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IMPROVING THE ACCURACY OF SELECTION INDICES USING MULTISOURCE OF INFORMATION IN LAYING CHICKENS

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ABSTRACT

Data were collected from one pedigreed generation of Norfa layers. 149 cocks and 477 hens were used. Each cock artificially inseminated three hens. 498 completely records of progeny were used. 15 selection indices were constructed by using different combinations of 4 traits and 3 sources of information. The studied traits were age at sexual maturity (SM), body weight (BW_M), egg weight (EW_M) and egg number (EN_{42wk}). The sources of information were own performance (OP), full sibs (FS) and half sibs (HS). The Least Squares and Maximum Likelihood General Purpose Program-Mixed Model "LSMLMW" (Harvey, 1990) was used to estimate heritability and phenotypic and genetic correlations of studied traits.

Heritability estimates of SM, BW_M, EW_M and EN_{42wk} were 0.32, 0.93, 0.17 and 0.57, respectively. The genetic and phenotypic correlations between SM, BW_M and EW_M were positive, while these correlations between each of these three traits and EN_{42wk} were negative. The value of each trait was affected by the source of information and number of traits in the index. By using the same source(s) of information, the value of each trait increased if the index was constructed by using 3 traits instead of 4 traits.

The accuracy of the index (r_{TI}) depends on number of traits; sources of information and the value of each trait were used to construct the index. There is a negative correlation between the value of omitted trait in the original index and the relative efficiency of the index. Excluding OP as a source of information from the index caused the highest decreasing in the accuracy of the index (r_{TI}). On the other hand excluding HS caused the lowest decreasing in the accuracy of the index. In relation to the original index (I_1), the most effective index (r_{TI}=100.6) was I_{13} which include the 4 traits (SM, BW_M, EW_M and EN_{42wk}) and all available sources of information (OP, FS and HS).

The main objective of this study was to evaluate a single source of information selection index versus multisource of information of information multi-traits selection indices in Norfa layers.

Key words: body weight, egg weight, egg number, genetic parameter, selection index, Multi-Source.

INTRODUCTION

The animal phenotypic value is influences with several or many traits at a time. Many investigators tried to develop a selection method to improve many traits simultaneously. Smith (1936) applied Fisher's (1936) concept of discriminate function to develop a selection index for many traits at a time in plant lines. Hazel (1943) extended selection index procedure in animal populations. Abplanalp, (1973), El-Wardany (1999) and Enab et al. (2000) indicated that the method of selection index is superior to other selection methods.

The sources of information regarding to different traits under selection may vary widely. Information coming from animal's own-performance and/or its relatives. Lush (1947) combined information from relatives to predict an individual genotype. Osborn (1957), Henderson et al. (1959) and Henderson (1963) derived an index by using more than one traits and different sources of information. Cunningham (1969) and Van Vleck (1979) reported that selection index can be used when selection of individuals for several traits considered simultaneously, using records on the individuals themselves and / or on their relatives.

Ben Naser et al. (2010) used 4 traits to construct 10 reduced indices in two selected lines of Norfa strain during two generations. They found that omitting one or two traits from the general index caused decreasing in the relative efficiency of the index. Mohapatra et al. (1983) found multisource of information multi-traits selection indices were more efficient than selection index with single source of information. Enab et al. (2001) concluded that multisource of information index considering five traits were superior to multisource of information index involving only three or four traits. Moreover, Enab et al. (2012) found that an index based on three sources of information was the most efficient index, and it could be applied to improve egg production and immune response traits.

The main objective of this study was to evaluate a single source of information selection index versus multisource of information of information multi-traits selection indices in Norfa layers.

MATERIAL AND METHODS

This study was carried out at poultry experimental farm of the faculty of agriculture, Minufiya University, Shebin El-Kom, Egypt. Norfa strain was used and data were collected from one pedigreed generation. 149 cocks and 447 hens were used, each cock artificially inseminated three hens. 498 records of progeny were used. Mating of relatives was avoided. At 8^{th} wk of age all chicks were debeaked. Chicks were brooded and reared in batteries, at 14^{th} wk of age cockerels were moved to individual cages in cocks' house, while pullets were moved to individual cages in laying house at 16^{th} wk of age. Only birds with complete records were included in the index, which comprised the following traits:

1- Age at sexual maturity (SM); the age at first egg laid in days.
2- Body weight at 38 wk of age (BW_M) in grams.
3- Egg weight (EW_M); the average weight of 5 eggs during 35-38 wk of age in grams.
4- Egg number (EN_{42wk}); number of eggs up to 42 wk of age.

