Desired Gain Selection Indices for Pre-Weaning Body Weights in Zaraibi Male Kids in Egypt

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Abstract: The aim of the current study was to estimate the genetic parameters and evaluate various desired-gain selection indices for pre-weaning live body weights of Zaraibi male kids in Egypt. From 2005 to 2012, data of 763 does mated with 75 bucks of Zaraibi goats raised at El-Serw Experimental Station belonging to the Animal Production Research Institute were collected. Data were analyzed with REML using animal model to determine genetic parameters and using SAS to construct different desired-gain selection indices. Direct heritability (h^2_d) for BW, W30, W60 and WW were 0.25, 0.22, 0.31 and 0.35, respectively. Corresponding maternal heritability (h^2_m) for aforementioned traits were 0.145, 0.141, 0.099 and 0.073, respectively. While total heritability (h^2_t) above traits were 0.25, 0.38, 0.48, 0.49 and 0.34, respectively. The direct-maternal genetic correlations (r_{dm}) were positive for W30 (0.35) and W60 (0.47), while negative for BW (-0.23) and WW (-0.19). Genetic correlations (r_{d1d2}) among studies traits ranged from 0.80 to 0.95, while phenotypic correlations (r_{p1p2}) among all traits ranged from 0.69 to 0.84. Comprisable between selection indices was the highest number of generations required (T) to attain the pre-estimated goals was 5.6143 in I_4. In contrast, the lowest number of generations required (T) was 2.0220 in I_{14}. Therefore, I_{14} was considered the best selection index lead to save time and efforts for genetic improvement of studied traits in Zaraibi male kids in Egypt.

Keywords: Zaraibi goat, live body weights, desired-gain and selection indices

INTRODUCTION

Goats in Egypt are nearly 5 million heads (FAO, 2017). Zaraibi goats, also called Egyptian Nubian goats, are the most pronounced dairy goat among the local goat breeds in Egypt. Gall (1981), Devendra and Mc Leroy (1982) stated that this breed is a progenitor for the standard international Anglo-Nubian. The population size of Zaraibi breed is small, which estimated as 2% of Egypt's total goat population, the breed has a good reputation in the Near East and Egypt due to its high milk production and prolificacy (Galal *et al*., 2005).

It is very important to study the Zaraibi goats under variation environmental conditions and in a large size for development breeding strategies (Marai *et al*., 2002). Lopes *et al*. (2013) reported that the improvement in traits was when used the selection indices in dairy goats and added that the use of indices relies on the definition of selection and on the measurability of the selection criteria. El-Awady (2009) reported that the amount of weight given to each trait in the selection index depends on genetic and phenotypic variance and co-variances among traits.

In Kutci goats, Yadav *et al*. (2005) indicated that the highest genetic gain in body weight at 12 months will be achieved using selection index included body weight at 3 and 9 months. The relative economic value for all traits in aggregate genotype is essential of selection indices. Assessment of economic value is a stressful process and it is related to change the price trend in the market. A selection index for achieving prearranged desired genetic gain, where describe aggregate genotype and determine of relative economic values of all traits are not required (Pešek and Baker, 1969). Furthermore, In Zaraibi goat, Desoky (2012) indicated that the application of selection indices strategy will result in an expected genetic gain for weaning weight about 0.592 kg per generation. Therefore, the aim of this study was to establish varied desired-gain selection indices to improve pre-weaning body weight in Egypt's Zaraibi male kids.

