IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS)
e-ISSN: 2319-2380, p-ISSN: 2319-2372. Volume 11, Issue 12 Ver. I (December 2018), PP 53-59
www.iosrjournals.org

Realized correlated selection response for feed efficiency of egg production under different feeding regimens in Sinai chickens

Soltan M.E., Farrag S.A. and Enab A.A.
Poultry and Fish Production Dept., Faculty of Agriculture, Menoufia Univ., Egypt.
Corresponding Author: Farrag, S.A.

Abstract: *Recent study held at Research farm of Poultry and Fish production Department, Menoufia University, Egypt, aiming to determine the realized correlated responses in some economic traits due to selection for feed efficiency under different feeding regimens (free (i.e. once) at 08:00 am and twice (50%:50%) at 08:00 am and 03:00 pm) in local Egyptian chickens Saini/Bedouin fowl. Data on body weight at 24, 35 weeks of age, egg number during first 90 days of production, egg weight at sexual maturity and egg mass produced through first 90 days of production cycle were collected for three successive generations and statistically analyzed for all genetic groups (584 hens were used). Results indicated that, after two generations of selection for feed efficiency:*

- *Body weight at 24 weeks and at maturity significantly decreased by selection, but, didn't affected by regimen of feeding.*
- *Number of produced eggs during the first 90 days of production cycle increased significantly due to line and feeding regimen effects.*
- *Egg weight statistically increased in selected lines comparing with control lines. While, no significant effects were observed in egg weight at maturity due to feeding regimen effect.*
- *Significant effects were noticed due to lines and feeding regimen on egg mass produced during first 90 days of egg production.*

So, it can be concluded that selection for feed efficiency (integrating data from relatives) improved productive performance of local chicken Sinai. Additionally, birds fed twice a day corresponded to selection better than those fed freely (once a day), consequently, we recommend to practice twice feeding regimen alongside with breeding plans aimed to improve local chickens.

Keywords:*correlated selection response, egg production, feed efficiency*

Date of Submission: 29-11-2018 Date of acceptance: 12-12-2018

I. Introduction

It is already very well documented that, feed efficiency represent one of the key factors in poultry production process that affected profitability (represent 60 -70 % of costs) [1-4]. The importance of selection for feed efficiency is continues to rising in poultry industry [4]. Additionally, feed efficiency for both meat and egg production have genetic bases [5] therefore it should be considered in any breeding plan as selection trait to determine breeding goals in future [3,4]. It is very important to assess economics of poultry production process continuously to protect the industry over time [4]. Generally, including feed conversion ratio as a selected trait in selection programs resulted in good achievement in production enhancement in poultry. Although, selection indirectly for feed efficiency in both meat and egg production industries resulted in realized genetic gain less (20-80%) than expected [6], feed efficiency for egg production have been improved in commercial laying stocks by direct selection for number of produced eggs.

There are three main characteristics influencing efficiency of feed utilization by layers hens: 1) body weight, 2) egg production, and 3) genetic differences in feed conversion[3,7,8]. It have been reported that 70-90% of feed intake could be attributed to egg mass, body weight and changes in body weight [6,9,10]. Feed conversion affected mainly by body weight, age, sex and environmental factors like management procedures, temperature, feed quality and humidity [11] in addition to genetic variations.

Selection for one or more desirable trait/traits lead to correlated responses in unselected traits. Since selection process may be affected by genetic correlations between different traits, these correlations must be considered and accurately estimated. Most of economic traits of egg production industry (i.e. number and size of eggs, fertility and hatchability, interior and exterior egg quality) are correlated with the ability of birds to convert their feed (feed efficiency). Genetic correlation between feed efficiency and other important economic traits have been reported in literature [1,2,3,4,12].

Breeding plan strategy for feed efficiency improvement mainly depend on the genetic correlations with other economic traits and the feed efficiency trait to be used as a selection criterion (i.e. FCR or RFI) as reported by Willems, 2014 [4]. Improving indigenous (local) chickens could be obtained by enhancement of environment and management practicesalongsidewith genetics [13]. Regarding local strains selection for egg production have been improved egg production and may lead to produce commercial local layer strain [14]. Layers value mainly based on number of economic traits (i.e. age at sexual maturity, body weight, number and weight of produced eggs) as reported by Alilo, 2017 [15].

