toward highly efficient egg mass production at low maintenance costs. There is, however, considerable variation in feed intake between chickens with the same body weight and production level, which is reflected in variation in residual feed intake (RFI). Under standardized environment, differences in production, body weight and weight gain explains only 80-90% of the variation in efficiency between strains of laying hens and 70-90% of the variation between individuals within strains (Bentsen, 1980). The unexplained variation in feed consumption (residual feed consumption) can be though of as a variation in deviation between observed feed intake and expected feed intake.

The dwarf genes (sex-linked or autosomal case) are important major genes in the poultry industry. The main effect of the dwarf genes is to reduce skeletal growth and body weight (Missohou *et al.,* 2003; Chen *et al.,* 2004; Rashid et al., 2005). Numerous pleiotropic effects of dwarf genes on egg production, especially a significant decrease in egg number for light egg-laying strains (Mérat, 1990) and on physiological, nutrition, behavior and pathology (Rashid et al., 2005) are well established. Heat tolerance and feed efficiency can be improved in layers by the dw gene, which causes a reduction in body size and is an important factor of acclimatization to warm environments through heat loss by radiation and convection on one hand and endogenous heat production on the other (Gowe and Fairfull, 1995). The use of the naked neck (Na) gene in poultry production has been discussed in many studies (Mérat, 1986; Fraga *et al.,* 1994; Galal, 1999). At high ambient temperature, the advantage of Na gene is explained by decreased feather cover, which allows for increased sensible heat loss (Cahaner *et al.,* 1993). Several short cuts have been suggested to improve feed efficiency without measuring individual feed consumption in large numbers of hens:1) measurements of feed consumption in males, which would have two advantages: fewer individuals to measure and no statistical complications due to variable egg production (Boichard et al., 1990; Tixier-Boichard et al., 1995);2) indirect selection on the basis of comb size, wattle length and body temperature (Bordas and Merat, 1984), plumage condition (Tullet et al., 1980) and behavior traits (Braastad and Katle, 1989); and 3) use of sex-linked dwarf gene to reduce metabolic body weight and increase egg output per kg body weight (Nordskog et al., 1972). The current study was conducted to improve the feed efficiency via minimizing residual feed intake of laying hens by introducing dwarf and naked neck genes.

MATERIALS AND METHODS

Genetic Flocks And Husbandry

One hundred and fifty eight brown Dahlem laying hens (39 nanaDw, 43 nanadw-, 33 NanaDw- and 43 Nanadw-) were used. At 18 weeks of age, the birds were housed in individual cages suitable for the quantitative measurements of egg production and feed intake. All birds were kept under similar environmental, managerial and hygienic conditions, given 16h light/24h. The birds were provided *ad libitum* access to a commercial egg layer diet containing 18 crude protein and 2900 kcal ME/ kg. The average high and low ambient temperatures recorded during experimental period were 32.7±2.14 and 29.6±2.40C, respectively.

Measurements and Observations

Body weights were determined at 20 and 40 weeks of age. Egg production was recorded daily from the onset of lay until 40 weeks of age. The hens were individually weighed at the beginning of the feed consumptions experiment (20 weeks of age) and thereafter, they were reweighed on 40 weeks. Change in body weight was calculated by subtracting beginning weight from ending weight. Total egg mass produced in grams in that period, along with total feed consumption at this time were obtained. Feed wastage was carefully controlled to be very small. At 40 weeks of age, an egg quality experiment was applied for each genotype. Eggs were collected and weighed to the nearest 0.1 g. After measuring of internal egg quality (albumen %, albumen height, yolk % and yolk height), the liquid contents of the egg were a side and shell plus membranes washed to remove adhering albumen. Then, shells were weighed upon cooling to the nearest 0.01g. Eggshell thickness in mm was measured using a digital micrometer.