The Least Squares and Maximum Likelihood General Purpose Program-Mixed Model "LSMLMW" (Harvey, 1990) was used to estimate heritability and phenotypic and genetic correlations of studied traits. The weighting factors (b's) of the original selection index were obtained by solving the following equation given by Cunningham (1969):

$$\mathbf{P\,b = G\,v, \quad to\ give \quad b = P^{-1}\,(G\,v)}$$

Where: P = phenotypic variances and co-variances matrix, P^{-1} = inverse of phenotypic variances and co-variances matrix, b = weighting factors column vector, G = genetic variances and covariances matrix, and v = economic value column vector.

Furthermore, according to Cunningham (1969), the other different properties of the selection index were calculated as following:

Standard deviation of the index (σi) = $\sqrt{b'Pb}$,

Standard deviation of the aggregate genotype (σt) = $\sqrt{v'Gv}$

Correlation between the index and the aggregate genotype (R_{IH})= $\sigma i/\sigma t$

Value of each trait in the index = Vt

$$Vt = 100 - \sqrt{\frac{b'Pb - b_i / W_{ii}}{b'Pb}} \times 100$$

Selection Index Program (Wagenaar et al., 1995) was used to develop original index and all other multisource of information multi-traits indices. The original index (I_1) included the four traits under investigation and own performance as the only source of information. Selection indices I_4, I_7, I_{10} and I_{13} were constructed by using the four traits under investigation and different combinations of available sources of information, i.e. own-performance (OP), full-sibs (FS) and half-sibs (HS). Selection indices I_2, I_5, I_8, I_{11} and I_{14} were constructed by omitting SM and using three traits (BW_M, EW_M and EN_{42wk}) and different combinations of the three sources of information. Finally, Selection indices I_3, I_6, I_9, I_{12} and I_{15} were constructed by omitting BW_M and using three traits (SM, EW_M and EN_{42wk}) and different combinations of the three sources of information.

The average size of sire family (half-sibs) was 7, while the average size of dam family (full-sibs) was 3. The relationship (r_G) among HS and FS were assumed to be 0.25 and 0.50, respectively. Selection intensity equal 1.

The relative economic values of studied traits were calculated according to Lamont (1991), this method estimate economic values of traits by using heritability values of the studied traits. The economic values of studied traits were presented in table (1).

Table 1: Heritability estimates (diagonal), phenotypic correlations (above diagonal), genetic correlations (below diagonal), means, phenotypic standard deviations (σp), genetic standard deviations (σt) and economic values (v) used to construct selection indices.

Trait [a]		SM	BW_M	EW_M	EN_{42wk}	Means	σ_p	σt	*v*
SM	(days)	0.32	0.092	0.05	-0.38	161.0	24.27	7.769	1.78
BW_M	(gr)	0.27	0.93	0.47	-0.12	1260	232.74	216.45	0.61
EW_M	(gr)	-0.05	0.78	0.18	-0.102	44.5	4.90	0.883	3.16
EN_{42w}	(eggs)	-0.32	-0.34	-0.001	0.57	65.9	26.77	15.26	1.00

a: Traits; SM=age at sexual maturity, BW_M = body weight at 38 wk of age, EW_M = the average weight of 5 eggs during 35-38 wk of age, EN_{42wk} = egg number up to 42 wk. *v*= relative economic value.

RESULTS AND DISCUSSION

The genetic and phenotypic parameters were used to construct the selection indices are presented in table (1). Heritability values of SM, BW_M, EW_M and EN_{42wk} were 0.32, 0.93, 0.17 and 0.57, respectively. Generally, there were positive phenotypic and genetic correlations among SM, BW_M and EW_M, while these correlations between each of these three traits and EN_{42wk} were negative.

