ASSESSMENT OF GENETIC PARAMETERS VIA REML AND ML METHODS FOR SOME MILK TRAITS IN ZARIBI GOATS

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ABSTRACT

The aim of the present study is to investigate some factors affecting milk traits in Zaribi goat and estimate its genetic parameters. The data set comprised from 786 lactation records of 328 does, progeny of 56 sires and 232 dams for total milk yield at 90 day (90 DMY), total milk yield (TMY)), daily milk yield (DMY) and lactation period (LP) were collected from a herd of Zaribi goat raised in El-Serw Experimental Station, located in the North Eastern part of the Nile Delta, Egypt, which belongs to Animal Production Research Institute (APRI), Ministry of Agriculture through 10 years from 2003 to 2012. Fixed and random factors affecting the traits were investigated according to GLM procedure of Statistical Package Program (SAS, 2004). Also, two methods (REML * ML) were used to obtain the variance components. Overall means along with their standard deviation for TMY, 90DMY, DMY and LP were 245.21 ± 70.33(Kg), 88.53 ±24.43 (Kg), 0.997 ±0.266 (Kg) and 247.06 ±40.66 (day), respectively. Least squares analysis of variance revealed that buck, parity, birth type, kidding season and kidding year were highly significant (P<0.001) sources of variation for all milk traits under study except the effect of kidding season was not significant. Heritability estimates via REML were 0.27, 0.20, 0.06 and 0.16 while those estimated by ML were 0.25.0.19, 0.04 and 0.14 for TMY, 90DMY, LP and DMY, respectively. Genetic, phenotypic and environmental correlations were positive showing no antagonism except that between lactation period and daily milk yield was negative in sign.

It is concluded that the two methods for variance component estimation gave relatively similar findings. In addition, the influence of non-genetic factors should be considered in selection program and an adjustment for the significant environmental factors should be made.

Key words: Buck, Variance Components, Heritability, Milk Traits, Zaribi goats

INTRODUCTION

Milk yield is considered an important economic trait in livestock species. It is a great source of income in most dairy enterprises. Economic traits are generally affected by genetic factors but environmental factors such as calving year, parity, calving season and age at first calving have significant influence on milk yield (Pirzada,

2011) The breeding values of animal are affected by these environmental factors, so these environmental factors must by adjusted in order to get a true genetic evaluation for milk traits (Djemali and Berger, 1992).) Accurate estimates of the genetic parameters largely depend on the pedigree structure, fixed effects, population sample and method of estimation. Various methods have been developed to estimate variance components and genetic parameters such as heritability, genetic and phenotypic correlations (Güler *et al*., 2010) The most common from these methods are (REML) restricted maximum likelihood, Type I, II, III methods of Henderson, (ML) maximum likelihood and (MIVQUE) minimum variance quadratic unbiased estimation. Many researchers have used these methods to estimate unbiased variance components for many important yield traits in livestock (Aksakal *et al*., 2012).

The present investigation was planned to analyze genetic and non-genetic factors affecting some milk traits such as 90-day milk yield, total milk yield, lactation period and daily milk yield in Zaribi goat and estimate the variance components using REML and ML methods.

MATERIALS AND METHODS

Data

Data utilized in this study was collected from the Zaribi herd raised in El-Serw Experimental Station, located in the North Eastern part of the Nile Delta, Egypt, which belongs to Animal Production Research Institute (APRI), Ministry of Agriculture. Data were collected through 10 years from 2003 to 2012, which consisted of 786 lactation records of 328 does, progeny of 56 sires and 232 dams for total milk yield (TMY),90 -day milk yield (90-DMY), daily milk yield (DMY) and lactation period (LP).

Management and feeding:

Animals were kept under open pens and fed on Egyptian clover, rice straw and green fodder during the winter season, while in the summer season were fed on the same foods season. Does are first mated at about 16 months of age (≈30 kg of body weight). Does were randomly divided into mating groups of 25-30 does, each group was assigned to a fertile buck. Bucks were replaced after 2 mating seasons with others from within the herd. The mating system followed was once a year with half of herd mated in October and the other half in June.

Statistical analysis:

PROC GLM procedure of the Statistical Analysis System (SAS, 2004) was used to analyze the Least-squares means (LSM) and standard errors (SE) in each level of random and fixed effects and the differences between means were detected by Duncan`s Multiple Range Test. The following model was used to analyze total milk yield:

$$Y_{ijklm}=\mu + S_i + Y_j + P_k + T_l + Se_m + bL\,(X - \bar{X}) + bQ\,(X - \bar{X})^2 + e_{ijklm}$$

Where:

Y_{ijklm} = the individual observation.

