Polymorphism Detection in Alpha-Lactalbumin Gene and its Association with Some Productive Traits in Egyptian Goats

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ABSTRACT

The objectives of this study were to identify polymorphisms in exon III of the α-lactalbumin gene among three Egyptian goat breeds (Zaraibi, Damascus and Barki) and to investigate the effect of α-lactalbumin gene polymorphism, goat breed, type of birth, season of kidding, litter size and lactation stage on body weight and milk yield traits in Egyptian goats. One hundred and sixty blood samples were collected for DNA extraction; 74 from Zaraibi, 41 from Damascus, and 45 from Barki breeds. Two genotypes, TT and TC, in the α-lactalbumin gene were identified using single strand conformation polymorphism. DNA sequencing resulted in one non-synonymous MT163744: g.128T>C SNP (TCG Ser>CCT Pro) at the sixth nucleotide of α-lactalbumin gene exon III. Barki breed showed the highest heterozygosity (0.260) and effective number of alleles (1.345). The T>C SNP showed non-significant association with body weight traits. Body weights at birth, 3 months and 12 months in Damascus goat were significant and higher than those in Zaraibi. Kids born single were heavier than twins and triplets at birth age. The highest milk yield was recorded for Zaraibi does with three kids and at the first month of lactation stage. Moreover, the T>C SNP in the Zaraibi α-lactalbumin gene may be a useful marker for assisted selection programs to improve goat milk yield trait.

INTRODUCTION

Goats are considered one of the most important livestock especially in desert and semi-desert regions. Moreover, goats are easier to keep and less expensive than other livestock especially in developing countries, like Egypt (Khalil et al., 2013; Nowier et al., 2019). In Egypt, the main goat breeds include Baladi and Barki for meat production and Zaraibi for milk production (Galal et al., 2005). In addition to Damascus goats or Shami which are considered dual-purpose breed, imported from Syria to Egypt by Ministry of Agriculture (Jnied et al., 2013). Goat milk is highly recommended for infants, elderly, and convalescents, because of its higher nutritional value, digestibility, immunological properties, and the hypo-allergenicity compared to others (Le Parc et al., 2014). Goat milk can be consumed as it is, but a large proportion is processed to cheese and other dairy products producing a large amount of whey (Hejtmánková et al., 2012; El-Tarabany et al., 2018). Whey proteins have high nutritive value and considered one of the good sources of readily available proteins. α-lactalbumin (α-LA) is the most important and abundant whey protein in goat milk (Hejtmánková et al., 2012).

α-LA gene codes for α-lactalbumin and located on the fifth chromosome of goat (Ma et al., 2010). It has been hypothesized that the volume of milk yield is regulated by α-LA protein through synthesis of milk lactose which acts as a principle osmole of milk by drawing the water into the vesicles (Ma et al., 2010). α-LA is an important protein for nutrition, growth and development of the body (Layman et al., 2018). Therefore, α-LA gene is considered a candidate gene for the identification of molecular markers associated with milk yield and growth traits in farm animals. α-LA gene was associated with milk yield and composition traits in many farm animals such as cattle (Voelker et al., 1997; Kazmer et al., 2001), buffalo (Dayal et al., 2006) and goat (Dettori et al., 2015). Moreover, α-LA gene was associated with body size and performance traits such as chest circumference and cashmere productivity in goats.
Previous studies have shown that genetic and non-genetic factors such as genetic type of the animal, type of birth and season of kidding effect on body weight of goats (Mioč et al., 2011; Mahal et al., 2013; Atoui et al., 2017; Tesema et al., 2017) and lactation stage, parity and litter size effect on milk yield of goats (Mahmoud et al., 2014; Plegeuezuelos et al., 2015; El-Tarabany et al., 2018; Zamuner et al., 2020).

Single-strand conformation polymorphism (SSCP) is considered a powerful molecular technique for detection of DNA polymorphisms and may be used as a tool for the selection of economically important goat traits (Caroli et al., 2007). However, studies of the association of α-LA gene polymorphisms with milk yield and growth traits in goats are very scarce (Dayal et al., 2006; Zhou and Dong, 2013; Mir et al., 2014). Therefore, the objectives of this study were first, to identify polymorphisms in exon III of the α-LA gene in three Egyptian goat breeds (Zaraibi, Damascus and Barki), second, to investigate the effect of α-LA gene polymorphisms, breed, type of birth and season of kidding on body weight traits in Zaraibi and Damascus breeds and third, to investigate the effect of α-LA gene polymorphism, litter size and lactation stage on milk yield trait of Zaraibi goats.