Table (2) shows value of each trait according to the source of information was used to construct multisource of information indices. The results show that the value of each trait was affected by the source of information. The results in table (2) Indicates that, whether the index was constructed by using 3- or 4- traits, each trait had the highest value when its information was gotten from the individuals themselves (OP). Comparing to OP as a source of information, for each trait HS had the lowest effect on the value of the trait, these results agree with those found by Mohapatra et al. (1983) and Enab and Bahie El-Deen (2001).

Moreover, according to the number of traits were used to construct the index, the value of each trait increased if the index was constructed with 3 traits instead of 4 traits if the index was constructed by using the same source(s) of the information, these results agree with those found by Mohapatra et al. (1983) and Enab and Bahie El-Deen (2001).

Table (3) presents Weighting factors (b) and correlation of the index with aggregate genotype (index accuracy, r_{TI}) of all multisources of information indices. From results in tables (2) and (3) the accuracy of the index (r_{TI}) depends on number of traits, sources of information and the value of each trait were used to construct the index. Results in table (3) show that, the most effective index was I_{13} which used all studied traits and all available sources of information. Omitting or excluded any trait or source of information caused decreasing in the accuracy of the index, these results agree with those found by Mohapatra et al. (1983), Enab and Bahie El-Deen (2001) and Enab et al. (2012).

The results in tables (2) and (3) indicate that, there is a negative correlation between the value of omitted trait in the original index and the relative efficiency of the index (r_{TI}) was constructed by omitting this trait. This result agrees with Ben Naser (2007) and Ben Naser et al. (2010). Results in table (2) shows that the values of SM and BW_M in the original index (I_1) were 29.78 and 10.57, respectively. Constructing the index by omitting SM and using the same source of information (I_2) caused decreasing in the accuracy of the index (r_{TI} = 70.27). On the other hand, the accuracy of the index (r_{TI}) due to constructing the index by omitting BW_M with the same source of information (I_3) was 89.49.

Results in table (3) show that, the relative efficiency of the index decreasing due to exclude any source of information. Excluded OP from the index caused the highest decreasing in the accuracy of the index (r_{TI}).

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On the other hand excluded HS caused the lowest decreasing in the accuracy of the index. These results agree with those found by Enab and Bahie El-Deen (2001) and Enab et al. (2012).

In relation to the original index (I_1) which used the 4 traits and OP as source of information, the most effective index (r_{TI} = 100.6) was I_{13} which used the 4 traits and all available sources of information (OP, FS and HS) index these results agree with those found by Mohapatra et al. (1983), Enab and Bahie El-Deen (2001) and Enab et al. (2012). Moreover, the highest decreasing in the accuracy of index was caused due to omit the trait had the highest value (SM) and the most important source of information (OP). I_{11} was the lowest effective index (r_{TI} = 60.82) comparing to I_1 (Table, 3). This index (I_{11}) was constructed by three traits, BW_M, EW_M, EN_{42wk} and only two sources of information, FS and HS.

Table (4) shows expected genetic gains of studied traits by using the different multisource of information multi-traits indices. The results in table (4) show that the expected genetic gains for SM, BW_M, EW_M and EN_{42wk} due to apply the most accurate index (I_{13}) were 10.75, 89.21, 0.727 and 11.97, respectively. On the other side, the expected genetic gains for SM, BW_M, EW_M and EN_{42wk} due to apply the lowest accurate index (I_{11}) were 5.01, 77.59, 0.797 and 7.30, respectively.

Table 4: Expected genetic gains for studied traits using the selection indices.

Traits	I_1	I_2	I_3	I_4	I_5	I_6	I_7	I_8	I_9	I_{10}	I_{11}	I_{12}	I_{13}	I_{14}	I_{15}
SM (days)	10.62	5.38	9.79	10.74	6.29	10.17	10.64	5.53	9.85	7.59	5.01	7.23	10.75	6.33	10.19
BW_M (grams)	88.51	122.6	-01.84	89.21	118.1	21.6	88.66	121.8	1.766	67.70	77.59	31.5	89.21	117.9	22.66
EW_M (grams)	0.732	1.194	0.149	0.728	1.153	0.301	0.732	1.192	0.172	0.536	0.797	0.313	0.727	1.148	0.308
EN_{42wk}(eggs)	11.99	6.278	16.75	11.97	7.96	15.46	11.99	6.63	16.54	7.991	7.30	9.63	11.97	7.98	15.40