Expected (EFC) And Residual (RFC) Feed Consumption

Residual feed consumption (RFC) was calculated as the difference between observed (OFC) and expected (EFC) feed consumption, which estimated from a multiple regression within feed intake as the dependent variable and egg mass, metabolic body weight and weight gain as independent variables. Regression equations were computed separately within each genotype. Since the coefficients of these equations were not significantly different between genotype. The expected feed consumption for each hen was predicted to derive regression equation according to genotype. Each genotype had its own regression coefficients according to the following equation:

$$EFC = aBW_i^{0.75} + bEM_i + c\Delta W_i + d$$

Where: EFC = expected feed consumption of hen i (grams);

$BW_i^{0.75}$= mean metabolic body weight of hen i ($kg^{0.75}$);

EM_i = egg mass production of hen i (grams);

a, b and c = partial regression coefficients;

d = intercept.

Statistical Analysis

All calculations and analyses were made using General Linear Models (GLM) procedure of SAS User's Guide, 2001 according to the following fixed model.

$$Yijk = \mu + dw_i + Na_j + (dw*Na)_{ij} + e_{ijk}$$

Where; μ=overall mean, dw_i=dwarf gene effect, Naj=naked neck gene effect, $(dw*Na)_{ik}$=interaction between dwarf and naked neck genes, e_{ijk}=experimental error.

Correlation coefficients of RFC with productive traits were estimated for each genotype using the PROC CORR procedure of SAS.

RESULTS AND DISCUSSION

Phenotypic Parameters

Data listed in Table 1 showed that the dw gene significantly reduced body weight in either normal or naked neck genotypes. This reduction in body weight caused by the dw gene reported in the current study confirmed with Chen *et al.* (2004). However, the body weight of laying hens was not significantly affected by Na gene. With respect to egg production parameters, the current results revealed that the presence of dw gene significantly reduced total egg number, egg mass and egg weight compared to normally body sized sibs. The effect of sex-linked dwarf gene on egg production and egg size confirmed results reported by Garces *et al.* (2001). Missohout *et al.* (2003) reported that the total egg number and egg weight were significantly reduced by the dw gene. Moreover, the small egg size reflects the high and positive correlations between body weight and egg size and may be associated with smaller reproductive tract of dwarf layers (Katongele *et al.,* 1990). Opposite trend was noticed for Na gene, whereas the presence of Na gene increased total egg number, egg mass and egg weight compared to normally feathered sibs, but the differences were not statistically significant. Moreover, the incorporated Na gene into dwarfed body sized compensated the negative effect of dw gene on egg production parameters.

The presence of dw gene in a single state or combined with Na gene significantly reduced feed intake by about 3.4kg (20.6%) and 3.7kg (21.9%) compared to normal (nanaDw-) type (Table 1). In agreement with Missohou *et al.* (2003), the dw gene resulted in a lower feed intake, which has been described as an important characteristics of dwarf layers. As unexpected, the presence of Na gene reduced feed intake by about 0.3kg (1.8%) compared to normally feathering genotype. Concerning the feed conversion ratio, the presence of dw gene in a single state or combined with Na gene significantly improved feed conversion ratio. Similar trend was observed for Na gene, but the difference was not statistically significant. Lower feed intake and better feed utilization are economically important characteristics of the dwarf layers (Katongole *et al.,* 1990). Also, Mathur and Horst (1992) reported that the feed efficiency was improved by dwarf gene. On the other hand, Rashid et al.(2005) reported that the existence of dwarf in an autosomal recessive state (adw) led to better feed utilization and higher hen day egg production. Moreover, Younis (2001) reported that the Na gene improved feed conversion ratio in either normal or dwarf genotype. If reduction in feed intake is an stress indicator, Braastad and Katle (1989) reported that selection for higher efficiency of feed use in laying hens might result in birds that are less frustrated prior to laying, i.e., act less stressfully. Then the observation that feed intake of positive residual feed intake chickens decreased considerably after transportation, whereas feed intake of negative residual feed intake chickens remained almost unaffected (van Eerden et al., 2004).

