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CONSTRUCTION AND EVALUATION OF SELECTION INDICES FOR IMPROVEMENT OF BODY WEIGHTS IN BROWN STRAIN OF JAPANESE QUAIL

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ABSTRACT

A total of 56 selection indices were computed in Brown strain of Japanese quail based on the body weights at 1, 2, 3 and 4 weeks of age with its dams AFE, dams EP16, dams EW16 and dams EM16. The aggregate genetic gain (δH) expected from the selection indices constructed with dams performance, of body weights at different ages ranged from 0.28 to 90.22, 0.71 to 99.58, 0.69 to 90.27 and 1.69 to 65.99 respectively. The egg mass is repeated in all the indices combinations. The heritability of the indices under the study was observed to be ranged from 0.03 to 0.89. The ideal indices identified were I_{52}, expected to reduce the body weight by 0.11 g, but increase the egg production by 2.50 eggs and eggmass by1.83 g.

KEYWORDS : **Selection Indices, Body weight, Egg mass, Japanese quail**

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INTRODUCTION

Selection indices are of interest to breeders to select for more than a single trait. To maximize genetic progress simultaneously in all the traits, it has been suggested that a desirable proposition would be to combine them into an index when the information is available on all the traits. Index selection is the most efficient method of selection for improving genetically antagonistic traits. Hazel and Lush (1942) compared the relative efficiency of different selection methods and indicated that multi-trait index selection is most effective than others when several traits are involved The economic value in quails depends on various traits like age at sexual maturity, body weight, number of eggs produced etc., some of which may be genetically incomparable to each another (egg number and egg weight).. Effective selection on egg production in quails resulted to reduction in egg weight and body size. Whereas an index of total performance involving many traits may not cause much changes in body weight and egg size. The ultimate goal of a poultry breeder is to improve the overall genetic economic worth of the bird through multitrait selection by considering maximum number of traits at a time. The present investigation was therefore undertaken to compute and evaluate various selection indices at different stages by incorporating different traits in various combinations to get genetic improvement in Japanese quail under long-term selection for high 4-weeks body weight.

MATERIALS ND METHODS

The data were recorded on 204 Japanese quails maintained at poultry experimental station, Hyderabad, A.P and undergone 10 generations of long term-selection for high 4-week body weight. These birds were reared under the uniform conditions of management throughout the period of the study. The traits studied were the body weights from 1 to 4 weeks age, age at sexual maturity (ASM), egg production (EP16), egg weight (EW16) and egg mass at 16 weeks (EM16) of age, comprising of egg number multiplied by average egg weight at 16 weeks of age. The quails were produced in two generations and multiple hatches, so the data were corrected for significant effect of generation and hatch by least squares techniques as per Harvey (1975), by using the hatch corrected data the variances and covariances of the traits were computed according to Becker (1985) by pair-mating analysis. Equal relative economic weight (1) was assigned to all the traits because several authors have concluded that the efficiency of index was not very sensitive to their economic weights (Santhosh et al ., 2007). Selection indices were constructed based on the information on individual's own body weight from 1 to 4 weeks of age, along with its dams AFE, dams EP16, dams EW16. The indices were constructed as per Becker (1985), Basu (1985) and Singh and Kumar (1994) in the form of $I = b_1X_1 + b_2X_2 + b_3X_{3+}\, b_4X_4 + b_5X_5 + b_6X_6$ Where, b_1, $b_{2,}$ $b_{3,}$ b_4, $b_{5,}$ and b_6 are derived optimum weighing factors for the traits X_1, X_2, X_3, X_4, X_5 and X_6 respectively. The b_i values were obtained by solving a set of simultaneous equations represented in matrix notation as [P] [b] = [G] [a] Where,

[P] = Phenotypic variance and covariance matrix
[b] = a row vector of index coefficients to be computed
[G] = Genotypic variance and covariance matrix
[a] = a row vector of relative economic values
[b] = $P^{-1}Ga$

Relationship between the index and aggregate genotype

(R_{IH}) was estimated as $R_{IH} = \sigma_I / \sigma_H$ Where,

Variance of index (σ^2_I) = b'Pb ; $\sigma_I = \sqrt{b'Pb}$
Variance of aggregate genotype (σ^2_H) = a'Ga; $\sigma_H = \sqrt{a'Ga}$

The equal (1) relative net economic weights [a] were considered for the traits included in the construction of selection index (Raj Narayan *at al.*, 2000; Lata Sharma *at al.*, 2003). The change produced in each individual trait as a result of selection on the basis of index was also computed. Heritability of the index (h_I^2) was estimated as $h_i^2 = (b'Gb) / (b'Pb)$