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تحسين كفأة الادلة الانتخابية باستخدام مصادر متعددة للمعلومات في الدجاج البياض

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جُمعت البيانات من جيل واحد منسب من سلالة نورفا البياضة. استخدم ١٤٩ ديك و ٤٧٧ دجاجة ، كل ديك لقح اصطناعيا ثلاثة دجاجات. استخدم ٤٩٨ سجلا كاملا من النسل الناتج. استخدمت اربع صفات وهي العمر عند النضج الجنسي (SM) ووزن الجسم الناضج (BW_M) ووزن البيض الناضج (EW_M) وعدد البيض حتى عمر ٤٢ اسبوع (EN_{42wk})، بالاضافة الي ثلاثة مصادر مختلفة للبيانات وهي اداء الفرد نفسه (OP) واداء الاخوة الاشقاء (FS) واداء الاخوة انصاف الاشقاء (HS).و قد استخدم برنامج هارفى ١٩٩١ لتحليل البيانات بطريقة معظمة الناتج.

قدرت قيم المكافيء الوراثى لصفات العمر عند النضج الجنسي ووزن الجسم الناضج ووزن البيض الناضج وعدد البيض حتي عمر ٤٢ اسبوع كانت ٠,٣٢ و٠,٩٣ و٠,١٧ و٠,٥٧، على التوالي . وبشكل عام، كان هناك ارتباطات مظهرية ووراثية موجبة بين صفات العمر عند النضج الجنسي ووزن الجسم الناضج ووزن البيض الناضج، في حين كانت هذه الارتباطات سالبة بين اي من هذه الصفات وصفة عدد البيض حتى عمر ٤٢ اسبوع.

بينت النتائج ان قيمة الصفة في الدليل تاثرت بكل من مصدر البيانات وعدد الصفات المستخدمة لتكوين الدليل. باستخدام نفس مصدر المعلومات، قيمة نفس الصفة في الدليل المكون من ثلاثة صفات اعلى منها في الدليل المكون كانت اربع صفات. دقة الدليل (r_{TI}) متعدد المصادر والصفات اعتمدت على عدد الصفات ومصادر المعلومات وقيمة الصفة في الدليل الاصلي المستخدمة في تكوين الدليل. بينت النتائج وجود علاقة سالبة بين قيمة الصفة في الدليل الاصلي المحذوفة من الدليل متعدد المصادر والصفات والكفاءة النسبية للدليل. حذف OP كمصدر للمعلومات من الدليل سبب في اعلى انخفاض في الكفاءة النسبية للدليل. من ناحية اخرى، حذف HS كمصدر للمعلومات سبب في اقل انخفاض في الكفاءة النسبية للدليل. مقارنة بالدليل الاصلي I_1 يعد الدليل الاعلي كفاءة *(r_{TI}=100.6)* هو الدليل I_{13}، وهو مكون باستخدام الاربع صفات وجميع مصادر المعلومات المختلفة المتاحة.

الهدف الرئيسى للبحث هو تقييم مصدر المعلومات للحيوان نفسه و المصادر المتعدده للمعلومات فى دجاج النورفا.

قام بتحكيم البحث

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Table 2: Value of each trait according to source of information of all multi-source of information multi-trait indices