Concerning egg quality, data listed in Table 2 concluded that the albumen %, yolk %, albumen height and yolk height were not significantly affected by dw, Na and double segregation genes. However, incorporated Na gene into dwarfed body size increased haugh unit. Opposite trend was noticed when incorporated Na gene into normal body sized laying hens. With respect to eggshell quality, the presence of dw gene increased percentage and thickness of eggshell by about 3.3 and 3.9 %, respectively compared to normal body sized. Similar trend was noticed for Na gene. Moreover, the better eggshell quality was more pronounced in Nanadw- genotype rather than either nanadw- or NanaDw- genotype alone.

Multiple Regression Equation Of Feed Consumption

Data listed in Table 3 showed that the observed feed consumption, egg mass, change in body weight and metabolic body weight for each hen within each genotype were used to estimate the regression coefficients. The results revealed that the equation calculated for Nanadw- genotype had a better rate of determination (R^2=0.69) followed by nanadw- (R^2=0.46) and NanaDw- (R^2=0.35) genotypes compared to nanaDw- (R^2=0.28) sibs. That is mean, the figures of RFI calculated from these equations are more reliable and have a highly applicable prospective. The present results appears that the regression of body weight on feed consumption may differ between genotypes, but the accuracy of feed consumption predictions is independent of the power used to express metabolic body weight. Pirchner (1985) reported that differences in observed feed consumption (OFC) and expected feed consumption (EFC) are caused by variability in several factors, such as composition of product (eggs), body weight change, food spillage, metabolic rate and in the ability to synthesis egg and body constituents. Figures 1 depicts the observed against expected feed consumption for each hen within each strain. While, figures 2, 3 and 4 illustrates the residual feed consumption values for each hen. It was generally noticed that the observed values were closely to expected values for Nanadw-, nanadw- and NanaDw- genotypes compared to nanaDw- sibs. This adjacency was reflected on RFC, where it was more consistent to zero line. Bearing in mined that the negative values of RFC are desirable rather than positive ones. The efficient hens which had negative RFC figures were more frequent than inefficient ones for dwarf and naked neck hens to normal type hens. Chickens with low RFC (R-) eat less than predicted, and therefore are considered more efficient producing birds than chickens with high RFC (R+). It is hypothesized that extra energy intake of R+ birds, which is not put into producing processes, is available for other resource-demanding functions or life traits, as deduced from the resource allocation theory (Beilharz et al., 1993; van Eerden et al., 2004). Also, The results of El-Sayed and El-Hakim (1994); Hussein *et al.* (2000) and Fathi *et al.* (2000) confirmed that the efficient birds were less actives, less heat production, spent more time resting and less time standing than inefficient bird.

Phenotypic Correlation Coefficients

Calculation RFC by phenotypic multiple regression analysis is an acceptable alternative in a breeding program of no reliable estimates of genetic correlation are available (Luiting and Urff, 1991). This suggestion was reported because the author found the estimates of genetic correlation of RFC with the economic traits did not clearly differ from zero. Also, Tixier-Boichord *et al.* (1995) found that the genetic correlation between RFC and the independent variables used in the prediction equation (metabolic body weight, change in body weight and egg mass) were generally low, which confirms the validity of the selection on a phenotypic assessment of RFC. Data listed in Table 4 showed that phenotypic correlation coefficients between RFC and some quantitative traits of nanaDw-, nanadw-, NanaDw- and Nanadw-genotypes. Positive relationships between RFC and egg mass were observed in nanadw- and NanaDw- genotypes. However, these relationship were inverse in nanadw- and Nanadw- genotypes. The relationship between RFC and egg number was positive in all genotypes. Similar result was obtained by Tixier-Boichard *et al.* (1995). They indicated that positive correlation between RFC and egg number.