Fasting period in laying hens had a negative effect on egg production by affecting gonadotropin secretion from the pituitary, plasma luteinizing hormone concentration, estradiol and progesterone concentrations [16-18], so, decreasing fasting period could improve egg production. Availability of nutrients when needed by body tissues could improve hens productive performance [19], hence, two or three times feeding per day enhance the existence of such nutrients to different metabolic processes (time to be absorbed). In addition, multi-times feeding regimens led to shortening fasting period of layers and reducing competition for feed by hens, so, improving performance [16,18,20,21]. Taherkhani et al., 2010 [22] supposed that frequent feeding could decrease blood glucose and delay lipo-toxicity in broiler breeders leading to improving productive and reproductive performance of hens.

Twice feeding a day is a good alternative to traditional feeding regimen (once a day) and it is applicable for farm management without difficulties, while, three or four times feeding a day didn't showed any advantage comparing with two times feeding regimen [21].In broiler breeders farms twice feeding regimen had improved early egg production (first part of cycle) as published by [18-20]. Moreover, Taherkhani et al., 2010[22] found that twice feeding of broiler breeders enhanced entire egg production instead of once feeding a day.

In this regard, current work was held aiming to investigate the realized correlated genetic gains in some productive traits as a response to selection for egg production feed efficiency in Sinai fowls subjected to two different feeding regimens.

II. Materials and methods

Current study held at the research farm of Poultry Production Department, Menoufia University, Egypt for three successive generations (base, first and second) on 584 Sinai Bedouin fowl hens. Selection for egg production feed efficiency under two feeding regimens was applied and corresponding control lines were established. Recent research aimed to investigate the realized correlated response to selection for egg production feed efficiency on some economic traits under different feeding regimens. History of used flock have been illustrated by Soltan et al., 2009a,b [12,23]. Selection was applied using an index that contains information about full-sib family of the individual. Selected and corresponding control lines subjected to two feeding regimens (free and twice feeding a day). Selection procedure and collecting data have been previously discussed in details by Soltan et al., 2014 [3]. The value of individual index was calculated according the following equation:

$$I = b_1(X_1 - \overline{X}) + b_2(X_2 - \overline{X})$$

Where:

X_1 = the value of the selection trait on the individual.

X_2 = the mean value of the selection trait on full-sibs family of the individual.

$\overline{X}$ = the mean value of the trait for the studied strain.

$b_1$and b_2 = a weighted factors for the selection trait for individuals (b_1) and full-sibs families (b_2), extracted from Flock et al., 1971 [24].

Assuming $\sigma^2c = 0$ and h^2 value of feed efficiency = 0.3, b_1 and b_2 values will be 0.25 and 0.35 if full-sibs family = 5; b_1 and b_2 values of 0.26 and 0.62 in the case of full-sibs family = 3, respectively [24]. The best 40% of birds were selected as parents of the next generation.

The daily amount of feed introduced were the same in different lines. The birds under free feeding regimen received their daily feed at 08:00 am and the birds under twice feeding regimen received 50% of their feed at 08:00 am and 50% feed at 03:00 pm. To decrease generation interval measuring period was shortened to first 90 days of egg production. At the same time data about relatives were incorporated in selection plan to reduce the environmental effects.

Statistical analysis: Recorded data were subjected to statistical analysis usingIBM SPSS Statistics for Windows, program version (21.0). The following model was used:

$$Y_{ijkl} = \mu + G_i + L_j + FR_k + (G \times L)_{ij} + (G \times FR)_{ik} + (L \times FR)_{jk} + (G \times L \times FR)_{ijk} + e_{ijkl}$$

Where:

Y_{ijkl} = The observation on l^{th}bird.

μ = The overall mean.

G_i = The fixed effect of i^{th} generation.