μ= the overall mean.

S_i= the random effect of the **ith** sire, i= 1……………… 56

Y_j=the fixed effect of the **jth** year of kidding [2003, 2004……….2012].

P_k=the fixed effect of the **kth** parity number [1, 2, 3, ≥4]

T_l= the fixed effect of the **lth** number of kids born [single, twins, Triplet or more].

Se_m= the fixed effect of the **mth** season of kidding [1= March and 2=October].

bL& bQ= partial linear and quadratic regression coefficients, respectively for total milk yield on lactation length.

X=lactation period (days) of doe, $\bar{X}$ average lactation period.

e_{ijklm}= residual error assumed as random.

The same mixed model mentioned before was used to analyze daily milk yield and 90-day milk yield but the effect of lactation length was excluded.

Estimates of variance components:

Estimation of variance components was made using the mixed model for estimating of heritability, genetic, phenotypic and environmental correlations. σ^2s (sire variance) and σ^2e [variance in sire's family (among half-sibs)] were calculated through REML (Restricted Maximum Likelihood), (Patterson and Thompson 1971) and ML (Maximum Likelihood) (Hartley and Rao 1967) methods as described by Rasch and Mašata (2006) using the PROC VARCOMP option of Statistical Analysis System (SAS, 2004).

RESULTS AND DISCUSSION

Descriptive statistics:

Table (1): shows that the overall mean of total milk yield (245.21 kg) was higher than those reported by Arun *et al*. (2004) (112.56 ± 5.65 kg) in Kutchi goats and Muhammad *et al*. (2007) (155 ± 5.10 kg) in Sudanese Nubian goats and lower than those recorded by Valencia *et al*. (2007) (800 kg) in Sannen goats and Carnicella *et al*. (2008) (288.2 ± 57.3 kg) in Alpine Maltese goats. The estimated value for 90- DMY in the present study (88.53 kg) was higher than that listed by Dudhe *et al.* (2016) (61.79 ± 2.48 kg) in Sirohi goat. On the other side, Roy and Ajoy (2010) and Singh *et al*. (2014) reported that the average total milk yield at 90 day was found to be 79.89±1.41 and 78.30±0.68 litres in Jamunapari goats.

Table (1): Data structure, unadjusted mean, Standard Deviation (SD) and Coefficient of variation (CV %) for Total Milk Yield (TMY),total milk yield at 90 day (90 DMY) Lactation Period (LP) and Daily milk yield (DMY)

Traits	Code	Records	Mean	SD	CV%
90-day milk yield	90-DMY	786	88.53	24.43	27.60
Total milk yield	TMY		245.21	70.33	28.68
Lactation period	LP		247.06	40.66	16.46
Daily milk yield	DMY		0.997	0.266	26.68

The mean of LP (247.06 day) was higher than the mean of 162.01 ± 2.68 and 150.75 ± 0.72 day, obtained by Roy and Ajoy (2010) for Jamunapari goats and Dudhe *et al*. (2016) for Sirohi goats, respectively and lower than the mean of 273.12 day, noted by Bolacali and Kucuk (2012) for Saanen goats. Overall mean of daily milk yield (0.997 kg) was lower than those reported by several investigators [Boro *et al*. (2008) (2.63 kg/day) in Croatia goats, and Bolacali & Kucuk (2012) (1.37 kg/day) in Saanen goats].

Non genetic factors:

Least squares means for all traits are shown in Table 2. TMY, DMY and 90 DMY were affected by sire, year of kidding, parity number and litter size. The present results complies with several authors working on different breeds [Boro *et al*., 2008; Tyagi *et al*., 2013; Mohan *et al*., 2014; Mustapha *et al*., 2015; Dudhe *et al*., 2016]. Although milk production in March was superior on October but the difference was trivial (only, 13.86 kg) may be due to the good administrative plans followed in nutrition. Non significant effect of kidding season on total milk yield was showed by Zahraddeen *et al*. (2007) for Nigerian indigenous does because of the uniform nutrition.

Least square analysis of variance showed that value of partial linear regression coefficient of total milk yield on lactation length was positive (1.50430 ± 0.3918 kg/day) and highly significant (P=0.0064) Meanwhile the value of partial quadratic regression coefficient was negative (-0.00144 ± 0.00085 kg/day^2) and non significant (p=0.7468) (Table,2) The present statements correspond with that shown by Ishag *et al.* (2012) working on Saanen goats, they classified the dairy goats according to lactation length into three groups the first one was < 180 days, followed by 181 – 300 days, followed by > 300 days and reported that total milk yield affected significantly by lactation length, where there was a linear increase in milk yield from 208.26±13.17 kg in the first group to 466.02±17.09 kg in the third group.