Both observed feed consumption and feed conversion ratio was highly significant positive correlations with RFC in all genotypes. Negatively correlated between RFC and albumen percentage was observed in all genotypes. Conversely, the relationships between RFC and yolk percentage were positive in all genotypes. Badawe et al. (2005) found that the yolk percentage was significantly positive correlated with RFC. El-Sayed and El-Hakim (1994) calculated significant and high positive association between RFC and the yolk percent in full-sib normal and dwarf hens. The author showed that the positive correlation probably reflects the increase in dry matter percentage and energy content in the egg when the proportion of yolk increases. Also, Heil (1976) and Bentsen (1980) found positive correlations between the percentage yolk and feed consumption rate. The relationship between shell percentage and RFC was inverse and low in all genotypes. Similar trend, but positive, was observed between RFC and shell thickness.

In Conclusion, the current results suggest the incorporation of dw and Na genes into laying chickens led to improved feed efficiency by minimizing residual feed consumption. The results also suggested that more consideration should be given the difference among various genetic stocks in their requirements for maintenance and egg production. Moreover, it is possible to use of residual feed consumption as selection criteria for improve feed efficiency.

Table1. Mean ±SE of body weight, egg production parameters, feed consumption and feed conversion ratio for dwarf, naked neck and normal genotypes.

	Feather	Body size			Gene effect			Prob.		
Parameter	**Type**	**Normal**	**Dwarf**	**Overall**	**dw-**	**Na**	**dw*Na**	**dw-**	**Na**	**dw*Na**
Body weight (20wk), g	**nana**	1910.4±33.37	1294.7±21.25	**1602.6**						
	Nana	1946.5±25.83	1272.7±22.20	**1609.6**						
	Overall	**1928.4a**	**1283.7 b**		**-33.43**	**+0.44**	**-33.38**	**0.001**	**NS**	**NS**
Body weight (40wk), g	**nana**	1899.6±31.21	1357.3±23.49	**1628.5**						
	Nana	1941.7±22.60	1339.4±22.95	**1640.5**						
	Overall	**1920.7 a**	**1348.3 b**		**-29.80**	**+0.74**	**-29.49**	**0.001**	**NS**	**NS**
Egg mass, kg	**nana**	6.21±0.59	5.53±0.68	**5.87**						
	Nana	6.43±0.43	5.74±0.39	**6.09**						
	Overall	**6.32 a**	**5.64 b**		**-10.76**	**+3.75**	**-7.56**	**0.001**	**NS**	**0.05**
Egg number, No	**nana**	102.56±3.18	94.25±4.52	**98.41**						
	Nana	102.41±4.21	96.91±3.87	**99.66**						
	Overall	**102.49 a**	**95.58 b**		**-6.74**	**+1.27**	**-5.51**	**0.001**	**NS**	**0.02**
Egg weight, g	**nana**	60.52±1.82	58.47±1.15	**59.65**						
	Nana	61.81±1.67	59.21±1.32	**61.11**						
	Overall	**61.66 a**	**59.01 b**		**-4.30**	**+2.45**	**-2.16**	**0.001**	**NS**	**0.05**
Feed consumption (kg)	**nana**	16.77±1.28	13.27±1.27	**15.02**						
	Nana	16.40±1.09	13.09±1.35	**14.75**						
	Overall	**16.59 a**	**13.18 b**		**-20.55**	**-1.80**	**-21.94**	**0.001**	**NS**	**NS**
Feed conversion ratio	**nana**	2.70±0.06	2.40±0.05	**2.56**						
	Nana	2.55±0.05	2.28±0.03	**2.42**						
	Overall	**2.63 a**	**2.34 b**		**-11.03**	**-5.47**	**-15.56**	**0.001**	**NS**	**0.01**

Gene effect = [(dw-nana, or Dw-Nana, or dw-Nana - Dw-nana)/Dw-nana]*100

Table 2. Internal and external egg quality (X±SE) of dwarf, naked neck and normal genotypes.