Sources of information	Index	I_1	I_2	I_3	I_4	I_5	I_6	I_7	I_8	I_9	I_{10}	I_{11}	I_{12}	I_{13}	I_{14}	I_{15}
Own performance	SM	29.78	-----	42.82	16.68	-----	22.1	26.05	-----	36.93	-----	-----	-----	16.6	-----	21.86
	BW_M	10.57	27.18	-----	4.463	9.642	-----	8.682	21.36	-----	-----	-----	-----	4.439	9.509	-----
	EW_M	0.021	0.085	2.906	0.004	2.292	1.82	0.017	0.11	2.717	-----	-----	-----	0.004	0.174	1.779
	EN_{42WK}	34.05	33.16	41.23	16.38	0.178	20.05	28.34	25.72	34.28	-----	-----	-----	16.32	9.478	19.94
Full-sibs	SM	-----	-----	-----	0.195	-----	1.275	-----	-----	-----	11.91	-----	25.01	0.169	-----	1.08
	BW_M	-----	-----	-----	0.188	0.736	-----	-----	-----	-----	5.630	19.22	-----	0.157	1.900	-----
	EW_M	-----	-----	-----	0.002	9.702	1.753	-----	-----	-----	0.008	1.168	5.204	0.002	0.706	1.559
	EN_{42WK}	-----	-----	-----	0.057	8.664	0.259	-----	-----	-----	15.24	32.75	11.48	0.047	7.065	0.209
Half-sibs	SM	-----	-----	-----	-----	-----	-----	0.044	-----	0.188	0.128	-----	0.348	0.003	-----	0.042
	BW_M	-----	-----	-----	-----	-----	-----	0.052	0.411	-----	0.054	0.296	-----	0.001	0.065	-----
	EW_M	-----	-----	-----	-----	-----	-----	0.001	0.050	0.263	0.000	0.102	0.224	0.000	0.065	0.078
	EN_{42WK}	-----	-----	-----	-----	-----	-----	0.017	1.841	0.027	0.103	0.599	0.026	0.000	0.171	0.010

Table 3. Weighting factors (b), correlation of the index with aggregate genotype (r_{TI}) and relative efficiency of all multi-source of information multi-trait indices.

Sources of information	Index	I_1	I_2	I_3	I_4	I_5	I_6	I_7	I_8	I_9	I_{10}	I_{11}	I_{12}	I_{13}	I_{14}	I_{15}
		b-value	b-value	b-value	b-value	b-value	b-value	b-value	b-value	b-value	b-value	b-value	b-value	b-value	b-value	b-value
Own Performance	SM	1.227	-----	1.263	1.148	-----	1.199	1.211	-----	0.875	-----	-----	-----	1.147	-----	1.197
	BW_M	0.848	0.911	-----	0.727	0.814	-----	0.823	0.892	-----	-----	-----	-----	0.726	0.811	-----
	EW_M	-0.187	-0.260	1.692	-0.088	-0.426	1.429	-0.168	-0.302	1.653	-----	-----	-----	-0.08	-0.423	1.417
	EN_{42WK}	1.180	0.759	1.133	1.121	0.553	1.129	1.167	0.718	1.131	-----	-----	-----	1.121	0.549	1.130
Full-sibs	SM	-----	-----	-----	0.237	-----	0.534	-----	-----	-----	1.207	-----	1.494	0.229	-----	0.513
	BW_M	-----	-----	-----	0.2432	0.627	-----	-----	-----	-----	0.844	1.235	-----	0.233	0.605	-----
	EW_M	-----	-----	-----	-0.185	-2.30	3.279	-----	-----	-----	-0.234	-2.259	3.96	-0.17	-2.274	3.156
	EN_{42WK}	-----	-----	-----	0.108	0.910	-0.200	-----	-----	-----	1.076	1.245	0.826	0.103	0.872	-0.192
Half-sibs	SM	-----	-----	-----	-----	-----	-----	0.090	-----	0.166	0.113	-----	0.173	0.026	-----	0.085
	BW_M	-----	-----	-----	-----	-----	-----	0.104	0.208	-----	0.079	0.159	-----	0.018	0.095	-----
	EW_M	-----	-----	-----	-----	-----	-----	-0.098	-0.395	0.971	-0.026	-0.479	0.666	-0.01	-0.493	0.558
	EN_{42WK}	-----	-----	-----	-----	-----	-----	0.050	0.346	-0.055	0.090	0.177	0.042	0.006	0.122	-0.038
r_{TI}		0.942	0.662	0.843	0.948	0.732	0.875	0.943	0.675	0.848	0.667	0.573	0.620	0.948	0.734	0.876
Relative efficiency (%)		100	70.27	89.49	100.6	77.70	92.88	100.1	71.65	90.02	70.80	60.82	65.81	100.6	77.91	92.99