ESTIMATION OF GENETIC PARAMETERS FOR PRE-WEANING GROWTH TRAITS IN TEDDY GOATS

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ABSTRACT

The objective of present study was to estimate genetic parameters of some pre-weaning growth traits in Teddy goats. Data available on 18702 kidding and performance records of 5150 Teddy goats and progeny of 382 sires maintained at three different locations (I) Livestock Experiment Station Rakh Ghulaman, District Bakkhar (1983-2008) (II) Livestock Experiment Station, Rakh Khariewala District Layyah (1971-2008) and (III) Livestock Experiment Station Chak Katora, District Bahawalpur (1975-2008) Punjab, Pakistan were analyzed for this purpose. Restricted Maximum likelihood (REML) procedure fitting an Individual Animal Model was used for variance component estimation. Estimates of breeding values for various performance traits like birth weight (BW), 60 day weight (60DW), weaning weight (WW), and pre-weaning daily gain (PrWDG) were calculated by using BLUP. For these purposes WOMBAT software was used. The heritability estimates for BW, 60DW, WW and PrWDG were 0.28±0.23, 0.26±0.44, 0.23±0.32, and 0.21±0.32, respectively, while the repeatability estimates for BW, 60DW, WW (as dam traits) were 0.53±0.02, 0.46±0.04, and 0.34±0.04, respectively. The increasing trend was observed in genetic trends for BW and WW during the period of study. It is envisaged from the present study that over the 34 years period selection remained ineffective to bring the desired changes and it will remain so if random use of breeding animals is practiced.

Key words: Genetic parameters, BLUP, REML, growth traits

INTRODUCTION

Any program of breed improvement is based on maximum exploitation of genetic variation. The potential of genetic improvement largely depends on genetic variation of the trait and its relationship with the other traits. Knowledge of repeatability, heritability and correlations among various traits is essential for formulating efficient breeding plan and selection strategies. These genetic parameter estimates help in the determination of the selection method, to forecast direct and correlated response to selection, choosing a more realistic breeding system to be adopted for the future improvement as well as in the estimation of genetic gain. Trend lines can convey a rapid assessment of a breeder's selection success in the previous generations. Breeders involved with larger herds can compare alternative methods of selection or management with the use of trend lines. The trend lines can be helpful in reinforcing selection and management goals established by a breeder (Javed *et al.* 2007). However, a need for changes in selection methods and/or managmental practices may be as a result of such trend lines. When trend lines deviate from the anticipated results it is clear that the response to selection were not appropriate or too much optimistic expectations were made. The actual amount of selection applied in the scheme is also demonstrated by these trend lines (Wilson and Willham 1986). In the past, some sporadic studies have been conducted on Teddy goats but genetic parameters vary with location, time period, size of data set and method used for their estimation, therefore, the present investigation thus was planned to analyze the data on Teddy goats maintained at Livestock Experiment Stations, (I) Rakh Khariewala (District: Layyah) (II) Rakh Ghulaman, (District: Bakkhar) and (III) Chak Katora, (District: Bahawalpur) Punjab, Pakistan. Therefore, the present study has been designed to i) Estimate genetic parameters viz. repeatability, heritability of pre-weaning growth traits and genetic correlations among these traits. ii) Estimating breeding values of different pre-weaning growth traits and iii) To study the genetic trends in present flock so as to generate information, this will help in future development of breeding plans for genetic improvement in the breed.

MATERIALS AND METHODS

Source of Data: Data available for the analysis were collected from the breeding flock of Teddy goats maintained at three locations in Livestock Experiment Stations (I) Rakh Ghulaman, District: Bakkhar (1984-2008) (II) Rakh Khariewala District: Layyah (1972-2008) and (III) Chak Katora, District: Bahawalpur (1974-2008). The growth traits used for the analysis were birth weight

(BW), 60 Day weight (60DW), weaning weight (WW) and pre-weaning daily gain (PrWDG). The available recorded information pertaining to birth weight, monthly weight and weaning weight was used for estimating genetic parameters of different performance traits.