In connection to lactation period the present results clearly demonstrated that sire, season of kidding, parity number and litter size had no significant effect on lactation period, while kidding year affected significantly. The present results were in accordance with the statements of Mustapha *et al*. (2015) who reported non significant effect of number of kids born on lactation length working on Draa goats (112.9±2.89 and 117.4±3.03 day for single and twins or more, respectively). Dudhe *et al*. (2016) reported non significant effect of sire and parity number on lactation period in Sirohi goats. Ishag *et al*. (2012) showed significant effect of kidding year on lactation length for saanen goat in Sudan. In contrast, Boro *et al*. (2008) in Alpine and Saanen goats reported significant effect of parity number on lactation period.

Table (2): Least squares means (LSM±S.E) for TMY, DMY, LP and 90DMY (kg) as affected by different factors

Classification	No.	TMY	DMY	LP	90-DMY
Sire	56	***	**	NS	**
kidding season		NS	NS	NS	NS
March	431	251.471± 3.82	1.029 ± 0.01	245.53 ± 3.41	92.651 ± 1.67
October	355	237.609 ± 5.12	0.958 ± 0.01	248.91 ± 3.46	86.198 ± 1.69
kidding year		***	***	***	***
2003	17	219.14 ± 24.66^{cd}	0.826 ± 0.09^{c}	264.00 ± 16.64^{a}	74.44 ± 8.16^{c}
2004	80	165.63 ±16.23^{e}	0.711 ± 0.05^{d}	236.15 ± 10.96^{c}	64.01± 5.37^{d}
2005	84	219.39 ±13.43^{cd}	0.885 ± 0.04^{c}	245.30 ± 9.06^{bc}	79.63 ± 4.44^{c}
2006	127	252.33 ± 9.31^{b}	1.041 ± 0.03^{b}	245.66 ± 6.28^{bc}	93.68± 3.08^{b}
2007	155	263.84 ± 7.01^{b}	1.027 ± 0.02^{b}	258.01 ± 4.73^{ab}	92.44 ± 2.32^{b}
2008	121	261.42 ± 6.65^{b}	1.043 ± 0.02^{b}	250.87 ± 4.49^{abc}	93.92 ± 2.20^{b}
2009	83	265.38 ± 8.64^{b}	1.084 ± 0.03^{b}	246.63 ± 5.83^{bc}	97.47± 2.86^{b}
2010	47	279.88 ± 12.62^{a}	1.137 ± 0.04^{a}	248.79 ± 8.52^{abc}	111.39± 4.17^{a}
2011	49	240.96 ± 13.98^{cb}	1.010 ± 0.05^{b}	238.36 ± 9.43^{c}	90.86± 4.62^{b}
2012	23	210.00 ± 18.45^{d}	1.009 ± 0.06^{b}	239.22 ± 12.45^{d}	90.76 ± 6.10^{b}
Parity number		***	***	NS	***
1	270	211.80 ± 6.67^{c}	0.840 ± 0.02^{c}	250.74 ± 4.50	75.63 ± 2.20^{c}
2	214	242.04 ± 5.75^{b}	0.979 ± 0.02^{b}	247.80 ± 3.88	88.05 ± 1.90^{b}
3	168	276.08 ± 7.55^{a}	1.142 ± 0.03^{a}	243.68 ± 5.10	102.82 ± 2.50^{a}
4	100	278.32 ± 11.02^{a}	1.157 ± 0.04^{a}	242.88 ± 7.44	104.10 ± 3.64^{a}
≥ 5	34	275.57 ± 18.11^{a}	1.131 ± 0.11^{a}	244.65 ± 19.43	101.23 ± 5.14^{a}
Litter size		***	***	NS	***
Single	192	239.80 ± 5.83^{b}	0.949 ± 0.02^{b}	253.35 ± 3.93	85.34 ±1.93^{b}
Twins	444	240.29 ± 4.80^{b}	0.983 ± 0.01^{b}	244.94 ± 3.24	88.49 ± 1.58^{b}
Triplet or more	150	266.71 ± 6.35^{a}	1.100 ± 0.02^{a}	245.26 ± 4.28	99.02 ± 2.10^{a}

a,b, means within a column and class not followed by the same letter differ significantly.

Genetic parameters:

Table (3) show estimates of heritability as well as genetic, environmental and phenotypic correlations among different milk traits through REML and ML methods. Estimates of heritability of a trait can vary considerably from study to study depending upon breed, population sampled, environmental and management conditions, and errors, both random and systematic, in the estimation procedures (Kennedy *et al*.1981).