L_j = The fixed effect of j[th] line within the i[th] generation.
FR_k = The fixed effect of the k[th] feeding regime.
$(G \times L)_{ij}$ = The interaction between i[th] generation and j[th] line.
$(G \times FR)_{ik}$ = The interaction between i[th] generation and k[th] feeding regime.
$(L \times FR)_{jk}$ = The interaction between j[th] line and k[th] feeding regime.
$(G \times L \times FR)_{ijk}$ = The interaction between i[th] generation and j[th] line and k[th] feeding regime.
e_{ijkl} = The random error assumed to be normally distributed with zero mean and variances σ_e^2

The least squares and maximum likelihood general purpose program – mixed model LSMLMW [25] model (4) was used to estimate the values of heritability and phenotypic, genetic and environmental correlation for the studied population. The general random model utilized by (LSMLMW) was as follow:

$$Y_{ijk} = \mu + S_i + D_{ij} + e_{ijk}$$

Where:
Y_{ijk} = Observation of the K[th] progeny of the i[th] sire and j[th] dam.
μ = Common mean
S_i = Random effect of i[th] sire
D_{ij} = Random effect of j[th] dam within i[th] sire.
e_{ijk} = Random error assumed to be normally distributed with zero mean and variance $\sigma^2 e$.

- Heritability was estimated according to the method of Becker (1984):

$$h^2_{S+D} = 2\,(\sigma^2_D + \sigma^2_S)/(\sigma^2_D + \sigma^2_S + \sigma^2_e)$$

where:
σ^2_S = Sires component of variance.
σ^2_D = Dams component of variance.
σ^2_e = Progeny within mating components of variance.

The realized correlated responses in studied traits due to selection under different feeding regimens were calculated by the following equation [27]:

$$Realized\ correlated\ response = (S_n - C_n) - (S_0 - C_0) \ldots\ldots\ldots\ldots (Chen\ and\ Tixier - Boichard, 2003)$$

where S_n and S_0 represent the mean of the selected line in calculation (n) and base (0) generations, respectively. and C_n and C_0 represent the corresponding means of control line.
All studied groups were kept in open housed farm and have been reared at the same environmental and hygienic conditions. During the first 16 weeks of age all birds allowed to reach water and feed freely (*ad libitum*), composition of brooding diet represented in Table (1). After that, pullets were transferred to layer house and kept in individual numbered battery cages according to their line and feeding regimen, and the diet replaced by layer ration as shown in Table (1).

Table (1): Composition of the experimental rations.

Ingredients	Starter ration	Layer ration
Ground yellow corn	57	65
Soybean meal	37	27
Limestone	1.8	2.5
Salt	0.5	0.5
di-calcium phosphate	2	2.35
Bone meal	1.35	2.3
Methionine	0.1	0.1
Vitamin and mineral premix %*	0.25	0.25
Total kg	100	100
Crude protein	21.1	17.4
ME/kg. kal.	2734.6	2779.6

* Pfizer premix provided per kilo gram of diets:-
10000 IU Vit. A, 2000 IU Vit. D_3, 2 mg Vit. E, 3 mg Vit. B_3, 3 mg Vit. B_2, 10 mg pantothenic, 250 mg choline, 25 mg Fe, 10 mg Mg, 2 mg Cu, 1.2 mg I and 0.2 mg Co.

The recorded traits were as follow:

1. Body weight at 24 (BW_{24}) and 35 (at maturity – BW_M) weeks of age in g.
2. Egg number during the first 90 days of egg production (EN_{90}).
3. Egg weight at sexual maturity (in gram) (EW_{SM}).
4. Egg mass during the first 90 days of laying in grams (EM_{90}).

III. Results and Discussion

Data in Table (2) present the means of studied traits (i.e. BW_{24}, BW_M, EN_{90}, EW_{SM} and EM_{90}). Body weight at 24 weeks of age decreased significantly in selected lines comparing with control lines under both investigated feeding regimens, 941.16 g in selected line with free feeding vs. 1009.29 g in control line with free feeding and 994.33 g in selected line under twice feeding vs. 1002.92 g in corresponding control line fed twice daily after two generations of selection for feed efficiency of egg production. Concordant findings have been reported by Soltan et al., 2009a [12], they recorded BW_{24} as 1239.0 and 1060.0 g after 3 generations of selection for EF (g feed/g egg) in Sinai fowl, they also found that BW_{M} reduced from 1309.0 to 1112.64 due to selection. Spradley et al., 2008 [18] found that twice feeding a day decreased body weight at 31, 38 and 40 weeks of age comparing with free feeding in broiler breeders hens. Feeding regimen affected BW_{24} in Sinai chickens significantly as shown in Table (2). Body weight at 24 weeks of age significantly differed according to generation effect (the same trend was observed by Soltan et al., 2009a [12]) and the interaction between line and feeding regimen. On the other hand other interactions L×G, G×FR and L×G×FR have no statistical significances on BW_{24} (Table, 2). The same was observed regarding BW_{M} (i.e. body weight at 35 weeks of age), it had been decreased significantly in selected (1037.66 and 1089.39 g) comparing with control (1101.79 and 1091.08 g) lines under free and twice feeding regimens, respectively, after two generations of selection. The reduction of body weight in birds fed twice compared with those fed once could be attributed to the favorable partitioning of nutrients resulting on regulation of body tissue building; tending to utilization of such nutrients in egg production [18-19].