	Feather	Body size			Gene effect			Prob.		
Parameter	Type	Normal	Dwarf	Overall	dw-	Na	dw*Na	dw-	Na	dw*Na
Egg weight, g	**nana**	61.48±2.14	59.90±1.84	**60.69**						
	Nana	62.23±1.89	60.54±2.10	**61.39**						
	Overall	**61.86**^{a}	**60.22**^{b}		**-2.65**	**+1.15**	**-1.53**	**0.01**	**NS**	**0.04**
Albumen, %	**nana**	60.67±0.62	59.65±0.65	**60.16**						
	Nana	59.95±0.46	59.28±0.59	**59.62**						
	Overall	**60.31**	**59.47**		**-2.21**	**-0.90**	**-2.29**	**NS**	**NS**	**NS**
Yolk, %	**nana**	29.66±0.43	30.62±0.62	**30.14**						
	Nana	30.43±0.31	30.52±0.37	**30.48**						
	Overall	**30.05**	**30.57**		**+1.73**	**+1.13**	**+2.90**	**NS**	**NS**	**NS**
Shell, %	**nana**	9.67±0.35	9.73±0.55	**9.70**^{b}						
	Nana	9.62±0.31	10.20±0.39	**9.91**^{a}						
	Overall	**9.65**^{b}	**9.97**^{a}		**+3.32**	**+2.16**	**+5.48**	**0.05**	**0.02**	**0.05**
Yolk height, mm	**nana**	17.11±0.16	17.24±0.23	**17.18**						
	Nana	17.16±0.16	17.14±0.16	**17.15**						
	Overall	**17.41**	**17.19**		**-1.26**	**-0.17**	**+0.17**	**NS**	**NS**	**NS**
Albumen height, mm	**nana**	6.02±.20	5.87±0.30	**5.95**						
	Nana	5.67±0.23	5.92±0.23	**5.80**						
	Overall	**5.85**	**5.90**		**+0.85**	**-2.52**	**-1.66**	**NS**	**NS**	**NS**
Haugh unit	**nana**	75.36±1.32	74.94±1.55	**75.15**^{a}						
	Nana	72.73±1.63	75.21±1.64	**73.97**^{b}						
	Overall	**74.05**	**75.08**		**+1.39**	**-1.57**	**-0.20**	**NS**	**0.01**	**0.05**
Shell thickness, mm	**nana**	0.354±0.01	0.369±0.01	**0.362**						
	Nana	0.363±0.01	0.376±0.01	**0.370**						
	Overall	**0.359**^{b}	**0.373**^{a}		**+3.90**	**+2.21**	**+6.21**	**0.05**	**NS**	**0.05**

Gene effect = [(dw-nana, or Dw-Nana, or dw-Nana - Dw-nana)/Dw-nana]*

Table3. Coefficients of partial regression and constant for nanaDw-, nanadw-, NanaDw- and Nanadw- genotypes.

Genotype	Constant	EM	ΔW	$BW^{0.75}$	R^2
nanaDw-	3538.13**	1.84**	-2.92	-29.81*	0.28
nanadw-	2017.24	1.99**	3.40	-2.86	0.46
NanaDw-	9508.67*	1.07**	-1.30	-1.10	0.35
Nanadw-	4211.51	1.60**	-1.19	-0.03	0.69

EM = egg mass ΔW = body weight change

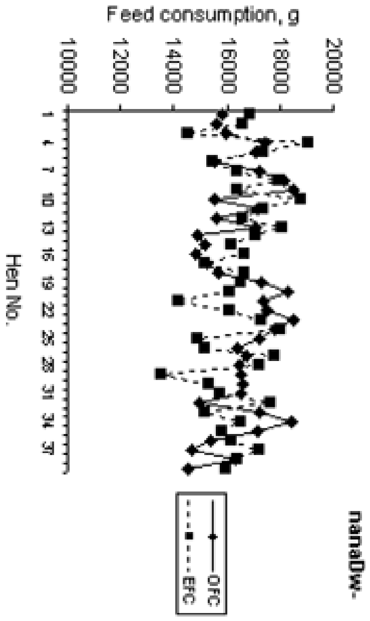
$BW^{0.75}$ = metabolic body weight R^2 = rate of determination