Farm Locations: The Livestock Experiment Station, Rakh Ghulaman District Bhakhar originally started as "Common Wealth Livestock Development Farm" in 1951. The Livestock Experiment Station at Rakh Khariewala, District Layyah in the Punjab province of Pakistan was established in 1962. The Livestock Experiment Station at Chak Katora, District: Bahawalpur was established in 1974 and is working under Directorate Livestock Farms; however from 2005 the financial and administrative control is with Buffalo Research Institute, Pattoki District Kasur. The primary purpose of establishing these farm being the conservation and propagation of different livestock breeds in addition to produce candidate bull calves and quality Rams and Bucks. The average rainfall is 120 mm. Temperatures in summer range from 25ºC to 46ºC, while winter is bit cooler with temperature ranging from 9ºC to 22ºC. The average rainfall is very low with recordings of 10 cm in the whole year.

Selection of Breeding Stock and Breeding Policy: Teddy goats were introduced at LES Rakh Ghulaman in 1984 when Teddy goats were purchased from different areas of Punjab to establish nucleus herd at the farm, while at LES Khariewala and LES Chak Katora introduction of Teddy goats took place in 1963 and 1972, respectively. It has been a general practice to select the does mainly among those produced at the farm, with primary emphasis on body conformation and breeds characteristics, however during 1972-73 and 1985-86 goats were also purchased from outside area. Selection of the bucks was based on the body conformation and breed characteristics. Emphasis on growth characteristics and body size of a buck for selection were also given emphasis. A scheme entitled Goat Development Centre at Rakh Khariewala was started in 1972-73 and in addition to existing flock 100 more does and 5 bucks were added to already existing flock. Teaser bucks were used to detect the does in heat, color bags were tied to bellies of teaser bucks for recognizing the does mounted by teasers. The does after being detected in heat by the teaser bucks were exposed for natural mating with the breeding bucks. For breeding purpose it was a normal practice to select 5-6 bucks in a year. As Teddy goat is a meat purpose goat, therefore, focus in the breeding plan was on chevon production. As considerable number of Teddy goats exhibit estrous round the year, so kid crop has also been produced during all the four seasons.

General Management and Feeding Practices: Management and feeding practices at the experiment stations were almost identical and have been more or less the same since the introduction of Teddy goats. The adult animals were maintained in open enclosures throughout the year with sufficient area being covered to offer enough shade and shelter during the extremes of weather. Normal practice was to allow animals to graze for 7-9 hours daily on range except during harsh weather, wherein the animals were retained inside the sheds. In scarcity period animals were provided a concentrate mixture. The breeding females were also provided with concentrate mixture 45 days before breeding for flushing and 60 days after parturition at the rate of 250 to 500 grams per doe. Breeding bucks were also offered a concentrate mixture at the rate of 500-750 grams during breeding. The young kids were mostly kept indoors up to one month of age and remained with their dams to suckle freely from evening to morning of next day, when does were again taken out to graze. After one month of age the kids remained with their mothers for 24 hours up to weaning. The weaned kids were transferred to new pens for rearing. Feed composition was different in different periods of the year as it depended mostly on the availability of fodder crops. Green Jowar (*Andropogon sorghum*), Maize (*Zea mays*), Guara (*Cyamposis psoraliodes*), Moth (*Phaseolus aconitiflovis*) and Cow peas (*Vigna sinensis*) were fed during the months of May to October. The Bajra Napier hybrid, Sorghum and Sudan grass hybrid (Sudex) and Teo-sinte were introduced at these farms were introduced from 1977-1980. During winter and spring Berseem and Lucern were major fodder crops for grazing. The concentrate mixture consisted of crushed gram (*Cicer arietium*), Barely (*Hordeum vulgare*), oats (*Avena sativa*), wheat bran and oilseed cakes (cottonseed, rapeseed).

Description of data set: Available data had the information of the doe, the buck, kid identities, birth date, birth weight, monthly weight recordings, date of service and date of kidding. Derived variables included weight at 60 days of age, weaning weight, and pre-weaning daily gain. The objectionable/ambiguous were removed from the data. Initially 20455 breeding records of 5545 does sired by 406 bucks were available.

Editing criteria: Different types of edits were made to the data in order to get rid of the outliers before analysis. Following edit criteria were used for different performance traits:

1 kg ≥ birth weight ≤ 3.5 kg, 6 kg ≥ weaning weight ≤ 13 kg, 90 days ≥ weaning age ≤ 150 days

The above given ranges were selected keeping in view the small size of Teddy goats. Data with any recorded abnormality were also excluded from the analysis.