Expected response to index selection

Response in aggregate genotype (δH) was calculated as $\delta H = i\sigma_I = a'Gb\ (i/\sigma_I)$
Response in the individual trait (δg_i) was computed as $\delta g_i = g_i b\ (i/\sigma_I)$

Genetic cost of restriction

The percent reduction in rate of genetic gain in aggregate genotype, if a particular trait is dropped from the index is called genetic cost of restriction can be estimated by the following formula (Singh and Kumar, 1994) Per cent reduction in genetic gain = $100 \{1 - \sqrt{[(b'Pb - b_i^2/w_{ii}) / b'Pb]}\}$ Where,

b_i = Weighting coefficient for the i^{th} trait
w_{ii} = Corresponding diagonal element of P^{-1}
b' Pb = Variance of the index.

The relative efficacy of an index was computed in percentage by dividing the aggregate genetic gain (δH) of an index with the aggregate genotype of the standard index which included all the 6 traits.

RESULTS AND DISCUSSION

A total of 56 number of selection indices could be successfully constructed based on the genetic parameters computed for various traits in the present study. The b_i's, R_{IH}, G_i, δH, relative efficacy and genetic cost of restriction of different indices constructed based on its dams source of information i.e., with dams performance are detailed in Table 1. The usefulness of an index is based on its correlation with aggregate genotype (R_{IH}), the expected gain in aggregate breeding value (δH) and the number of traits included in the index. The indices I_{14}, I_{28}, I_{42} and I_{56} were observed with highest aggregate genetic gain of 90.22, 99.58, 90.27 and 65.99 (Table 1). Among all indices the highest genetic gain was observed in I_{56} (65.99) including all the 5 traits. The highest RIH of 8.04 was observed in index I_{49} constructed with 3 traits. The accuracy of the index expressed in terms of R_{IH} value based on the combination of body weight at different ages with its dams AFE, dams EP16, dams EW16 and dams EM16. The highest R_{IH} (1.53) was observed in body weight at 1st week with 2 traits (I_4) and body weight at 2nd week (0.98) (I_{28}) and body weight at 3rd week (1.43) (I_{42}) with all the 5 traits and at the selection age of 4 weeks body weight had shown highest R_{IH} (8.04) (I_{49}) with 4 traits combination. These values are in good confirmation with the R_{IH} values for the selection indices constructed based on 4th week body weight, ASM, EN18 and EW18 weeks in Japanese quails by Raj Narayan *et al.*, 2000. In all these indices apart from the body weight, the egg mass which takes care of the egg production and egg weight was included, thus showing its importance. In general the heritability estimates of various indices constructed under the study were observed to be low to high at all the ages. High heritability of the various indices constructed in the present study reflected that the selection on the basis of these indices would improve the aggregate genotype without considering other sources of information for the traits of the index. (Lata Sharma *et al*.,2003 and Malik *et al*.,2005). Perusal of the contents of table 1 based on dams performance revealed that the I_{14}, I_{28}, I_{42} and I_{56} indices reduce the AFE, increase the egg mass, which takes care of the egg production and egg weight and keep the body weight constant, reduce or marginally increase which is a favorable trend. The egg mass is repeated in all the indices mentioned above. The superior index identified i.e., I_{52} is expected to reduce the body weight by 0.11 g, increase the egg production by 2.50 eggs and egg mass by 1.83 g, while the index I_{56} will reduce the body weight by 1.42 g, age at first egg by 5.28 days and increase the egg production by 3.59 eggs, egg weight by 0.84 g and egg mass by 21.55 g respectively. In the indices (I_{52}) the genetic cost of restriction was high for egg mass Rs.18.44 and in ($I_{56)}$ Rs.-49.06 respectively. This study recommends based on δH and R_{IH} values, that the index I_{14} constructed with dams performance, including all 5 traits was found to be most efficient and the possibility of simultaneous improvement in negatively correlated traits in Japanese quails.

Table 1

Partial regression coefficients (bi's), heritability of the indices (hi^2), Correlation of the index with the aggregate genotype (R_{IH}), Genetic improvement in individual traits (Gi's),Response in aggregate genotype (∆H) and % reduction in the genetic gain in aggregate genotype (Genetic cost of restriction) of selection indices with body weights at different ages