* $P< 0.05$ **$P<0.01$

Table 4. Phenotypic correlation coefficients for some quantitative traits with residual feed consumption (RFC)

	Genotype			
Trait	**nanaDw-**	**nanadw-**	**NanaDw-**	**Nanadw-**
Egg mass, g	0.29	-0.33	0.30	-0.37
Egg number, No.	0.22	0.31	0.27	0.28
Observed feed consumption, g	0.67**	0.74**	0.85**	0.80**
Feed conversion ratio	0.89**	0.97**	0.67**	0.90**
Albumen, %	-0.34	-0.44	-0.24	-0.41
Yolk, %	0.27	0.48	0.31	0.56*
Shell, %	-0.17	0.13	-0.14	-0.11
Shell thickness, mm	0.12	0.19	0.25	0.32

* $P<0.05$ ** $P<0.01$


nanaDw-
Feed consumption, g
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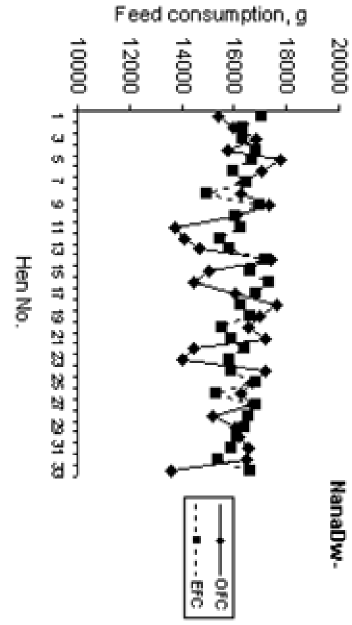
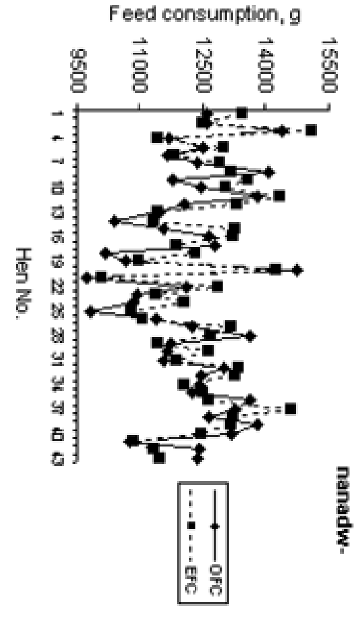
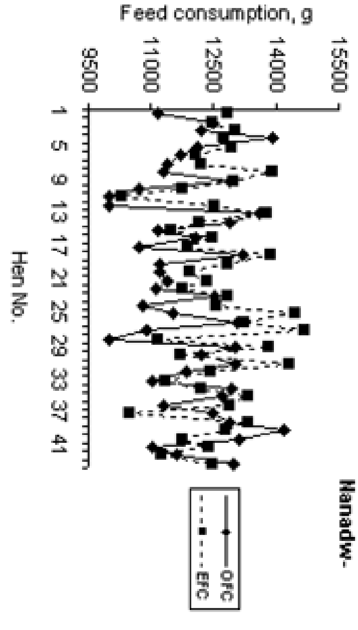
12000
14000
16000
18000
20000
Hen No.
1 4 7 10 13 16 19 22 25 28 31 34 37
OFC
EFC


NanaDw-
Feed consumption, g
10000
12000
14000
16000
18000
20000
Hen No.
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33
OFC
EFC


nanadw-
Feed consumption, g
9500
11000
12500
14000
15500
Hen No.
1 4 7 10 13 16 19 22 25 28 31 34 37 40 43
OFC
EFC