Estimation of Genetic Parameters: The genetic parameters viz. repeatability, heritability and genetic and

phenotypic correlations were estimated by using Restricted Maximum Likelihood procedure outlined by Patterson and Thompson (1971) fitting an Individual Animal Model. An attempt was made to reduce the bias as a result of selection and non-random mating by including all available pedigree in the analysis. The convergence criterion (variance of function values -2 log likelihood) for various genetic parameters was 1×10^{-8}.

Table 1. Characteristics of data set for different traits

Trait	No. of records before editing	No. of records after editing
Birth weight	20455	18702
60 day weight	18787	16232
Weaning weight	15588	15414

For data entry and manipulation MS Excel spread sheets were used.

Repeatability estimation: The repeatability of birth weight and weaning weight was estimated by assuming the following mathematical model:

$Y_{ijk} = \mu + F_i + C_j + e_{ijk}$

Where, Y_{ijk} = measurement of a particular trait, μ = population mean, F_i = fixed effects observed to be significant from the initial analyses, C_j = random effect of jth doe, and e_{ijk} = random error with mean zero and variance σ^2E.

The common environmental parameter estimated (c^2) represented the proportion of phenotypic variance (σ^2P) attributable to animal's permanent environmental effects and were calculated as follows:

$c^2 = \sigma^2PE / \sigma^2P$

Repeatability of the concerned traits were estimated as

Repeatability = $\sigma^2A + \sigma^2PE / \sigma^2P$

The model included animal's permanent environmental effect in addition to the animal's additive genetic effect and the residual effect assuming that it is uncorrelated to other random effects i.e. additive genetic and residual effects. In this case animal's permanent environmental effects were fitted as an Additional Random effect.

Heritability estimation: For heritability estimation the mathematical model assumed was as follows:

$Y_{ijk} = \mu + F_i + A_j + e_{ijk}$

Where, Y_{ijk} = measurement of a particular trait, μ = population mean, F_i = Fixed effects observed to be significant from the initial analyses, A_j = Random additive genetic effect of j^{th} animal with mean zero and variance σ^2A, e_{ijk} = Random error with mean zero and variance σ^2e

The heritability was calculated by the following formula:

Heritability (h^2) = σ^2A / σ^2P

Estimation of Breeding Values and Genetic Trends: Breeding values of animals for various growth traits were estimated by best linear unbiased prediction (BLUP) procedure as outlined by Henderson (1973). The WOMBAT set of computer programmes also generates Estimated Breeding Values (EBVs) as a by-product. Breeding values thus estimated were fitted in a fixed effect model having year of birth as the only fixed effect. The least squares solutions of breeding values were drawn against year of birth to depict the genetic trend. The REML programme used above also generates Estimated Breeding Values. After estimating breeding values they were fitted in a fixed effect model which had only year of birth as the only fixed effect. Genetic trends were depicted by drawing the least squares solutions of breeding values against the year of birth.

RESULTS AND DISCUSSION

Data available on 18702 kidding and performance records of 5150 Teddy goats and progeny of 382 sires maintained as separate flocks at three Livestock Experiment Stations (I) Rakh Ghulaman, District Bakkhar (1983-2008) (II) Rakh Khariewala District Layyah (1971-2008) and (III) Chak Katora, District Bahawalpur (1975-2008) Punjab, Pakistan were utilized in the present study. Genetic sources of variation on different pre-weaning growth traits of economic importance in these three flocks were studied. An attempt was made to calculate estimated breeding values (EBVs) and genetic trends in order to assess the previous selection strategies.

A) Heritability of growth traits: The estimates of heritability for different growth traits obtained in the present study are presented in Table 2.