MATERIALS AND METHODS

Statement of animal rights

All procedures performed in this study involving animals were in accordance with the ethical standards of the institution or practice at which the studies were conducted (Committee of Animal Care and Welfare, Benha University, Egypt) with an approval number: BUFVTM 2019.

Animals and management

One hundred and sixty goats belonging to three breeds; Zaraibi (n= 74), Damascus (n= 41) and Barki (n= 45) were used in this study. These animals belong to Animal Production Research Institute, Agriculture Research Center, Ministry of Agriculture, Egypt. Semi-open pens were used for housing goats. They were fed on Egyptian clover (Trifolium alexandrinum) from December to May and on a concentrate mixture and rice straw during the rest of the year. The concentrate mixture was composed of cotton seed cake, maize, rice bran, wheat bran, calcium carbonate and sodium chloride, with an average composition of 16% crude protein, 15% crude fiber and 3% crude fat. During the mating season (June and October), does were randomly divided into mating groups and each was randomly assigned to a fertile buck. First mating of young females was occurred at the age of 18 months. At kidding, newborns were tagged and their gender, type of birth and pedigree were recorded.

Measurement of live body weight of Zaraibi and Damascus kids

Data on Zaraibi and Damascus kids at different ages including live body weights at birth (BW), 3 months (3MW), and 12 months (12MW) were determined by individual weighing on an electronic scale with accuracy of± 0.05 kg.

Measurement of milk yield of Zaraibi goats

The elected Zaraibi dairy goats were primiparous at first parity of lactation with healthy and symmetrical udders. Zaraibi goats were examined daily for clinical signs of mastitis. Any dairy goats suffering from mastitis were eliminated from the study. Estimation of milk yield (MY) during suckling period was calculated biweekly for each doe by weigh-suckle-weigh method in addition to the residual milk obtained by hand milking (Benson et al., 1999). Kids were separated from their dams and allowed only to access milk from their dams at 08:00 and 17:00 o’clock daily. This protocol started at 3rd day after birth until weaning at day 90th day. The MY of the doe was calculated by adding the sucked milk at the two periods by the kid to the residual milk (Benson et al., 1999). After suckling period, MY was recorded on a biweekly basis for each individual goat throughout their first parity. Animals were hand milked twice weekly in the morning with two workers having comparable efficiency. The yield of each doe was determined by weighing the milk then lactation stage was divided into seven months across the first studied parity.

DNA extraction and polymerase chain reaction

Genomic DNA was extracted from blood samples of the 160 goats using a GeneJET Genomic DNA Purification Kit, following the manufacturer’s protocol (#K0721, Fermentas, Waltham, MA, USA). DNA fragment of 268 bp from exon III of the α-LA gene was amplified using previously published primers (Cosenza et al., 2003). PCR mixture was consisted of 1.0 μM forward and reverse primers, 0.2 mM dNTPs, and 1.25 U of Taq polymerase. The reaction mixture was added to PCR tubes containing 50 ng of goat genomic DNA. Reactions were conducted using the following cycling conditions: initial denaturation for 5 min at 95°C followed by 30 cycles of denaturation at 95°C (60 sec), annealing at 60°C (60 sec) and extension at 72°C (120 sec) and the final extension for 10 min at 72°C. PCR amplicons were tested by electrophoresis on 2% agarose gel in 1x TBE buffer alongside a Gene Ruler TM 100 bp Ladder (Thermo Fisher Scientific, Waltham, MA,
USA) as a molecular weight marker. Agarose gels were stained with ethidium bromide (Gibco-BRL, Waltham, MA, USA) and visualized on UV trans-illuminator.