Number of eggs produced during first 90 days of egg production increased significantly in selected (39.93 and 38.33 eggs)comparing with control (35.96 and 29.85 eggs) lines subjected to free and twice feeding regimens, respectively, after two generations of selection. Significant differences were detected in EN_{90} due to line, generation, feeding regimen and L×G interaction effects, while the interactions between L×FR, G×FR and L×G×FR not affected EN_{90} significantly (Table, 2). Little improvement of egg production have been recorded by Heil and Pirchner[28] due to selection for feed efficiency in Leghorn layers for 3 generations. In 1985, Soltan et al., [29] recorded 20.7 eggs during first 90 days of production cycle in Sinai fowl.Soltan and Ahmed [30] reported values of 34.5 (selected) and 31.6 eggs (control) in Saini hens during first 90 days of egg production. Soltan[31] argued that selection based on partial records in Sinai chickens represent a valuable tool for breeders to improve this strain. On another study on Sinai chickens EN_{90} was 48.5 eggs in selected line for egg number [32]. The same trend was noticed by Soltan et al., 2009a (43.57 vs. 26.38 eggs) in selected and control lines, respectively, in the last generation of selection experiment for FE in Sinai fowl. They also reported that line and generation affected EN_{90} significantly. Moreover, Spradley et al., 2008 [18] detected significant improvement of hen-day egg production (58% comparing with 56%) in broiler breeders birds subjected to twice feeding vs. those fed once a day.Moradi et al., 2013 [20] reported that twice or thrice feeding a day enhanced egg production (+4.8 eggs) than once a day feeding regimen, he attributed this improvement in egg number to the decreasing of fasting period. On the other hand, no statistical differences were noticed between feeding once or twice a day (186.3 vs. 186.5 eggs, respectively) as observed by de Avila et al., 2003 [33].

Selection for feed efficiency of egg production improved egg weight significantly (Table, 2). Average egg weights after two generations of selection in selected lines were 38.63 and 38.23 g under free and twice feeding regimens, respectively, while the corresponding values of egg weight in control lines were 35.96 and 29.85 gfor birds fed free and twice daily, respectively. Higher average of egg weight in Sinai chickens was found by Soltan et al., 1985 (47.2 g). In selection experiment on Sinai fowl Soltan and Ahmed [30] recorded EW 41.1 vs. 42.0 g in selected and control lines, respectively. Average egg weight in Sinai hens was heavier (43.3 g) than Fayoumi (37.3 g) and Baladi (39.2 g) chickens as noticed by Soltan, 1992 [32]. Significant differences in egg weight were recorded according to line, generation and L×G interaction effect, but no significances due to feeding regimen, L×FR, G×FR and L×G×FR were recorded. Cave, 1981 reported significant differences in egg weight caused by feeding birds twice or thrice a day comparing with control birds (fed once a day). In broiler breeders, Spradley et al., [18] reported that egg weight increased in birds fed twice comparing with birds fed once a day, they argued that, this increase may be due to introducing feed in the late part of the day. The same effect of dual mode feeding regimen on egg weight have been reported by Cave, 1981 [19]. Significantly heavier eggs were laid by broiler breeder hens fed twice daily than those fed once a day [22]. Additionally, egg weight improved by splitting feed of laying hen by 2 or 3 times per day [20].

Egg mass during first 90 days of production increased significantly in selected (1541.44 and 1461.18 g) vs. control (1343.46 and 1106.38 g) lines under free and twice feeding, respectively. Line, generation, feeding regimen and L×G interaction significantly affected EM_{90}. Other interactions didn't showed any significant effects on EM_{90} (i.e. L×FR, G×FR and L×G×FR).