Nanadw-
Feed consumption, g
9500
11000
12500
14000
15500
Hen No.
1 5 9 13 17 21 25 29 33 37 41
OFC
EFC

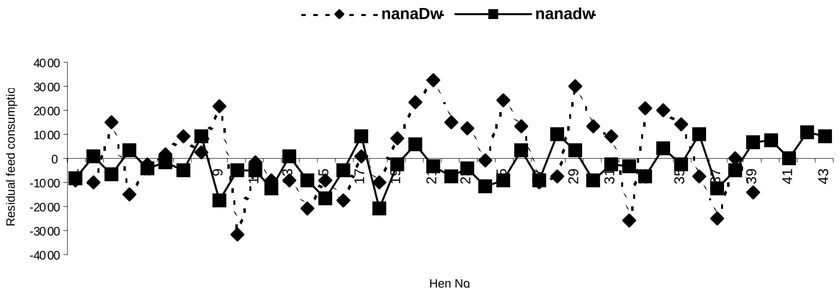


Fig.2. Residual feed consumption for dwarf (nanadw-) vs. normal type (nanaDw-) genotype.

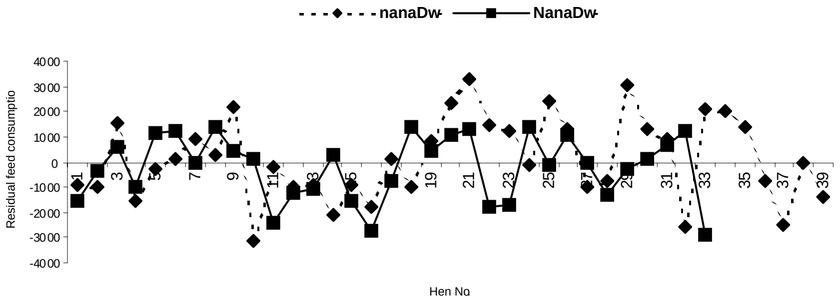


Fig.3. Residual feed consumption for naked neck (NanaDw-) vs. normal type (nanaDw-) genotype. .

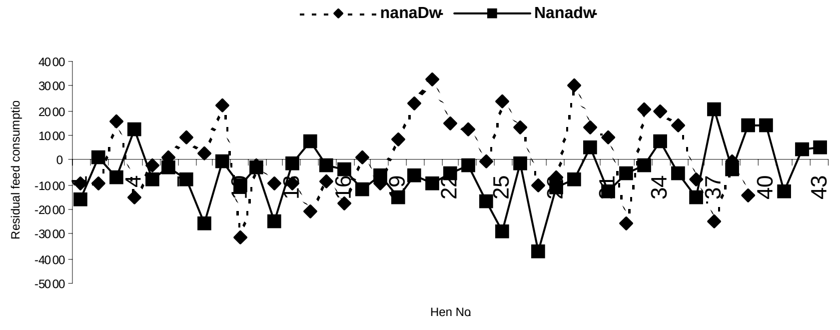


Fig.4. Residual feed consumption for naked neck dwraf (Nanadw-) vs. normal type (nanaDw-) genotype

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الملخص العربي

تقليل العلف المتبقي عن طريق إدخال العامل الوراثي المسئول عن القزمية وعامل عرى الرقبة في الدجاج البياض