MATERIALS AND METHODS

Data and management:

Data used were collected from the Zaraibi flock raised in El-Serw Experimental Station over a continuous span of 8 years (2005-2012), belonging to the Institute for Animal Production Research (APRI), Ministry of Agriculture. The data consisted of 1419, 1346, 1298 and 1283 records for body weights at birth (BW), body weight at 30 days (W30), body weight at 60 days (W60) and weaning weight (WW), respectively. The data relevant to 763 does presented to 75 buck. Mating system on the farm, where the does are divided into two groups per year. The first group was mating in June and another group was mating in October. Does don't mate with buck before 18 month of age or 30kg of live body weight. The kids after birth were ear-tagged, and kept with their dams over suckling period until weaning at 3 months of age. The kids were weighted within 24 hours of birth and then monthly until 18 months of age. The kids after weaning on concentrate mixture and green Egyptian clover (*Trifolium alexandrinum*) in Winter, while at Summer were fed on concentrate mixture and crop stubbles or rice straw or green fodder (if available). The animals were housed in semi-open barns and fed diets to meet the nutritional requirements of APRI depending on NRC, 2007.

The food was provided to animals twice daily before grazing in the morning and after grazing in the evening. The animals were allowed to drink water three times daily and minerals blocks were available at all

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times. Two weeks before the beginning of mating season supplementary concentrate was offered at a rate of about 0.25kg/doe/day, also the supplementary feed was given during the last 2-4 weeks of pregnancy and through the first week of lactation, if available (El-Awady *et al*., 2019).

Statistical analysis:

Variance and covariance

Variance and covariance components were obtained with Derivative-free restricted maximum likelihood (REML) procedure using the MTDFREML program of (Boldman *et al*., 1995) according to the following model:

$$Y = Xb + Z_d d + Z_m m + Z_c c + e$$

Where:

Y = a vector of observations.

b = a vector of fixed effects (Birth type, month and year of kidding) with an incidence matrix.

d, m, c, e = vectors of direct additive genetic effects, maternal genetic effects, permanent environmental effect of dam and the residual, respectively.

X, Z_d, Z_m, Z_c = incidence matrices relating observations to b, d, m and c, respectively.

Direct and maternal heritabilites were calculated according to the following formulas: $h^2_d = \sigma^2_d/\sigma^2_p$; $h^2_m=\sigma^2_m/\sigma^2_p$, while repeatability (r) and total heritability (h^2_t) were calculated according to (Willham, 1972):

$r = [(\sigma^2_d + 0.5\sigma^2_m + 1.5\sigma_{dm} + \sigma^2_{pe})/ \sigma^2_p]$

$h^2_t = [(\sigma^2_d + 0.5\sigma^2_m + 1.5\sigma_{dm})/ \sigma^2_p]$

Where: $\sigma^2_p = \sigma^2_d + \sigma^2_m + \sigma_{dm} + \sigma^2_{pe} + \sigma^2_e$.

Selection indices:

Different desired-gain selection indices were estimated using SAS program (SAS, 2012). Desired-gain selection indices were constructed according to Yamada *et al*. (1975). Selection was constructed based on the index: $I = b'X$.

Where: X=phenotypic records and b = selection index coefficient for traits was calculated as: $b = G'Q$.

Where: G= genetic variance-covariance matrix for traits in the index, and Q= desired gain matrix for the traits in the index.

The indices were evaluated in terms of the number of generations required to achieve the pre-defined/ desired gains and correlated responses. Furthermore, desired genetic changes for various traits (Q) were calculated as the difference between desired and observed means. Intended performances/improvement and hence desired gains/genetic changes for studied traits (Lwelamira and Kifaro, 2010). Values of partial regression coefficient and phenotypic co-variance matrix were utilized to calculate values of index variance as: $\sigma_I^2 = \bar{b}Pb$. Furthermore, we used σ_I to calculate number of generations required (T) to attain the goal as: $T = \frac{\sigma_I}{i_I} = \frac{(\bar{b}Pb)^{\frac{1}{2}}}{i_I}$

Where: $\bar{b}$ is the transpose of (b) vector of partial regression coefficients.

P = phenotypic variance-covariance matrix.

The expected genetic change (ΔG) for each trait, after one generation of selection on the index (i = 1) was obtained by solving either of the following equations (Van der Werf and Goddard, 2003):

$$\Delta G_i = \frac{ib'G_i}{\sigma_i}$$

Where: i = Selection intensity; σ_i = Standard deviation of the index; G_i = the i[th] column of the G matrix.

