Spontaneous Frequency of Sister Chromatid Exchanges in Different Breeds of Goat Reared in Egypt

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Summary The frequency levels of spontaneous sister chromatid exchanges (SCEs) were studied in 4 breeds of goats reared in Egypt namely, Zaraibi, Damascus, Baladi and Sahrawi. Blood samples from 21 animals belonging to these 4 breeds were collected and the lymphocytes were cultured in presence of bromodeoxyuridine. Slides were stained using Hoechst 33258 plus Giemsa technique. Thirty cells in second division were analyzed for each animal and the frequency of SCEs was recorded. The data were statistically analyzed using the Student t-test. The frequencies of sister chromatid exchanges (mean $\pm$ SD) were 5.36 ± 0.66 , 7.95 ± 0.77 , 5.72 ± 0.79 and 6.11 ± 0.27 in Zaraibi, Damascus, Baladi and Sahrawi, respectively. Statistical analysis between these 4 breeds showed that the Damascus breed has a significantly high level of SCEs ($p<0.001$) over the other 3 breeds. Also, a statistically significant difference ($p<0.05$) was recorded between Zaraibi and Sahrawi breeds.

Key words Goat, *Capra hircus*, Sister chromatid exchanges.

Sister chromatid exchanges (SCEs) result from DNA breakage and reunions, presumably in homologous loci. It can be visualized after 2 cell replication cycles in the presence of tritium-labeled thymidine (^3H -Thd) (Taylor *et al.* 1957) or bromodeoxyuridine (BrdU) (Latt 1973).

Sister chromatid exchanges have been widely used to detect chromosomal fragility in humans (Chaganti *et al.* 1974) and cattle (Di Berardino *et al.* 1983) and to determine the mutagenic effects of chemical compounds (Carrano *et al.* 1978, Latt *et al.* 1981, Anderson *et al.* 1990). Sister chromatid exchanges have also been used to compare human races (Butler 1981).

In farm animal breeding programs, SCEs can play a role in an efficient genetic evaluation of the breeding animals under selection (Di Berardino *et al.* 1997). The frequency of spontaneous SCEs has been investigated in cattle breeds (Di Berardino and Shoffner 1979, Iannuzzi *et al.* 1991a), goat breeds (Lopez and Arruga 1992, Di Meo *et al.* 1993), sheep breeds (Di Meo *et al.* 2000, Oraby *et al.* 2002), horses breeds (Mursmatsu *et al.* 1999) and river buffalo (Iannuzzi *et al.* 1988).

The frequency of SCEs has also been used to compare different species such as cattle, goat, river buffalo and sheep (Di Berardino *et al.* 1997).

We use here sister chromatid exchanges to compare different breeds of goat (*Capra hircus*) reared in Egypt. The frequency of spontaneous sister chromatid exchanges was investigated in representative samples of 4 different breeds of goat reared in Egypt.

Materials and methods

Blood lymphocytes were collected from 4 goat breeds, Zaraibi, Damascus, Baladi and Sahrawi reared in 4 different locations in Egypt namely El Serrwo, Sakha, Ain Shams and Ras Sider, respectively.

Blood lymphocytes were cultured at 37°C for 72 h in RPMI 1640 medium (Gibco) supple-

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mented with 20% fetal calf serum (Gibco), 0.1% garamycin (Schering), 1% L-glutamine (Gibco) and 4% phytohaemagglutinin (Wellcome). The blood cultures were treated, 24 h after culture initiation, with bromodeoxyuridine (BrdU) at a final concentration of 10 $\mu\text{g/ml}$.

Two hours before harvesting, colchicine was added to blood cultures at a final concentration of 20 $\mu\text{g/ml}$. At harvest, the cells were treated with a hypotonic solution (0.075 M KCl) and incubated at 37°C for 20 min. After that, the cells were fixed 3 times with the fixative (3 methanol:1 acetic acid). Finally, the cells were spread onto cold slides dipped in 70% ethyl alcohol. The slides were air-dried and stained using the fluorescence plus giemsa technique (Goto *et al.* 1975).

Thirty cells in second division were analyzed for each animal and the frequency of SCEs/animal was recorded. The means of SCEs and standard deviations were calculated for each breed and the data were statistically analyzed using the Student t-test.

Results and discussion

The frequency level of spontaneous sister chromatid exchanges was investigated in 21 animals belonging to 4 different breeds. The mean frequencies of SCEs/cell in Zaraibi, Damascus, Baladi and Sahrawi breeds were calculated as presented in Table 1. The frequencies of sister chromatid exchanges (mean $\pm$ SD) were 5.36 ± 0.66 , 7.95 ± 0.77 , 5.72 ± 0.79 and 6.11 ± 0.27 in Zaraibi (Fig. 1), Damascus (Fig. 2), Baladi (Fig. 3) and Sahrawi (Fig 4), respectively.