Table 2. Heritability estimates for some growth traits in Teddy goats

Growth Trait	No. of records	Dams	Sires	Heritability
Birth weight	18702	5150	382	0.28±0.23
60 day weight	16222	5001	365	0.26±0.56
Weaning weight	15414	4970	298	0.23±0.32
Pre-weaning daily gain	15414	4970	298	0.21±0.32

I) Birth weight: The heritability estimates for the trait in the present study was 0.28±0.23. The estimates were based on the birth records of 18702 kids produced by 5150 does sired by 382 bucks through univariate analysis, which did not change when bivariate analysis was carried. The present findings were in line with those reported by Baneh *et al.* (2012) in Naeini goats in Iran (0.25 ± 0.05), Singh *et al.* (2005d) in Barbari (0.27),

Kenneth et al. (2016) in meat goats in USA (0.27%±0.081) and Shafiq and Sharif (1996) in Teddy goats. A low heritability estimates (0.048 and 0.04) for birth weight in Teddy goat breed has been reported by Tahir *et al.* (1995) and Hyder (2000), while Shafiq *et al.* (1994) documented heritability estimates of 0.31 in Teddy goats. Lower estimates of heritability than the present findings were reported in different goat breeds by (Ali and Khan 2008; Roy *et al.* 2008; Zhang *et al.* 2008; Maghsoudi *et al.* 2009; Ekambaram *et al.* 2010; Roy *et al.* 2011), while heritability estimates for the trait by many workers (Singh *et al.* 2005a; Singh *et al.* 2005c; Rashidi *et al.* 2008; Kantanamalakul *et al.* 2008; Zhang *et al.* 2009; Alade *et al.* 2010; Gowane *et al.* 2011) from different parts of the world in different goat breeds were higher than the present findings. Bhattarai et al. (2017) in a study on Khari goat kids from Nepal reported that heritability estimates for the birth weight was 0.37±0.12. In other study on Hainan Black goats in China Zhou et al. (2015) reported that estimates for heritability for the traits were 0.45± 0.03. Menezes et al. (2016) reported a very low heritability 0.08 ± 0.07 for birth weight in Boer goats in Brazil. Kheirabadi and Rashidi (2016) reported that heritability estimates for the birth weight was 0.17 in Markhoz goats.

II) 60 day weight: The heritability estimates of 60-day weight calculated from 5001 does sired by 365 bucks was 0.26±0.56 (Table 2). After bivariate analysis the estimates did not change. Ballal *et al.* (2008) in a study reported that heritability estimates for 60 day weight was 0.22±0.19 in Sudanese Nubian goats. Medium heritability estimates as obtained in the present investigation pointed towards a significant role played by the environment for the expression of weight at 60 days of age, hence, improvement in the trait through selection may not be so effective.

III) Weaning weight: The heritability estimates of weaning weight based on 15414 records of kids born of 4970 does sired by 298 bucks was 0.20±0.35 in present study. The present estimates were in close agreement with Baneh *et al.* (2012) in Naeini goats in Iran 0.16 ± 0.06 and Menezes et al. (2016) in Boer goats in Brazil 0.23 ± 0.13. Lower estimates (0.10±0.012, 0.18±0.09 and 0.12) in the same breed were reported by (Tahir *et al.* 1995; Shafiq and Sharif 1996; Hyder *et al.* 2002). Low heritability estimates then the present study were reported in literature (Ali and Khan 2008; Boujenane and El Hazzab 2008; Rashidi *et al.* 2008; Roy *et al.* 2008; Maghsoudi *et al.* 2009). Higher estimates than the present study were reported by many scientists (Singh *et al.* 2005a; Singh *et al.* 2005b; Singh *et al.* 2005c; Singh *et al.* 2005d). In two different studies Baneh *et al.* (2012) in Naeini goats in Iran and Menezes et al. (2016) in Boer goats in Brazil reported heritability estimates for the trait as 0.16 ± 0.06 and 0.23 ± 0.13, respectively. Kenneth et al. (2016) also reported higher estimates of heritability (0.33±0.078) for the trait in meat goats in USA. Bhattarai *et al.* (2017) in a study on Khari goat kids from Nepal reported that heritability estimates for the trait was 0.42±0.13.

There was a wide variation in the heritability estimates of weaning weight in different goat breeds in different parts of the world. The differences in present findings and those of the many others reported earlier seem mainly due to breed and environmental conditions under which various flocks were maintained. The method of estimation of heritability also may lead to variation in estimates. The numbers of observations in most of the studies are smaller than the present study, which also causes differences in the estimates. The heritability estimates of weaning weight in present study are medium, which points out a greater influence of environmental factors like year, season and other factors like feeding and management. Therefore there is a greater scope of improvement in this trait by improving the environmental conditions.