RESULTS AND DISCUSSION

The current unadjusted means of BW, W30, W60 and WW were, 1.733, 5.309, 8.229 and 11.087 kg, respectively (Table 1). The present results were in general close up with those reported by Aboul-Naga *et al*. (2012) and El-Moghazy *et al*. (2015) for the same flock on another set of data and lower than those reflected by Tesema *et al*. (2017) in Central Highland x Boer crossbred goats and Mohammed *et al*. (2018) in Saudi Ardi goat breed and Damascus goat breed and their crosses for different live body weights from birth until weaning of kids. Those differences may be due to the variations in gene combinations related to growth rates between breeds. Estimate of the coefficient of variation for BW was lower than other traits of live body weights which these results agree with found by El-Awady (2011) in Barki Sheep raised in Egypt, which showed that the low effect of environment on birth weight.

Table (1): Unadjusted mean, Standard error (SE) and Coefficient of variation (CV %) for studied traits

Trait Kg	Records	Mean	SE	CV%
BW	1419	1.733	0.007	15.246
W30	1346	5.309	0.025	17.264
W60	1298	8.229	0.043	18.870
WW	1283	11.087	0.058	18.896

BW= birth weight, W30= weight at 30-day W60= body weight at 60 days and WW = weaning weight.

Genetic parameters

Direct heritability (h^2_d) for BW, W30, W60 and WW were moderate 0.25, 0.22, 0.31 and 0.35, respectively (Table 2). The current estimates of (h^2_d) were higher than those reviewed by Sadegh *et al*. (2013) in Iranian Adani goats for BW and WW were 0.23 and 0.18, respectively, Mohammed *et al*. (2018) in Saudi Ardi goat x Damascus goat for BW was 0.15 and Al-Saef (2013) in Damascus goats were 0.19 and 0.12, respectively.

Table (2): Estimates of genetic parameters for investigated body weights in Zaraibi male kids

Trait	σ^2_d	σ^2_m	σ_{dm}	σ^2_{pe}	σ^2_e	σ^2_p	h^2_d	h^2_m	r_{dm}	r	h^2_t
BW	0.017	0.010	-0.003	0.007	0.038	0.069	0.25	0.145	-0.23	0.36	0.25
W30	0.184	0.118	0.052	0.071	0.415	0.840	0.22	0.141	0.35	0.47	0.38
W60	0.750	0.239	0.201	0.218	1.003	2.411	0.31	0.099	0.47	0.58	0.49
WW	1.554	0.318	-0.133	0.286	2.364	4.389	0.35	0.073	-0.19	0.41	0.34

direct genetic variance (σ^2_d); maternal genetic variance (σ^2_m); maternal permanent environmental variance (σ^2_{pe}); residual variance (σ^2_e); direct-maternal genetic covariance (σ_{dm}); phenotypic variance (σ^2_p); correlation between direct and maternal genetic (r_{dm}); direct heritability (h^2_d); maternal heritability (h^2_m); total heritability (h^2_t); repeatability (r)

Maternal heritability (h^2_m) for BW, W30, W60 and WW were slightly and being 0.145, 0.141, 0.099 and 0.073, respectively. The present appreciation of (h^2_m) were complied with those determined by the pool of recent authors in different animal models Gholizadeh *et al*. (2010) in Raeini goats, Sadegh *et al*. (2013) in Iranian Adani goats, Baneh *et al*. (2012) in Naeini goats for BW and WW were ranged from 0.016 to 0.33 and 0.01 to 0.32, respectively). Likewise, Boujenane and El Hazzab (2008) find out h^2_m for BW and W30 in Draa goats were varied from 0.04 to 0.21 and 0.00 to 0.18, respectively.