Statistical analysis of the results indicates that the Damascus breed showed a highly significant level of SCEs ($p < 0.001$) than the other 3 breeds. In addition, the increase of SCE mean value in Sahrawi breed was found to be statistically significant ($p < 0.05$) when compared to that of Zaraibi breed. No statistical differences in SCE frequency were found between Baladi and Zaraibi or between Baladi and Sahrawi breeds.

Differences in frequency of SCEs/cell between breeds have been reported in different species of the farm animals. In 3 Italian cattle breeds, Polodian, Fresian and Romagna reared in the same farm, Iannuzzi *et al.* (1991b) found that the mean values of SCEs/cell were 7.9, 7.1 and 7.3, respectively. The statistical analysis showed a significant difference between the Polodian and the Fresian breeds.

Oraby *et al.* (2002) have also investigated the differences in frequency of SCEs/cell between different breeds of sheep. They reported the significant differences between Farafra breed and other 2 breeds, Chios and Ossimi, reared in the same farm in Egypt and they attributed these significant differences to a breed specific difference and not to the influence of the environmental factors.

The mean frequency of SCEs/cell in Egyptian goats is 6.28 ± 0.15 (Table 1). The SCE frequency distributions of the 662 cells analyzed is presented in Fig. 5. The cumulative SCE frequencies of the total cell population of the 4 goat breeds did not follow a Poisson distribution since the observed χ^2 value of SCEs were highly significant ($p < 0.001$). This was also true when individual breeds were analyzed.

Table 1. Frequency of SCEs/cell in 4 goat breeds

Goat Breed	No. of animals	No. of examined cells	Range of SCEs/cell/animal	SCEs/cell/breed Mean $\pm$ SD
Zaraibi	5	150	4.60–7.13	5.36 ± 0.66
Damascus	6	180	7.00–9.07	7.95 ± 0.77
Baladi	5	150	4.48–6.92	5.72 ± 0.79
Sahrawi	5	182	5.73–6.57	6.11 ± 0.27
Total breeds	21	662	4.48–9.07	6.28 ± 1.15

Significant difference between breeds. Damascus $\times$ Zaraibi $p < 0.001^{***}$. Damascus $\times$ Baladi $p < 0.001^{***}$. Damascus $\times$ Sahrawi $p < 0.001^{***}$. Sahrawi $\times$ Zaraibi $p < 0.05^*$. Baladi $\times$ Zaraibi Not significant. Baladi $\times$ Sahrawi Not significant.

Figs. 1–4. 1) Metaphase spread showing sister chromatid exchanges in goat animal from Zaraibi breed. 2) Metaphase spread showing sister chromatid exchanges in goat animal from Damascus breed. 3) Metaphase spread showing sister chromatid exchanges in goat animal from Baladi breed. 4) Metaphase spread showing sister chromatid exchanges in goat animal from Sahrawi breed.

Fig. 5. SCEs frequency distribution in the total goat cell population.

SCE distribution does not follow a Poisson distribution. This has been previously demonstrated in goat (Di Meo *et al.* 1993), cattle (Iannuzzi *et al.* 1991a, b, Rangel-Figueiredo *et al.* 1995), river buffalo (Iannuzzi *et al.* 1988) and sheep (Di Meo *et al.* 2000). However, a Poisson distribution of SCEs was reported in cattle by Di Bernardino and Shoffner (1979), in sheep (Di Bernardino *et al.* 1997, Oraby *et al.* 2002) and in goat (Di Bernardino *et al.* 1996).

It should be mentioned, however, that the frequency of SCE in goat that reported by Di Bernardino *et al.* (1996) followed Poisson distribution only when the concentration of 5-bromodeoxyuridine was below 5 µg/ml but in the present study the concentration of 5-bromodeoxyuridine was 10 µg/ml.

Our study roughly agrees with results obtained from other related species, where the SCEs/cell ranged from 5.36 to 7.95 in different breeds, where the mean SCEs/cell for total goat population was 6.28 SCEs/cell.

In Bovidae, the frequency of SCEs/cell ranges between 5 and 9. In European cattle (Iannuzzi *et al.* 1991a) and in Italian river buffalo (Iannuzzi *et al.* 1988), the frequencies of SCEs/cell were 7.5 ± 3.4 and 8.8 ± 3.4 , respectively. In American Holstein Friesian cattle, a mean value of SCEs/cell of 5.4 ± 2.1 was reported by Di Bernardino and Shoffner (1979).

In Maltese goat and its Syrian derivative, the frequencies of SCEs/cell were 6.64 and 6.6, respectively (Di Meo *et al.* 1993). The frequency of SCEs/cell in some European sheep breeds was 7.20 ± 2.5 (Di Meo *et al.* 2000). The mean value of SCEs/cell in the total cell population of 6 sheep breeds in Egypt was 6.29 SCEs/cell (Oraby *et al.* 2002). In addition, Mursmatsu *et al.* (1999) reported that the mean values of SCEs/cell were 5.43 and 5.62 in 2 different horse breeds.

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