IV) Pre-weaning daily gain The estimates of heritability of pre-weaning daily gain in the present study was 0.21±0.32 based on the univariate analysis of 15414 records of kids born of 4970 does sired by 298 bucks. In two earlier studies on Teddy goats by Shafiq and Sharif (1996) and Hyder (2000) the heritability estimates were 0.07±0.09 and 0.12±0.06, respectively. In Beetal goat breed the heritability estimates for pre-weaning daily gain was 0.14±0.033 (Ali and Khan 2008). Low estimates of heritability for the trait were reported by (Singh 2002; Singh *et al.* 2002), which indicated a strong influence of environment on the trait, while on the other hand very high estimates of heritability for the trait have been reported by Al-Shorepy *et al.* 2001, (0.42) in Emirati. The moderate heritability estimates of weaning weight and pre-weaning daily gain were 23 and 21 percent, respectively, which suggests that for selection an equal weightage should be given to both these traits.

B) Repeatability

I) Birth Weight: The repeatability estimates for birth weight (as dam trait) was 0.53±0.02, based on the records of 16533 records of 4201 dams sired by 245 bucks, supported by Hermiz *et al.* (2009) (0.53) in local Iraqi goat and its crosses with Damascus goats and Alade *et al.* (2010) (0.61±0.15) in West Africa. In a study, repeatability estimates for the trait was 0.2089±0.0315 (Tahir *et al.* 1995) in Teddy goats.

II) 60 Day weight: The repeatability estimates for 60 day weight (as dam trait) was 0.41±0.03, based on the records of 15123 records of 3989 dams sired by 227 bucks.

III) Weaning weight: The repeatability estimates for weaning weight (as dam trait) was 0.38±0.01, based on 12109 records of 3639 dams sired by 198 bucks. Tahir *et al.* (1995) reported low repeatability estimates (0.1381±0.0315) in Teddy goat. Higher estimates (0.72) in local Iraqi goats and their crosses were reported by Hermiz *et al.* (2009) and (0.52±0.12) in local goats in Sahelian region of West Africa by Alade *et al.* (2010).

Estimation of Breeding values and Genetic Trends

The genetic trends for BWT, WW and PrWDG are presented in Figures 1 to 3, respectively, while the estimates of breeding values in these traits are presented in Table 3. Hyder (2000) reported estimated breeding values (EBV's) in Teddy goats. The EBV's on the basis of pre-weaning daily gain ranged from +32.82 to -35.02 g. The overall phenotypic and genetic trends over the years for pre-weaning daily gains were slightly negative but close to zero. The genetic and phenotypic trends for birth and weaning weight showed an increased trend in Teddy goats in the present study. Ali and Khan (2008), reported that overall genetic trend for birth weight was static in Beetal goats and estimated breeding values ranged from -0.61 to 0.60 kg for bucks and -0.67 to 0.65 kg for does. The genetic trend for birth weight showed an upward trend, while the phenotypic trend line remained static throughout the study period, however in case of weaning weight both the trends showed an upward trends. Ali and Khan (2008) reported a static genetic trend for birth weight, while the phenotypic trend also kept oscillating around the zero in a study on Beetal goats. The genetic and phenotypic trend lines for six month, nine month and yearling weights followed the same pattern with no specific trend being observed for the traits. The genetic trends remained oscillating around the x-axis for all the traits which was indicative of no net genetic gain, however in nine month and yearling weight during a particular time period from 1995 to 2000 some genetic gain had been achieved with EBV's for those 5-6 years being on higher side for both these traits, but the trends dipped down below zero for both the traits after the year 2000. The phenotypic trend lines for six and nine month weight remained static around zero, however in case of yearling weight the phenotypic trend showed an upward trend during the last few years of the study. This was indicative of absence of any directional selection for these traits. Ali and Khan (2008) also reported that genetic trend for yearling weight was not different from zero in Beetal goats. The genetic trend for pre-weaning daily gain however showed an upward trend particularly from 1994-2008. The phenotypic trend however, remained oscillating around x-axis with static trend being observed for the trait. The genetic trends for post-weaning daily gain at six, nine and twelve months of age showed almost the same pattern as was observed in weight at six, nine and twelve months of age.