Moreover, the actual results of were h^2_m lower than the estimates of Aboul-Naga *et al*. (2012) on Zaraibi goats (BW and WW were 0.20 and 0.14, respectively) and Zhang *et al*. (2009) in Boer goats (WW were ranged from 0.26 to 0.43 and 0.16 to 0.30, respectively). On the other hand, the current estimates were higher of h^2_m than reviewed by Snyman (2012) in Angora goats for BW was 0.10 and Thomas *et al*. (2016) in Kiko × Boer goats for WW was 0.04.

Total heritability (h^2_t) for BW, W30, W60, and WW were moderate and being 0.25, 0.38, 0.49 and 0.34, respectively. These results suggest that mass selection would be very effective in improving studied traits. Direct- maternal genetic correlation (r_{dm}) were positive for W30 (0.35) and W60 (0.47), on the contrary for BW and WW were negative -0.23 and -0.19, respectively. The present results are comparable to those reported by some investigators (Rashidi *et al*., 2008) in Markhoz goats, Boujenane and El Hazzab (2008) in Draa goats, Zhang *et al*. (2009) in Boer goat, El-Awady (2011), Osman (2013) in Zaraibi goats and Sadegh *et al*. (2013) in Iranian Adani goats).

Estimates of repeatability for BW, W30, W60 and WW were 0.36, 0.47, 0.58 and 0.41, respectively presented in Table (2). The existing study for BW and WW were lower (0.61 and 0.52, respectively) than those stated by Alade *et al*. (2010) in Africa goats. Vice versa, the appreciation exists of repeatability for W60 and WW were higher than the estimates of Kuthu *et al*. (2017) in Teddy (0.41 and 0.38, respectively).

Estimates of different correlations among investigated traits in Zaraibi male kids are given in Table (3). Genetic and phenotypic correlations were lower between non-adjacent weights than adjacent ones. They were positive, indicating no genetic and phenotypic antagonism among them. Genetic correlations were ranged from 0.80 (BW and WW) to 0.95 (BW and W30). Meanwhile, phenotypic correlations were varied from 0.69 (BW and WW) to 0.84 (W60 and WW). In this respect, positive genetic and phenotypic correlations between live body weights in different breeds were obtained by several authors (Al-Shorepy *et al*., 2002; Shaat *et al*., 2007; Ballal *et al*., 2008; Haque *et al*., 2012; Sadegh *et al.,* 2013; Baneh *et al*., 2012). In contrast; Mugambi *et al*. (2007) detected negative phenotypic correlation in Kenya Dual Purpose Goats between BW and WW.

Table (3): Estimates of different correlations among investigated traits in Zaraibi male kids

Correlated traits	r_{d1d2}	r_{m1m2}	r_{pe1pe2}	r_{e1e2}	r_{p1p2}
BW-W30	0.95	0.86	0.81	0.34	0.79
BW-W60	0.86	0.81	0.68	0.27	0.73
BW-WW	0.80	0.72	0.61	0.22	0.69
W30-W60	0.91	0.77	0.78	0.85	0.83
W30-WW	0.88	0.74	0.69	0.76	0.75
W60-WW	0.90	0.86	0.84	0.86	0.84

direct genetic correlation (r_{d1d2}); maternal genetic correlation (r_{m1m2}); maternal permanent environmental correlation (r_{pe1pe2}); environmental correlation (r_{e1e2}); phenotypic correlation (r_{p1p2}).

Maternal genetic correlations between all investigated traits were positive and ranged from 0.72 (BW and WW) to 0.86 (BW and W30) and (W60 and WW), these indicated the selection on maternal potentials for any trait could result in an increase in other traits. The current results agree with El-Awady *et al*. (2019) in Zaraibi goats. Environmental correlations were positive among all traits. Which the Minimum estimate (0.22) was observed between BW and WW, while the maximum estimate (0.86) was found between W60 and WW. As will, the lowest estimation of permanent environmental correlation was 0.61 (BW and WW) while the highest value was 0.84 (W60 and WW). These results correspond with showed by El-Awady (2011) in Barki Sheep in Egypt.