Direct heritability estimates via REML were 0.27, 0.20, 0.06 and 0.16 while those estimated by ML were 0.25, 0.19, 0.04 and 0.14 for TMY, 90-DMY, LP and DMY, respectively. These estimates are low to moderate and in agreement with most of the previous investigators. The estimates of direct heritability for total milk yield in this study vary from method to another due to methods of estimating heritability relies on measuring the degree of resemblance between individuals after eliminating as much as possible the environmental contribution to this similarity (Lush, 1949). Higher heritability estimates for total milk yield (0.49 ±0.11, 0.378 ± 0.13, 0.56, 0.44±0.17 and 0.46) were recorded by Mavrogenis and Popachristoforou (2000) in Damascus goats through PHS, Desoky (2004) in Zaribi goats by PHS, Muhammed *et al*. (2007) via DFREML in Sudanese Nubian goats, Ishag *et al*. (2012) in Saanen goat by PHS and Hermiz *et al*. (2002) in Iraqi local goats and their crosses through animal model program, while the closest estimates were reported by Farrag *et al*. (2007) (0.28 ± 0.01) and Hamed *et al*. (2009) (0.26 ± 0.01) in the same herd on another set of data through MTDFREML.

Table (3): Estimates of heritability (on diagonal), genetic correlation (above diagonal) and phenotypic correlation (below diagonal) for milk traits according to Maximum Likelihood (ML) and Restricted Maximum Likelihood (REML)

ML (Maximum Likelihood)				
Traits	TMY	90-DMY	LP	DMY
TMY	**0.255 ± 0.11**	0.967 ± 0.02	0.578 ± 0.14	0.990 ± 0.00
90-DMY	0.705*** (0.632)	**0.194 ± 0.09**	0.492 ± 0.16	0.972 ± 0.02
LP	0.571*** (0.584)	0.155** (0.134)	**0.049 ± 0.01**	-0.480 ± 0.18
DMY	0.710*** (0.684)	0.963*** (0.920)	- 0.122** (-0.107)	**0.146 ± 0.08**
REML (Restricted Maximum Likelihood)				
TMY	**0.274± 0.12**	0.950 ± 0.03	0.550 ± 0.18	1.00
90-DMY	0.706*** (0.630)	**0.207 ± 0.09**	0.497 ± 0.20	0.979 ± 0.01
LP	0.572*** (0.586)	0.158** (0.134)	**0.062 ± 0.02**	- 0.491 ± 0.22
DMY	0.707*** (0.674)	0.961*** (0.912)	-0.126** (-0.106)	**0.168± 0.09**

Environmental Correlation was presented between brackets

Regarding the heritability of total milk yield at 90 day, the present results were in conformity with the range (0.17 to 0.24) reported by Roy and Ajoy (2010) working on 1367 lactation record for Jamunapari goats in India. On the other hand, higher estimates were showed by several authors working on different breed [Mavrogenis and

Popachristoforou (2000) (0.45 ± 0.11) in Damascus goats through PHS, Shaat *et al*. (2007) (0.27) in Zaribi goats through MTDFREML, Dudhe *et al*. (2016) (0.652 ± 0.101) in Sirohi goat through ML].

For heritability estimate of lactation period, Mohammed *et al*. (2012) through DFREML reported heritability estimates for lactation length in range from 0.00 ± 0.19 to 0.03± 0.12 for Arsi-Bale goat in Ethiopia, which was close to the present estimates, approximately. Lower estimates for the heritability of lactation period in the present study indicated that the refinements in the environmental conditions should be taken into consideration such as nutrition and the other management conditions.

Heritability estimate for daily milk yield were lower than those reported by Hermiz *et al*. (2002) (0.83) in Iraqi local goats and their crosses through animal model program and Zinat *et al*. (2012) (0.33±0.14) in Black Bengal goats through REML. In addition, Mohan *et al*. (2014) in Black Bengal goats via REML came to same result (0.15) as listed in the present study, approximately. On the other hand, Suzana *et al*. (2000) used single and multiple traits restricted maximum likelihood analysis and recorded heritability estimates for daily milk yield as 0.20 and 0.19 for single and multiple traits, respectively for Alpine and Saanen goats.