Realized correlated responses in studied traits are presented in Table (3). BW_{24} decreased by 6.73 % (-44.838 g) in selected line comparing with control line under free feeding regimen. On the other hand BW_{24} in birds fed twice a day decreased by only 0.85 % (-8.579 g). Regarding BW_{M} (35 weeks), selected birds fed freely weighed less than control birds under the same feeding regimen by 5.80 % (-41.973 g), the same trend was observed in birds fed twice daily, reduction by 0.15 % (-4.423 g) in selected birds comparing with control line. After two generations of selection for egg production feed efficiency EN_{90} increased by selection 4.00 (11.04 %)

and 8.168 eggs (28.40 %) in selected lines comparing with control lines subjected to free and twice feeding regimens, respectively. Current study results revealed that EW_{SM} improved due to selection for egg production feed efficiency and recorded correlated response of 1.285 and 1.191 g after two generations of selection under free and twice feeding regimens, respectively. Egg mass increased as a response of selection for egg production feed efficiency by 201.813 and 352.811 g in the first 90 days of egg production in birds fed free and twice daily, respectively. Body weight at maturity, EN_{90}, EW and EM_{90} positively responded to selection for EF (g feed/g egg) as 0.36 g, 17.19 eggs, 2.72 g and 759.13 g, respectively, as noticed by Soltan et al., 2009a. On the other hand, they reported negative response to selection for BW_{22}.

Table (2): Effect of line, feeding regimen and generation on correlated traits for Sinai chickens (Mean ± SE)

Line	Feeding Regimen	G	BW_{24}	BW_M	EN_{90}	EW_{SM}	EM_{90}
Selected	Free	Base	1039.80 ±11.21	1160.36 ±11.76	31.64 ±1.11	39.44 ±0.23	1244.98 ±42.78
		First	1025.38 ±9.83	1130.26 ±9.33	37.71 ±0.64	39.24 ±0.20	1482.01 ±27.20
		Second	941.16 ±9.84	1037.66 ±9.51	39.93 ±1.14	38.63 ±0.29	1541.44 ±44.96
	Twice	Base	1105.29 ±11.52	1226.94 ±12.11	30.19 ±1.03	39.34 ±0.27	1183.86 ±39.80
		First	1081.39 ±8.60	1184.94 ±8.06	33.63 ±0.90	39.15 ±0.26	1313.61 ±34.78
		Second	994.33 ±9.13	1089.39 ±8.58	38.33 ±0.93	38.23 ±0.30	1461.18 ±34.61
	Total	Base	1072.02 ±8.52	1193.12 ±8.92	30.92 ±0.76	39.39 ±0.18	1214.91 ±29.26
		First	1053.38 ±6.91	1157.60 ±6.55	35.67 ±0.58	39.20 ±0.16	1397.81 ±23.10
		Total	1030.57 ±4.86	1137.23 ±5.04	35.35 ±0.43	39.00 ±0.11	1375.51 ±16.52
Control	Free	Base	1063.09 ±11.59	1182.52 ±12.44	31.68 ±1.11	39.42 ±0.28	1248.81 ±44.13
		First	1089.37 ±15.73	1189.27 ±15.16	30.33 ±2.05	37.90 ±0.39	1151.27 ±79.69
		Second	1009.29 ±20.53	1101.79 ±19.61	35.96 ±2.73	37.32 ±0.53	1343.46 ±99.81
	Twice	Base	1105.31 ±9.19	1224.21 ±10.93	29.87 ±1.05	39.67 ±0.29	1181.88 ±40.90
		First	1084.40 ±24.31	1182.40 ±22.95	29.57 ±1.94	38.73 ±0.41	1142.40 ±74.12
		Second	1002.92 ±26.91	1091.08 ±25.96	29.85 ±2.13	37.40 ±0.55	1106.38 ±62.71
	Total	Base	1084.20 ±7.61	1203.36 ±8.46	30.77 ±0.76	39.55 ±0.20	1215.35 ±30.11
		First	1086.88 ±14.24	1185.83 ±13.53	29.95 ±1.39	38.32 ±0.29	1146.83 ±53.48
		Second	1005.98 ±16.77	1096.22 ±16.16	32.78 ±1.79	37.36 ±0.37	1220.18 ±64.16
	L		**	**	**	**	**
	G		**	**	**	**	**
	FR		**	**	**	NS	**
	L×G		NS	NS	**	*	**
	L×FR		**	**	NS	NS	NS
	G×FR		NS	NS	NS	NS	NS
	L×G×FR		NS	NS	NS	NS	NS