Selection index

Expected genetic gains per generation of BW, W30, W60 and WW (using selection intensity (i)=1 only for compression), and required number of generations (T) to attain goal of desired genetic gain in Zaraibi male kids begin 0.25, 0.5, 1 and 1.5 kg, respectively (Table 4). The highest values for genetic gains of all traits of kids were 0.069, kg for BW in index 1_6 (BW and W60), 0.220, kg for W30 in index I_4 (W30 and W60), 0.4875, kg for W60 in index I_{10} (W60 and WW), 0.7418, kg for WW in index I_{14} (WW). On the contrary, the lowest values of genetic gain for traits were obtained 0.0246, kg for BW in index I_{14} (WW), 0.089 and 0.1781, kg for W30 and W60, respectively in index I_4 (W30, W60 and WW), while the lowest value for WW was 0.2317, kg in index I_5 (BW and W30). Compare efficiency of these indices were judged based on number of generations required to attain the pre-estimated goals in Table 3, find out the index I_{14} which incorporated weaning weight required minimum number of generations (2.022) to attain genetic gain.

While maximum number of generations (5.6143) to attain genetic gain observed in index 1_4 which incorporated W30, W60 and WW. Thus, I_{14} was adjudges as the best selection index lead to save time and efforts for genetically improvement for studied traits and reaching the best weight at weaning in Zaraibi male kids.

Table (4): Expected genetic changes (ΔG, kg) per generation and the number of generations required to attain desired genetic gain (T) of studied traits in Zaraibi male kids for different selection indices

I	Selection criterion				b-values				Expected genetic change (ΔG, kg) per generation				T
					BW	W30	W60	WW	BW	W30	W60	WW	
I_1	BW	W30	W60	---	14.525	-2.802	1.659	---	0.0604	0.1208	0.2417	0.3282	4.1360
I_2	BW	W30	---	WW	13.850	-1.169	---	0.775	0.0645	0.1290	0.2644	0.3872	3.8735
I_3	BW	---	W60	WW	13.432	---	-1.040	1.169	0.0642	0.1269	0.2568	0.3852	3.8936
I_4	---	W30	W60	WW	---	7.485	-5.433	2.635	0.0199	0.0890	0.1781	0.2671	5.6143
I_5	BW	W30	---	---	13.238	0.441	---	---	0.0687	0.1375	0.2156	0.2317	3.6338
I_6	BW	---	W60	---	12.604	---	0.526	---	0.0690	0.1590	0.2762	0.3212	3.6197
I_7	BW	---	---	WW	12.421	---	---	0.552	0.0677	0.1602	0.3071	0.4067	3.6875
I_8	---	W30	W60	---	---	1.532	0.645	---	0.0350	0.2207	0.4414	0.5198	2.2651
I_9	---	W30	---	WW	---	1.510	---	0.616	0.0327	0.2056	0.4554	0.6170	2.4310
I_{10}	---	---	W60	WW	---	---	0.433	0.694	0.0276	0.1925	0.4875	0.7313	2.0509
I_{11}	BW	---	---	---	14.021	---	---	---	0.0674	0.1196	0.1815	0.1954	3.7046
I_{12}	---	W30	---	---	---	2.708	---	---	0.0344	0.2013	0.3669	0.3915	2.4826
I_{13}	---	---	W60	---	---	---	1.332	---	0.0308	0.2165	0.4833	0.6259	2.0686
I_{14}	---	---	---	WW	---	---	---	0.965	0.0246	0.1712	0.4639	0.7418	2.0220