**Single-stranded conformation polymorphism (SSCP)**

PCR products of α-LA gene were genotyped by SSCP analysis method (Orita et al., 1989). The obtained conformation patterns were identified and transformed into corresponding genotypes (TT and TC) according to sequenced samples. Equal volumes (5 μl) of PCR products and denaturing solution (95% formamide, 25 mM EDTA, 0.025% xylene-cyanol, and 0.025% bromophenol blue) were mixed and heated at 98°C for 10 min, and then chilled on ice. Denatured DNA was subjected to polyacrylamide gel electrophoresis (80x73x0.75 mm) in 1× TBE buffer at 200 volts for 2.5-3.0 hours. Gels were visualized under UV light after staining with ethidium bromide then photographed with an FX Molecular Imager apparatus (BIO-RAD, Hercules, CA, USA).

**DNA sequence**

DNA sequencing was conducted for four samples; two samples from each conformation pattern for converting these patterns into the corresponding genotypes (TT and TC). The amplicons were purified by a PCR Purification Kit (Roche, Mannheim, Germany) and sequenced using the same primers. A Big Dye Terminator v3.1 Cycle Sequencing Kit (Applied Biosystems, Foster City, CA, USA) was used for sequencing the samples according to the standard protocol, and then electrophoresed on an ABI PRISM 3500 Genetic Analyzer (Applied Biosystems). BLAST software (Altschul et al., 1990) was used for sequence identification and confirmation. Finch TV 1.4.0 (Geospiza, Inc., Seattle, WA, USA) and MEGA 7 (Kumar et al., 2016) softwares were used for sequence alignment and mutations detection.

**Statistical analysis**

Allele and genotype frequencies, heterozygosity (\(H_z\)), number of effective alleles (\(N_e\)), and Hardy-Weinberg equilibrium were estimated by using a GENALEX version 6.5 (Peakall and Smouse, 2012). The associations of different α-LA genotypes with body weight and milk yield traits were conducted using a two-way analysis of variance with fixed effects in a general linear model (GLM) using the SAS software ver 9.1.3 (SAS Institute Inc, Cary, NC, USA), with fixed effects in a general linear model (GLM) using the SAS software ver 9.1.3 (SAS Institute Inc, Cary, NC, USA), with fixed effects in a general linear model (GLM) using the SAS software ver 9.1.3 (SAS Institute Inc, Cary, NC, USA).

\[
Y_{ijkl} = \mu + G_i + B_j + L_k + M(L)_{jk} + e_{ijkl} \quad \text{Model 1}
\]

Where \(Y_{ijkl}\) is the body weight measurement, \(G_i\) is the fixed effect of the \(i\)th genotype (2 genotypes; TT and TC), \(B_j\) is the fixed effect of the \(j\)th breed (2 breeds; Zaraibi and Damascus), \(L_k\) is the fixed effect of the \(k\)th type of birth (three types; single, twins and triplets), \(e_{ijkl}\) is the random error assumed to be normally distributed with a mean = 0 and a variance = \(\sigma^2_e\)

\[
Y_{ijkl} = \mu + G_i + L_k + M(L)_{jk} + e_{ijkl} \quad \text{Model 2}
\]

Where \(Y_{ijkl}\) is the milk yield measurement, \(G_i\) is the fixed effect of the \(i\)th genotype (2 genotypes; TTand TC), \(L_k\) is the fixed effect of the \(k\)th litter size (three; single, twins and triplets), \(M(L)_{jk}\) is the interaction between the breed and type of birth, and \(e_{ijkl}\) is the random error assumed to be normally distributed with a mean = 0 and a variance = \(\sigma^2_e\)

**RESULTS**

**Sequence alignment and phylogenetic tree**

The nucleotide sequences of α-LA gene exon III that were conducted in this study were deposited in GenBank (NCBI accession No. MT163744.1 and MT163745.1). Alignment of the nucleotide sequences of this study via BLAST (Altschul et al., 1990) and Mega 7 (Kumar et al., 2016) software with the already published reference sequences of the caprine α-LA exon III gene including Spanish breeds (NCBI accession No. KF781121.1), Saudi breeds (NCBI accession No. KP940442.1), Chinese breeds (NCBI accession No. DQ673921.2 and DQ629104.1), French breeds (NCBI accession No. M63868) and Indian breeds (NCBI accession No. EU573193.1) revealed complete similarity except for nine SNPs at the start of exon III which resulted in changing of four amino acids at the beginning of exon III as shown in Figure 1.