Results in table (3) indicated that the highest genetic correlation coefficients were found between total milk yield and daily milk yield (0.990 ± 0.00 and 1 ± 0.00 via ML and REML, respectively). Also, between total milk yield at 90 day and daily milk yield (0.972 ± 0.02 and 0.979 ± 0.01 via ML and REML, respectively). Shaat et al. (2007) in the same herd on another set of data reported that the estimates of genetic correlation especially between total milk yield and both total milk yield at 90 day and lactation period were high and positive (0.89 and 0.80, respectively), They added that the estimate of genetic correlation between total milk yield at 90 day and lactation period was moderate (0.46), which was very close to that observed in the present study (0.492 ± 0.16 and 0.497 ± 0.20 by ML and REML, respectively). In contrast, negative genetic and phenotypic correlation between total milk yield at 90 day and lactation length (-0.205 ± 0.151 and -0.042 ± 0.030, for genetic and phenotypic correlation, respectively) was showed by Dudhe et al. (2016) in Sirohi goat through ML.

Meanwhile, there were negative genetic and phenotypic correlation coefficients between lactation period and daily milk yield [-0.480 and -0.491 through ML and REML, respectively for genetic correlation; -0.122 and -0.126 through ML and REML, respectively for phenotypic correlation] The present results were in agreement with Mohammed et al. (2012) in Arsi-Bale goat in Ethiopia who reported negative genetic and phenotypic correlation coefficient between lactation period and daily milk yield (-0.01 and -0.19 for genetic and phenotypic correlation, respectively).

Regarding environmental correlation coefficients, all coefficients were positive, showing no antagonism among them except that between daily milk yield and lactation period (only -0.10) through two methods. In contrast, Ishag et al. (2012) in a study conducted on Saanen goats in Sudan recorded positive environmental correlation coefficient between lactation period and daily milk yield (0.192).

CONCLUSION

It is suggested that the method of REML was adjudged as the best way to estimate variance component as it gave the higher values for genetic parameters. Also of the advantages of this method, is that it can be a suitable choice even if the data do not follow the normal distribution and it is not affected by the bias resulting from the small sample size and selection.

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الملخص العربى

تقدير المعايير الوراثية بطريقتي REML و ML لبعض صفات الحليب في الماعز الزرايبي

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2- قسم الانتاج الحيوانى - كلية الزراعة - جامعة دمياط - مصر
3- مديرية الطب البيطرى بدمياط - مصر

الهدف من هذه الدراسة هو التحقق من تأثير بعض العوامل على صفات اللبن فى الماعز الزرايبى وتقدير المعايير الوراثية لها. ملف البيانات مكون من 786 سجل حليب يعود الى 328 عنزة كنتاج ل 56 ذكر و 232 انثى لصفات انتاج اللبن الكلى وانتاج اللبن عند 90 يوم وانتاج اللبن اليومى وطول موسم الحليب تم تجميعها من محطة السرو البحثية الواقعة فى الجزء الشمالى الشرقى من دلتا النيل التابعه لمعهد بحوث الانتاج الحيوانى - وزارة الزراعة خلال عشرة اعوام من 2003 وحتى 2012 . تم دراسة تأثير العوامل الثابتة والعشوائية طبقا للنموذج الخطى العام للبرنامج الاحصائى SAS بالاضافة الى استخدام طريقتى REML و ML فى حساب مكونات التباين . المتوسطات العامة جنبا الى جنب مع الانحراف المعيارى لصفات النتاج اللبن الكلى وانتاج اللبن عند 90 يوم ومتوسط الادرار اليومى وطول موسم الحليب كانوا 245.21 ±70.33 كجم و88.53±24.43كجم و 0.997 ±0.266كجم و247.06±40.66 يوم على التوالى . متوسطات مربعات التباين الصغرى بينت ان كل من الذكر وموسم الولاده ونوع الولادة وعام الولادة كانوا مصادر تباين عالى المعنويه لجميع صفات اللبن تحت الدراسة بينما تأثير فصل السنه لم يكن معنويا . تقديرات المكافئ الوراثى بطريقة REML كانت 0.27 و0.20 و 0.06 و 0.16 بيينما المقدرة بطريقة ML كانت 0.25 و 0.19 و 0.04 و 0.14 للانتاج اللبن الكلى وانتاج اللبن عند 90 يوم وطول موسم الحليب ومتوسط الادرار اليومى على التوالى . الارتباطات الوراثية والمظهرية والبيئية كانت موجبة لا يوجد بينها تضاد فيما عدا تلك الموجود بين طول موسم الحليب ومتوسط الادرار اليومى كان سالب الاشارة . يمكن استخلاص ان الطريقتين المستخدمتين فى تقدير مكونات التباين اعطوا نتائج مماثله نسبيا كما يجب الاخذ بعين الاعتبار تاثيرات العوامل الغير الوراثية والتعديل لها فى برامج الانتخاب كما ويجب عمل التعديل للعوامل البيئية ذات التاثير المعنوى بالدرجة الاولى.