a) Body weight at 1 week

No. of traits	Index	b_i					h_i^2	R_{IH}	G_i					δ H	Relative efficacy	Genetic cost of restriction				
		Dams BW (X_1)	Dams AFE (X_2)	Dams EP16 (X_3)	Dams EW16 (X4)	Dams EM16 (X_5)			BW (X_1)	AFE (X_2)	EP16 (X_3)	EW16 (X4)	EM16 (X5)			BW (X_1)	AFE (X_2)	EP16 (X_3)	EW16 (X4)	EM16 (X_5)
2	I_1	0.22	0.86				0.82	0.86	0.07	0.90				0.96	0.99	2.38	75.61			
	I_2	0.07		0.86			0.89	0.92	-0.03		1.74			1.69	1.75	0.09		99.61		
	I_3	0.12			0.92		0.80	0.59	0.04			0.24		0.28	0.29	8.60			64.02	
	I_4	0.20				2.16	0.89	1.53	0.00				23.90	38.74	40.28	0.00				95.37
3	I_5	0.18	0.84	0.97			0.88	1.04	-0.05	0.10	1.53			1.79	1.86	0.41	12.19	85.77		
	I_6	0.12	0.84		0.92		0.84	0.85	0.04	0.88		0.11		1.01	1.05	0.69	52.23		3.32	
	I_7	0.21	0.85			0.57	0.89	0.08	-0.04	-0.22			23.85	2.16	2.24	0.00	0.17			76.81
	I_8	-0.03			0.91	2.03	0.89	0.53	-0.05			0.04	23.90	13.64	14.18	7.18			0.00	83.59
4	I_9	0.07		0.83	0.89		0.88	0.88	-0.04		1.72	-0.00		1.60	1.66	0.09		97.89	1.28	
	I_{10}	0.20		0.90		0.20	0.88	0.26	-0.04		1.67		23.76	7.14	7.42	0.03		0.40		3.92
5	I_{11}	-0.06	0.78	0.87	0.91		0.86	0.86	-0.23	0.38	3.76	0.05		4.00	4.37	0.56	12.51	76.02	1.24	
	I_{12}	0.09	0.80	0.93		0.45	0.89	0.51	-0.19	-0.61	4.23		61.68	31.02	36.66	0.01	0.17	0.11		5.26
	I_{13}	0.00	0.82		0.91	2.17	0.89	0.57	-0.21	-0.68		0.12	61.86	30.24	39.02	0.00	0.01		0.00	64.17
6	I_{14}	-0.45	0.20	1.45	0.73	2.41	2.60	1.43	-0.37	-1.23	7.17	0.19	105.69	90.22	100.00	0.00	0.00	0.00	0.00	-0.10

b) Body weight at 2 weeks

2	I_{15}	0.07	0.85				0.82	0.81	0.03	1.98				2.03	2.83	1.39	84.68			
	I_{16}	0.08		0.89			0.88	0.90	0.03		3.78			3.82	3.82	0.50		89.96		
	I_{17}	-0.09			0.91		0.65	0.52	-0.31			0.47		0.71	0.71	16.36			41.44	
	I_{18}	0.08				0.58	0.89	0.04	-0.04				52.02	35.40	35.40	0.00				99.40
3	I_{19}	0.00	0.83	0.91			0.88	0.96	-0.20	0.28	3.29			3.66	3.66	0.00	13.52	82.50		
	I_{20}	-0.09	0.82		0.88		0.82	0.83	-0.12	1.89		0.25		2.20	2.20	1.58	50.20		3.33	
	I_{21}	0.07	0.84			0.87	0.89	0.13	-0.04	-0.53			51.98	7.31	7.31	0.00	0.07			74.84
	I_{22}	-0.06			0.92	2.44	0.89	0.64	-0.18			0.09	52.02	35.64	35.64	0.00			0.00	82.60
4	I_{23}	-0.10		0.86	0.88		0.88	0.81	-0.06		3.72	0.01		3.65	3.65	0.70		87.18	1.16	
	I_{24}	0.14		0.92		0.55	0.89	0.56	-0.03		3.58		51.93	33.43	33.43	0.01		0.09		5.32
5	I_{25}	-0.06	0.68	0.87	0.94		0.86	0.66	-0.21	0.24	2.75	0.09		4.21	4.21	0.50	10.21	77.45	1.44	
	I_{26}	0.09	0.71	0.93		0.41	0.89	0.31	-0.10	-0.41	3.22		60.22	35.25	35.25	0.05	0.19	0.13		5.26
	I_{27}	0.08	0.80		0.92	2.01	0.89	0.47	-0.19	-0.55		0.23	67.22	37.52	37.52	0.01	0.04		0.11	64.01
6	I_{28}	-0.45	0.09	1.45	0.70	2.18	2.60	0.98	-0.44	-1.20	6.11	0.16	99.58	99.58	100.00	0.03	0.08	0.01	0.00	-0.14