![Fig. 1. Multiple sequence alignment of the first 14 nucleotides of α-LA gene exon III and their corresponding amino acids](image-url)

**Accession number (Species)**

| Accession number (Species) | 1 | 2 | 3 | 4 |
|----------------------------|---|---|---|---|
| MT163744.1 Capra hircus    | GCC | CTT | CGG | TAT |
| MT163745.1 Capra hircus    | P  | V  | H  | V  |
| MT163744.1 Capra hircus    | AGT | ATT | CTT | G  |
| MT163745.1 Capra hircus    | AGT | ATT | CTT | G  |
| KP940442.1 Capra hircus    | AGT | ATT | CTT | G  |
| KP940442.1 Capra hircus    | AGT | ATT | CTT | G  |
| DQ673921.2 Capra hircus    | AGT | ATT | CTT | G  |
| DQ673921.2 Capra hircus    | AGT | ATT | CTT | G  |
| M63868.1 Capra hircus      | AGT | ATT | CTT | G  |
| M63868.1 Capra hircus      | AGT | ATT | CTT | G  |
| EU573193.1 Capra hircus    | AGT | ATT | CTT | G  |
| EU573193.1 Capra hircus    | AGT | ATT | CTT | G  |
| DQ629104.1 Capra hircus    | AGT | ATT | CTT | G  |
| DQ629104.1 Capra hircus    | AGT | ATT | CTT | G  |
| KY485140.1 Ovis aries      | AGT | ATT | CTT | G  |
| KY485140.1 Ovis aries      | AGT | ATT | CTT | G  |
| KC415276.1 Bubalus bubalis | AGT | ATT | CTT | G  |
| KC415276.1 Bubalus bubalis | AGT | ATT | CTT | G  |
| JN258330.1 Bos taurus      | AGT | ATT | CTT | G  |
| JN258330.1 Bos taurus      | AGT | ATT | CTT | G  |

Fig. 1. Multiple sequence alignment of the first 14 nucleotides of α-LA gene exon III and their corresponding amino acids (NCBI accession No. MT163744.1 and MT163745.1) of this study with six α-LA reference sequences of goats retrieved from GenBank (NCBI accession No. KF781121.1 and KP940442.1 and DQ673921.2 and DQ629104.1 and M63868 and EU573193.1). Ovis aries (NCBI accession No. KY485140.1), Bubalus bubalis (NCBI accession No. KC415276.1) and Bos taurus (NCBI accession No. JN258330.1) species. P, Proline; V, Valine; H, Histidine; S, Serine; F, Phenylalanine; L, Leucine; D, Aspartic acid.
Neighbor-joining phylogenetic tree based on nucleotide sequences of $\alpha$-LA gene exon III of Egyptian goats with other goats’ reference sequences revealed that Egyptian sequences clustered together in one clade while others clustered in another clade with *Ovis aries* species as shown in Figure 2. The clustering pattern of *Bubalus bubalis* and *Bos taurus* might be explained by their different species type.

DNA sequencing resulted in one non-synonymous MT163744: g.128T>C SNP (TCG Ser>C CG Pro at position 81 of the mature protein) and within the sixth nucleotide in exon 3 of $\alpha$-LA gene (Fig. 4).

Fig. 2. Neighbor-joining phylogenetic tree based on nucleotide sequences of $\alpha$-LA gene exon III fragments of Egyptian goats (NCBI accession No.MT163744.1 and MT163745.1), with six $\alpha$-LA reference sequences of goats retrieved from GenBank (NCBI accession No. KF781121.1 and KP940442.1 and DQ673921.1 and DQ629104.1 and M63868 and EU573193.1), *Ovis aries* (NCBI accession No. KY485140.1), *Bubalus bubalis* (NCBI accession No. KC415276.1) and *Bos taurus* (NCBI accession No. JN258330.1) species act as out-group.

**Polymorphism in the $\alpha$-LA gene in Egyptian goat breeds**

The SSCP analysis showed two different conformation patterns (two genotypes) in the investigated three Egyptian goat breeds (Fig. 3).