Table 3. Estimated breeding values (EBV's) for different growth traits

Trait	EBVs Bucks	EBVs Does	EBVs overall
BWT(kg)	-0.16 to 0.08	-0.18 to 0.08	-0.18 to 0.08
60 DW (kg)	-0.37 to 0.26	-0.39 to 0.25	-0.39 to 0.26
WW(kg)	-0.61 to 0.40	-0.58 to 0.36	-0.61 to 0.40
PrWDG(gms)	-0.21 to 1.20	-0.30 to 0.80	-0.30 to 1.20

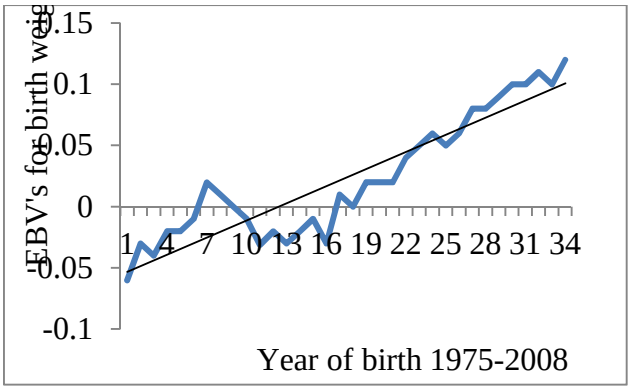

Figure 1. Genetic trend for BWT in Teddy goats during 1975-2008

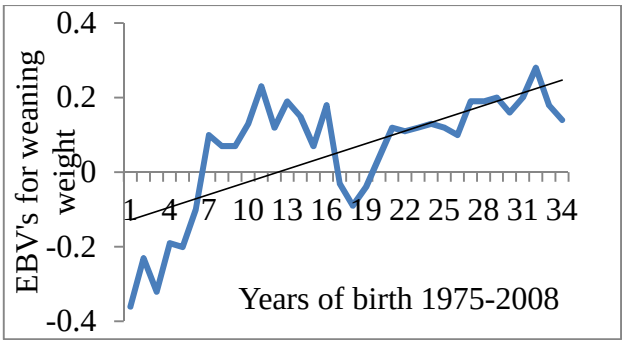

Figure 2. Genetic trend for WW Teddy goats during 1975-2008

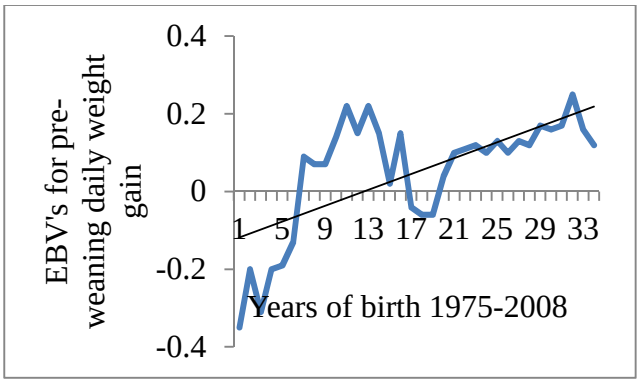

Figure 3. Genetic trend for PrWDG in Teddy goats during 1975-2008

Conclusion: Low to medium heritability was recorded in all the growth traits, which offers scope for genetic selection. Selection of animals to be the parents of future flock must be based on EBVs of growth traits. The genetic trends for growth traits indicated that the breeding programme in all the three flocks under study has not proved efficient. It also pointed out that the selection of the animals has not been practiced in a proper direction and random mating to some extent has been practiced. There can be many possible reasons a) the selection being carried on type and conformation, which becomes destructive when it is centered without fixing standards of production, where in the animals above the average in real usefulness, have been discarded because they did not conform to breed type in matters which were of little or no economic value. b) Another possible reason could be the genetic difference among the individuals which determines the rate of genetic improvement that can be accomplished through selection. With low estimates of heritability in some traits the anticipated improvement in those traits can be achieved more through altering the environment rather than selection. c) The culling of animals may have not been carried out according to the recommendation as mostly it is a practice at livestock farms in the past to cull those animals which are sick, unfit for breeding or repeaters and seldom culling is carried out on the basis of low production. The possible use of ineffective selection could be unavailability of efficient techniques for the evaluation of animals and incorrect performance recording etc. It is therefore, necessary to correct all these discrepancies by taking corrective measures.

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