BW_{24} = Body weight at 24 weeks of age; BW_M = Body weight at maturity (35 weeks); EN_{90} = Egg number; EW_{SM} = Egg weight at sexual maturity; EM_{90} = Egg mass; FE = Feed efficiency (g feed/g egg mass).
L = line; G = generation; FR = feeding regimen; L×G, L×FR, G×FR and L×G×FR = different interaction effects

Heritability, phenotypic and genetic correlations of investigated traits were represented in Table (4). Results showed that, all studied traits i.e. BW_{24}, BW_M, EN_{90}, EM_{90} and FE have moderate to high heritability values 0.419, 0.422, 0.330, 0.473 and 0.504 except EW_{SM} trait have low heritability value 0.078 in selected lines regardless of feeding regimen after two generations of selection. Higher values of h^2 were detected by Soltan et al., 2009a for BW, EN_{90} and EM_{90}, but, EW_{SM} and FE were moderately heritable. Non-genetic variance/random error may result in overestimation of h^2 values [26]. Fluctuations in heritability values have been widelyreported for selection experiments, and it is generally caused by the alteration of genetic variation as a result of selection. Data in Table (4), showed that, there are negative phenotypic and genetic correlations (Table, 4) between FE and EN_{90}, EW_{SM} and EM_{90} which means that these traits increased when feed efficiency of egg production improved (the lesser value of the equation of calculation EF means the best efficiency of feed utilization), these findings fully agreed with those obtained by Soltan et al., [12].Maijala, 1966 [34] recorded high positive (0.51 and 0.73) phenotypic and genetic correlations between FCR and egg mass. The opposite were observed, positive phenotypic and genetic correlations between FE and both of BW_{24} and BW_M. Negative genetic correlations have been reported by Willems, 2014 [4] among RFI (as feed efficiency indicator) with egg weight and total egg production, he also reported negative correlation between FCR and BW. High positive correlations were detected between feed efficiency with BW_{22} and BW_{35}[12].Moreover,Heil and Pirchner, [28] reported decrease in both BW and EW due to selection for feed efficiency in Leghorn hens.

Table (3): Realized correlated response in some productive traits for Sinai chickens.

Feeding regimen	Generation	BW_{24}	BW_M	EN_{90}	EW_{SM}	EM_{90}
Free	Base	-23.292	-22.157	-0.037	0.020	-3.830
	First	-40.700	-36.846	7.412	1.320	334.577
	Second	-44.838	-41.973	4.005	1.285	201.813
Twice	Base	-0.016	2.734	0.315	-0.334	1.984
	First	-2.995	-0.189	3.744	0.756	169.227
	Second	-8.579	-4.423	8.168	1.161	352.811
Total	Base	-12.174	-10.240	0.150	-0.156	-0.438
	First	-21.328	-17.989	5.566	1.037	251.417
	Second	-26.258	-22.647	6.203	1.222	281.865

BW_{24} = Body weight at 24 weeks of age; BW_M = Body weight at maturity (35 weeks); EN_{90} = Egg number; EW_{SM} = Egg weight at sexual maturity; EM_{90} = Egg mass; FE = Feed efficiency (g feed/g egg mass).

Table (4): Heritability estimates (±SEh^2, on diagonal), genetic correlations (below diagonal) and phenotypic correlations (above diagonal) for studied traits in selected lines after two generations of selection.

Trait	BW_{24}	BW_M	EN_{90}	EW_{SM}	EM_{90}	FE
BW_{24}	**0.419±0.186**	0.984	-0.193	-0.155	-0.236	0.198
BW_M	0.966	**0.422±0.186**	-0.207	-0.160	-0.250	0.211
EN_{90}	-0.876	-0.901	**0.330±0.174**	-0.105	0.916	-0.868
EW_{SM}	-1.549	-1.522	1.509	**0.078±0.127**	0.187	-0.162
EM_{90}	-0.935	-0.950	0.810	1.393	**0.473±0.192**	-0.898
FE	0.788	0.801	-0.729	-1.096	-0.735	**0.504±0.195**

BW_{24} = Body weight at 24 weeks of age; BW_M = Body weight at maturity (35 weeks); EN_{90} = Egg number; EW_{SM} = Egg weight at sexual maturity; EM_{90} = Egg mass; FE = Feed efficiency (g feed/g egg mass).