Among the three Egyptian goat breeds, the TT genotype showed the highest frequency of 78.1%, while the TC genotype occurred at a frequency of 21.9 %, and the CC genotype was absent. Genotype and allele frequencies, expected heterozygosity ($H_e$), number of effective alleles ($N_e$), and Hardy-Weinberg equilibrium are presented in Table I. The Damascus breed showed the highest values for $T$ allele (0.929) and TT genotype (0.857) frequencies, while the Barki breed showed the highest $H_e$ (0.260), and $N_e$ (1.345). A chi square test showed that Egyptian goat populations were in Hardy-Weinberg equilibrium.

**Effect of $\alpha$-LA genotype on body weight traits of Zaraibi and Damascus goat breeds**

Results of the association between $\alpha$-LA genotype, breed, type of birth and season of kidding on body weight of Zaraibi and Damascus goat breeds are presented in Table II. The results showed that the MT163744: g.128T>C SNP of $\alpha$-LA gene had non-significant effect on body weight traits. However, the T/C genotype recorded higher body weight at 12 months, the significance value was critical ($P = 0.051$). Body weights at birth, 3 months and 12 months of Damascus goat were higher and significant than those of Zaraibi. Kids born single of our study were heavier than twins and triplets at age of birth. On the contrary; there was no significant effect of kidding season on body weight traits. The interaction between the breed and type of birth was highly significant for studied body weight traits (data not shown).
Table I. Genetic polymorphism of α-LA gene in three Egyptian goat breeds.

| Breeds   | No. | Observed genotype frequencies | Expected genotype frequencies | Allele frequencies | Hardy-Weinberg equilibrium | χ²-test | P value |
|----------|-----|--------------------------------|-----------------------------|-------------------|---------------------------|---------|---------|
|          |     | TT  | TC | CC | TT  | TC | CC | T  | C | HE  | NE |          |         |         |         |
| Zaraibi  | 74  | 0.787 | 0.213 | 0.000 | 0.798 | 0.191 | 0.000 | 0.893 | 0.107 | 0.192 | 1.235 | 1.069 | 0.301*** |
| Damascus | 41  | 0.857 | 0.143 | 0.000 | 0.862 | 0.133 | 0.000 | 0.929 | 0.071 | 0.134 | 1.153 | 0.249 | 0.618*** |
| Barki    | 45  | 0.698 | 0.302 | 0.000 | 0.721 | 0.257 | 0.000 | 0.849 | 0.151 | 0.260 | 1.345 | 1.364 | 0.248*** |
| Mean     | 160 | ±0.046 | ±0.046 | ±0.000 | ±0.041 | ±0.036 | ±0.000 | ±0.023 | ±0.023 | ±0.036 | ±0.056 |         |         |

No, number of animals; HE, expected heterozygosity; NE, effective number of alleles; ns, not significant.

Table II. Effect of α-LA genotype, breed, type of birth and season of kidding on live body weight (Kg) (LSM±SE) of Zaraibi and Damascus goat breeds.

| Independent factors | N   | Weight at birth P value | Weight at 3M P value | Weight at 12M P value |
|---------------------|-----|-------------------------|----------------------|-----------------------|
| Genotype            |     |                         |                      |                       |
| TT                  | 93  | 2.37±0.08               | 11.42±0.32           | 24.78±0.87³          |
| TC                  | 22  | 2.38±0.12               | 11.01±0.46           | 27.44±1.24³          |
| Breed               |     |                         |                      |                       |
| Zaraibi             | 74  | 1.63±0.09³             | 10.03±0.35³          | 24.07±0.96³          |
| Damascus            | 41  | 3.13±0.12²             | 12.39±0.48²          | 28.14±1.30²          |
| Type of birth       |     |                         |                      |                       |
| Single              | 33  | 2.59±0.09³             | 11.13±0.37           | 25.69±1.01           |
| Twins               | 74  | 2.54±0.08               | 10.63±0.32           | 25.01±0.87           |
| Triplets            | 8   | 2.00±0.17               | 11.88±0.66           | 27.63±1.79           |
| Season of kidding   |     |                         |                      |                       |
| Autumn              | 25  | 2.44±0.11               | 11.31±0.44           | 26.59±1.19           |
| Spring              | 90  | 2.31±0.08               | 11.12±0.29           | 25.62±0.80           |