Faid-Allah (2014) constructed two desired selection indices in Friesian heifers, the desired gains for the first index were 1, 1.5, 1.75 and 2 kg for BW, W30, W60 and WW, respectively and the number of generations required to attain this goal was 2.071 generations (i=1) and 5.91 generation (i=0.35), while the desired gains for the second index were 1, 1.5, 1.5 and 2 kg for those traits and the number of generations required to attain this goal were 1.931 generation (i=1) and 5.5171 generation (i=0.35). He added that it could be using the second index for genetic improvement of pre-weaning body weights to save efforts and time. El-Wakil and Fooda (2014) in Dhofari goat constructed selection index contained only birth weight and founded that genetic improvement was 0.01, kg. Recently, El-Raghi (2019) in Zaraibi goats achieved expected genetic gain for the same studied traits ranged from 0.028 to 0.060, 0.102 to 0.247, 0.132 to 0.269 and 0.234 to 0.338, kg respectively using different types from selection indices (General, reduced and sub-selection indices).

CONCLUSION

The present investigation revealed modest estimates of direct and total heritability for pre-weaning body weights and high genetic and phenotypic correlations for these traits. These results suggested that including these traits in selection indices could lead to genetic improvement for these traits. Moreover, the findings for the current study confirmed that the index I_{14} showed the lowest number of generations (2.022) to attain the goal of genetic gain for pre-weaning body weights. Thus, using selection index I_{14} would lead to advance the efficiency of response to aggregate genotype and would lead to save time and efforts for genetic improvement of these traits in Zaraibi male kids.

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الأدلة الانتخابية ذات العائد المرغوب لأوزان الجسم قبل الفطام للجديان الزرايبى في مصر

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الهدف من الدراسة الحالية هو تقدير المعايير الوراثية وتقييم الأدلة الانتخابية المختلفة ذات العائد الوراثي المرغوب لأوزان الجسم قبل الفطام للجديان الزرايبى في مصر. والبيانات جمعت خلال الفترة من ٢٠٠٥ وحتى ٢٠١٢ من ٧٦٣ عنزة و ٧٥ تيس زرايبى من محطة السرو البحثية التابعة لمعهد بحوث الإنتاج الحيواني. وقد أجري تحليل البيانات بطريقة REML باستخدام MTDFREML لتقدير المعايير الوراثية كما تم استخدام برنامج SAS لبناء الأدلة الانتخابية. كانت تقديرات المكافئ الوراثي المباشرة لأوزن الجسم عند الميلاد و ٣٠ يوم و ٦٠ يوم و ٩٠ يوم ٠.٢٥ و ٠.٢٢ و ٠.٣١ و ٠.٣٥ على التوالي، والمكافئ الوراثي الأمي للصفات سابقة الذكر ٠.١٤٥ و ٠.١٤١ و ٠.٠٩٩ و ٠.٠٧٣ على التوالي، بينما كان المكافئ الوراثي الكلى لنفس صفات الأوزان السابقة هي ٠.٢٥ و ٠.٣٨ و ٠.٤٩ و ٠.٣٤ على التوالي. ولقد كان الارتباط الوراثى الأمي المباشر موجبًا لوزن الجسم عند ٣٠ يوم (٠.٣٥) ووزن الجسم عند ٦٠ يوم (٠.٤٧) بينما كان سالبًا لوزن الجسم عند الميلاد (-٠.٢٣) ووزن الجسم عند الفطام (-٠.١٩). وكانت الارتباطات الوراثية لجميع الصفات تتراوح بين ٠.٨٠ إلى ٠.٩٥ بينما تراوحت قيم الارتباطات المظهرية بين ٠.٦٩ إلى ٠.٨٤. وقد كان أعلى عدد من الأجيال اللازمة لتحقيق العائد الوراثى المرغوب ٥.٦١٤٣ جيل في الدليل رقم ٤ في مقابل ٢.٠٢٢٠ جيل في الدليل رقم ١٤ ، لذلك يعتبر الدليل رقم ١٤ هو أفضل دليل يمكن تطبيقه لتوفير الوقت والمجهود للتحسين الوراثى للصفات المدروسة في جديان الماعز الزرايبى في مصر.