c) Body weight at 3 weeks

No. of traits	Index	b_i					h_i^2	R_{IH}	G_i					δ H	Relative efficacy	Genetic cost of restriction				
		Dams BW (X_1)	Dams AFE (X_2)	Dams EP16 (X_3)	Dams EW16 (X_4)	Dams EM16 (X_5)			BW (X_1)	AFE (X_2)	EP16 (X_3)	EW16 (X_4)	EM16 (X_5)			BW (X_1)	AFE (X_2)	EP16 (X_3)	EW16 (X_4)	EM16 (X_5)
2	I_{29}	0.12	0.84				0.74	0.70	0.34	2.21				2.57	2.82	6.52	61.30			
	I_{30}	0.05		0.90			0.88	0.90	-0.15		4.51			4.57	5.02	0.36		95.97		
	I_{31}	0.01			0.91		0.89	0.30	0.04			0.67		0.69	0.75	1.23			85.21	
	I_{32}	0.08				1.01	0.89	0.71	-0.20				61.87	46.96	51.60	0.00				96.18
3	I_{33}	0.06	0.82	0.89			0.86	0.88	-0.08	0.33	3.87			4.30	4.73	0.70	13.55	81.36		
	I_{34}	0.02	0.81		0.91		0.84	0.69	0.13	2.29		0.30		2.55	2.80	0.19	52.56		3.50	
	I_{35}	0.10	0.83			0.98	0.89	0.14	-0.20	-0.64			61.83	9.64	10.60	0.00	0.05			74.38
	I_{36}	0.04			0.91	2.23	0.89	0.59	-0.21			0.11	61.87	38.72	42.59	0.00			0.00	83.20
4	I_{37}	-0.07		0.87	0.89		0.87	0.88	-0.29		4.43	-0.01		4.41	4.85	0.72		83.03	1.12	
	I_{38}	0.07		0.93		0.61	0.89	0.67	-0.14		2.89		42.13	31.92	35.11	0.00		0.06		5.53
5	I_{39}	-0.06	0.78	0.87	0.91		0.86	0.86	-0.23	0.38	3.76	0.05		3.00	3.3	0.56	12.51	76.02	1.24	
	I_{40}	0.09	0.80	0.93		0.45	0.89	0.51	-0.19	-0.61	4.23		61.68	35.05	38.53	0.01	0.17	0.11		5.26
	I_{41}	0.00	0.82		0.91	2.17	0.89	0.57	-0.21	-0.68		0.12	6.86	22.45	24.69	0.00	0.01		0.00	64.01
6	I_{42}	-0.45	0.20	1.45	0.73	2.41	2.60	1.43	-0.37	-1.23	7.17	0.19	105.69	90.27	100.00	0.00	0.00	0.00	0.00	-0.10

d) Body weight at 4 weeks

2	I_{43}	0.08	0.84				0.78	0.73	0.13	1.56				1.69	2.55	70.58	3.77			
	I_{44}	0.01		0.90			0.89	0.92	-0.18		3.08			3.11	4.69	0.01		96.72		
	I_{45}	0.37			0.92		0.11	1.39	0.38			0.11		2.20	3.32	75.66			2.27	
	I_{46}	0.06				1.11	0.89	0.78	0.07				42.18	35.25	53.22	0.002				98.88
3	I_{47}	-0.03	0.92	1.11			0.96	0.89	0.21	0.15	2.87			2.89	4.36	0.10	10.95	91.04		
	I_{48}	0.39	0.65		0.90		0.26	1.12	0.35	0.74		0.07		2.66	4.01	47.77	11.61		1.50	
	I_{49}	0.06	0.84			-6.68	0.03	8.04	0.11	0.43			-1.81	51.75	78.14	0.00	0.00			74.29
	I_{50}	0.40			0.91	13.90	0.03	5.58	-0.11			0.06	1.76	53.70	81.08	0.00			0.01	85.68
4	I_{51}	0.33		0.98	0.91		0.69	1.11	0.02		2.66	0.09		3.88	5.85	13.21		51.20	0.73	
	I_{52}	-0.02		31.07		0.91	0.03	2.75	-0.11		2.50		1.83	52.61	79.44	0.00		0.00		18.44
5	I_{53}	0.25	0.79	0.86	0.91		0.70	0.96	0.03	0.25	2.26	0.04		3.14	4.74	11.41	10.43	52.95	1.04	
	I_{54}	-0.03	0.92	1.01		29.03	0.03	2.93	-0.11	-0.42	2.50		1.83	52.42	79.15	0.00	0.00	0.00		18.40
	I_{55}	0.40	0.82		0.91	13.54	0.03	7.43	-0.11	-0.42		0.06	1.73	52.32	79.00	0.00	0.00		0.00	68.02
6	I_{56}	0.24	0.75	0.90	0.90	14.93	0.87	6.64	-1.42	-5.28	3.59	0.84	21.55	65.99	100.00	0.00	0.00	0.00	0.00	-49.06

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