IV. Conclusions

In conclusion, results of the current research revealed that merging family data in selection programs for egg production feed efficiency in Sinai chickens reduced body weight for mature birds and improved egg production as a realized indirect response. Additionally, twice feeding regimen positively affected egg production with lower reduction of body weight in selected lines comparing with free feeding regimen under selection for egg production feed efficiency and could be used alongside with selection planes to improve laying performance of local chickens.

References

[1] Hagger, C. and C. Marguerat, 1985. Relationship of Production Traits and Egg Composition to Feed Consumption and the Genetic Variability of Efficiency in Laying Hens. *Poultry Science 64*: 2223-2229.

[2] Basso, B., A. Bordas, F. Dubos, P. Morganx, and C. Marie-Etancelin, 2012. Feed efficiency in the laying duck: Appropriate measurements and genetic parameters. *Poultry Science 91*: 1065–1073.

[3] Soltan, M.E.; Enab, A.A. and Farrag, S.A. (2014). Direct selection response for feed efficiency of egg production under different feeding regimes in Sinai fowls. *7th International Poultry Conference – Proceeding, 3 – 6 November, Ain Sukhna, Red Sea – Egypt.* pp: 314-324

[4] Willems, O.W. (2014). *Evaluation methods and technologies for improving feed efficiency in the turkey (Meleagarisgallopavo)*. Ph.D. Thesis, The University of Guelph, Ontario, Canada.

[5] Bentsen, H.B. (1983). Genetic Variation in feed efficiency of laying hens at constant body weight and egg production. II - Sources of variation in feed consumption. *Acta Agric. Scandi. 33*: 305 - 320.

[6] Pirchner, F. 1980. Feed efficiency. *Proc. of 6th European Poultry Conf., Vol. I, Hamburg*. pp. 29-42.

[7] Miller, M. M. and J. H. Quisenberry, 1959. Factors Affecting Feed Efficiency for Egg Production in Selected Strains of Caged Layers. *Poult. Sci. 38 (4):* 757-766.

[8] Fairfull, R. W. and Chambers, J. R. 1984. Breeding for feed efficiency: Poultry. *Can. J. Anim. Sci. 64*: 513-527.

[9] Bentsen, H. B. 1980. Inherited variance in feed efficiency by laying hens. *Proc. 6th European Poultry Conf., Vol. II, Hamburg.* pp. 40-47.

[10] Byerly, T.C.; J.W. Kessler; R.M. Gous, and O.P. Thomas (1980). Feed requirements for egg production. *Poult. Sci. 59:* 2500 - 2507.

[11] Nordskog, A.W.; French, H.L.; Arboleda, Jnr. C.R. and Casey, D.W. 1972. Breeding for efficiency of egg production. Journal paper No. J-7094 of the Iowa Agriculture and Home economics Experiment Station, Project 1711 in cooperation with the North Central Rejional Poultry Breeding. Project NC-89.

[12] Soltan, M. E., S. Abed El-Rahman, F. H. Abdou and Rasha H. Ashour (2009a). Correlated selection response of some economic traits as result of selection for feed efficiency in Sinai laying hens. *Proc. of the First scientific conference for marketing the University applied researches, 7-8 October, Menoufia University, Egypt*, pp: 1-12.

[13] Ghanem, H.H.; Balat, M.M.; Abou El-Ella, N.Y.; Afifi, Y.K. and Aly, O.M. (2016). Selection for improving egg production in Mandarah chickens: 5- Direct and correlated response for some economic traits after eight generations of selection. *Egypt. Poult. Sci., 36 (4):* 1101-1115.