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صممت هذه التجربة لتقييم تأثير العامل الوراثي المسئول عن القزمية في صورته المنفردة أو مرتبط مع العامل الوراثي المسئول عن عرى الرقبة على الكفاءة الغذائية و إنتاج البيض في الدجاجات البياضة تحت الظروف المصرية صيفا. سجلت المقاييس المتعلقة بإنتاج البيض خلال الفترة من ٢٠ إلى ٤٠ أسبوع من العمر. قدرت كمية العلف المتبقي (RFC) عن طريق الفرق بين الاستهلاك الغذائي المشاهد (OFC) والاستهلاك الغذائي المتوقع (EFC)، والذي تم الحصول علية من خلال معادلات الانحدار المتعدد باستخدام الاستهلاك الغذائي (FI) كمتغير تابع وكتلة البيض (EM) ووزن الجسم المعدل ($BW^{0.75}$) والتغير في وزن الجسم (ΔW) كمتغيرات مستقلة. أوضحت النتائج المتحصل عليها أن العامل الوراثي المسئول عن القزمية يصاحب بانخفاض معنوي في وزن الجسم، عدد البيض الناتج، كتلة البيض، وزن البيض، الاستهلاك الغذائي مقارنة بالطيور طبيعة الجسم. شوهد عكس الاتجاه بالنسبة للعامل الوراثي المسئول عن عرى الرقبة، حيث أوضحت النتائج أن الدجاجات عارية الرقبة أنتجت كتلة بيض اثقل وعدد بيض اكثر من الطيور طبيعية التريش، ولكن كانت الاختلافات غير معنوية إحصائيا. أدى إدخال العامل الوراثي المسئول عن عرى الرقبة في الدجاجات القزمية إلى تعويض جزئي للتأثير السلبي لعامل القزمية على مقاييس إنتاج البيض. سجلت الدجاجات الحاملة للعامل الوراثي المسئول عن القزمية والأخرى الحاملة للعاملين الوراثيين كفاءة تحويل غذائي أعلى معنويا من الدجاجات الطبيعية. شوهد نفس الاتجاه في الدجاجات عارية الرقبة

ولكن الاختلافات لم تكن معنوية. أدى إدخال العامل الوراثي المسئول عن القزمية في الدجاجات الطبيعية التربيش أو عارية الرقبة إلى زيادة معنوية في الوزن النسبي للقشرة وسمك القشرة مقارنة بالدجاجات الطبيعية. سجلت الدجاجات القزمية عارية الرقبة أعلى معدلات في الوزن النسبي للقشرة وسمك القشرة مقارنة ببقية التراكيب الوراثية الأخرى.

أوضحت النتائج أن الدجاجات القزمية عارية الرقبة سجلت افضل قيمة لمعامل التحديد (R^2) بالنسبة لمعادلات الانحدار يليها الدجاجات القزمية ثم الدجاجات عارية الرقبة مقارنة بالدجاجات الطبيعية، بالإضافة إلى ذلك سجلت الدجاجات القزمية عارية الرقبة، الدجاجات القزمية، الدجاجات عارية الرقبة قيم استهلاك غذائي مشاهد يتقارب مع قيم الاستهلاك الغذائي المتوقع، والذي انعكس بدورة على كمية العلف المتبقي لكي تقترب من الصفر أو القيم السالبة. وجد ارتباط موجب بين العلف المتبقي وكتلة البيض في التراكيب الوراثية الطبيعية وعارية الرقبة، بينما سجلت هذه الارتباطات قيما سالبة في التراكيب الوراثية القزمية و القزمية عارية الرقبة. وجد ارتبط موجب معنوي وقوى بين كل من الاستهلاك الغذائي وكفاءة التحويل الغذائي وكمية العلف المتبقية في كل التراكيب الوراثية. وجد ارتباط موجب بين كمية العلف المتبقية والوزن النسبي للصفار في كل التراكيب الوراثية.

الخلاصة: أوضحت النتائج المتحصل عليها أن إدخال العامل الوراثي المسئول عن القزمية والعامل المسئول عن عرى الرقبة في الدجاجات البياضة يؤدى إلى تحسين معنوي في الكفاءة الغذائية وذلك من خلال تقليل كمية العلف المتبقي. كما تشير الدراسة إلى الاهتمام بالاختلافات بين القطعان الوراثية من حيث الاحتياجات الحافظة والإنتاجية، بالإضافة إلى إمكانية استخدام كمية العلف المتبقي (RFC) في برامج الانتخاب لتحسين الكفاءة الغذائية.