[14] Nassar, F.S; El-Komy, E.M. and Abdou, A.M. (2017). Ovarian morphology and egg quality traits of Egyptian selected strain for egg production compared with commercial laying strains. *Brazilian Journal of Poultry Science, 19 (4):* 683-688.
[15] Alilo, A.A. 2017. Review on flock improvement through genetic selection and culling of laying flock of poultry production. *Journal of biology, Agriculture and Health Care, 7(17):* 45-50.
[16] Morris, T. R., and A. V. Nalbandov. 1961. The induction of ovulation in starving pullets using mammalian and avian gonadotropins. *Endocrinology 68:*687–697.
[17] Tanabe Y, Ogawa T, Nakamura T (1981). The effect of short term starvation on pituitary and plasma LH, plasma estradiol and progesterone, and on pituitary response to LH-RH in the laying hen (*Gallus domesticus*). *Gen. Comp. Endocrinol. 43:* 392–398.
[18] Spradley, J. M., M. E. Freeman, J. L. Wilson, and A. J. Davis (2008). The Influence of a Twice-a-Day Feeding Regimen after Photo-stimulation on the Reproductive Performance of Broiler Breeder Hens. *Poultry Science 87:*561–568.
[19] Cave, N. A. 1981. Effect of diurnal programs of nutrient intake on the performance of broiler breeder hens. *Poult. Sci. 60:* 1287–1292.
[20] Moradi S, Zaghari M, Shivazad M, Osfoori R, Mardi M (2013) The effect of increasing feeding frequency on performance, plasma hormones and metabolites, and hepatic lipid metabolism of broiler breeder hens. *Poult. Sci. 92 (5):* 1227-1237.
[21] Soltanmoradi M. G., A. Seidavi, M. Dadashbeiki, F. Delgado and S. Gamboa(2013). Effect of time, amount and frequency of feeding on total egg production, fertility and hatchability in broiler breeders. *Arch. Tierz. 56,* published online 20 November 2013.
[22] Taherkhani, R., M. Zaghari, M. Shivazad and A. ZareShahneh (2010). A twice-a-day feeding regimen optimizes performance in broiler breeder hens. *Poult. Sci. 89 (8):* 1692-1702.
[23] Soltan, M. E., S. Abed El-Rahman, F. H. Abdou and Rasha H. Ashour (2009b). Direct selection response for feed efficiency of egg production. *Minufiya J. Agric. Res., 34 (3):* 1011-1025.
[24] Flock, D., H. Haussmann and D. Fewson (1971). *Tabellen fur die zuchtwertschatzungbeilandwirtschaftlichennutztieren*. Schriftenreihe des max-planch-Instituts fur Tierzucht and Tierernahrung, Heft 54.
[25] Harvey, W. (1990). User's Guide for LSMLMW. Mixed model least squares and maximum likelihood computer program. PC. Version 2.0 Ohio State Univ.,Col., OH, USA (mimeograph).
[26] Becker, W.A. (1984). *Manual of Quantitative Genetics.* Washington State Univ.
[27] Chen, C.F. and Tixier-Boichard, M. (2003). Estimation of genetic variability and selection response for clutch length in dwarf brown-egg layers carrying or not the naked neck gene. *Genet Sel. Evol., 35(2):* 219-38.
[28] Heil, G. and Pirchner, F. (1980). Selection on feed efficiency in lay hens: direct and correlated response. *Annales de Génétiqueet de SélectionAnimale, 12*: 126c.
[29] Soltan, M.E.; M.M. El-Nady; B.M. Ahmed, and A.M. Abou-Ashour (1985). Studies on the productive performance of Sinai Bedouin fowl. *Minoufiya. J. Agric. Res.10 (4):* 2147-2168.
[30] Soltan, M.E. and B.M. Ahmed (1990). Performance of selected Sinai fowl in comparison with Fayoumi and Baladi fowls as standard Egyptian local breeds. I. Egg production. *World Rev. of Anim. Prod. 25 (2)*: 17- 26.
[31] Soltan, M.E. (1991). Some phenotypic and genetic parameters of body reactions (body, skin and feather temperatures and respiration rate) in Sinai Bedouin fowl. *Minoufiya. J. Agric. Res. 16 (I):* 355- 372.
[32] Soltan, M.E. (1992). Phenotypic parameters in males and females for comb size and type, length of wattle, feather color, body weight and egg production traits of Baladi fowl in Al-Qassem area. *Minoufiya. J. Agric. Res.l7 (2):* 499 - 512.
[33] de Avila, V. S., A. M. Penz Jr., P. A. R. de Brum, P. S. Rosa, A. L. Guidoni, and E. A. P. de Figueiredo(2003). Performance of female broiler breeders submitted to different feeding schedules. *Braz. J. Poult. Sci. 5:*197–202.
[34] Mijala, K 1966. Repeatabilities and correlations of economic traits in the Finish random sample egg laying test. *Ann. Agr. Fenn. 5*: 48-63.

Soltan M.E." Realized correlated selection response for feed efficiency of egg production under different feeding regimens in Sinai chickens. "IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS) 11.12 (2018): PP- 53-59.