Within column, means bearing different superscripts differ significantly. No, number of animals; LSM, least square mean; SE, standard error; ***P < 0.001 ns, not significant; *p<0.05; **p<0.01; ***p<0.001

Effect of α-LA genotype on milk yield of Zaraibi goat breed

The associations between the α-LA genotype, litter size and lactation stage on the first parity milk yield of Zaraibi goats are presented in Table III. The results of this study showed that the MT163744: g.128T>C SNP of α-LA gene had a significant effect on milk yield of Zaraibi goats, with higher values observed in individual goats carrying the T/T than T/C genotypes. The triplets litter size recorded a higher and significant value for milk yield trait. Milk yield decreased significantly from early to late lactation stage. The interaction between lactation stage and litter size was highly significant for milk yield trait (data not shown).

DISCUSSION

In recent years, a growing demand for goat milk consumption has driven the commercialization of dairy goat farming and has urged the researchers for studying the factors affecting the productive traits of goats (El-Tarabany et al., 2018). Our study aimed to identify α-LA gene polymorphism in Egyptian goat breeds and determine its association with the growth and milk yield traits. The differences between the nucleotide sequences alignment in addition to the clustering pattern in the phylogenetic tree of Egyptian goat sequences after comparing them with the reference sequences of the caprine α-LA gene might be attributed to the differences in the breed origin and to
the different selection programs applied on Egyptian goat breeds. Two genotypes were detected in exon III of the Egyptian α-LA gene in this study. In the three investigated goat breeds, the T/T genotype predominated with a frequency of 78.1%. Similar results were reported by Lan et al. (2007), who identified only two α-LA genotypes; T/T and T/C with frequencies ranged from 95.3% to 100.0% and from 0.00% to 0.047% in nine Chines goat breeds respectively. Moreover, Cosenza et al. (2003) reported the highest frequency of 0.83% for the T/T genotype in three Italian goat breeds. By contrast, Jain et al. (2008) reported only one conformational pattern of α-LA exon III gene in Indian Jakhrana goats.

Table III. Effect of α-LA genotype, litter size, lactation stage on milk yield (litre) (LSM±SE) of Zaraibi goat breed.

| Independent factors | N  | Milk yield of 1*parity | P value |
|---------------------|----|------------------------|---------|
| Genotype            |    |                        |         |
| TT                  | 58 | 26.69±0.76e             | 0.025*  |
| TC                  | 16 | 24.72±1.03d             |         |
| Litter size         |    |                        |         |
| Single              | 32 | 23.24±0.67b             | 0.004** |
| Twins               | 39 | 23.20±0.65b             |         |
| Triplets            | 3  | 30.67±1.89b             |         |
| Lactation stage (monthly) | | | 0.007** |
| 1                   | 74 | 53.66±1.91d             |         |
| 2                   | 74 | 42.07±1.91d             |         |
| 3                   | 74 | 33.19±1.91d             |         |
| 4                   | 74 | 14.42±1.91d             |         |
| 5                   | 74 | 14.21±1.91d             |         |
| 6                   | 74 | 11.84±1.91d             |         |
| 7                   | 74 | 10.54±1.91d             |         |

Within column, means bearing different superscripts differ significantly. No. number of animals, LSM least square mean, SE standard error; * p<0.05; **p<0.01.

Our results showed that T>C SNP of α-LA gene had non-significant effect on body weight traits. Similar results were reported by Ma et al. (2010) who recorded a non-significant effect of α-LA exon 1 gene on body size traits such as body height and height at the withers of Chinese dairy goats. Damascus goats of this study showed heavier and significant body weights at birth, weaning and yearling ages than Zaraibi ones. Youssef et al. (2014) reported similar results, where Damascus breed showed heavier body weights than Zaraibi at birth and weaning ages.

Birth weight of kids is considered as one of the most important contributory factors for growth and survival of goats (Tesema et al., 2017). Type of birth significantly effect on kids’ birth weight of the current study, Kids born single were heavier than twins and triplets at birth age. Our results were in agreement with Mahal et al. (2013) in Bangladesh Black Bengal, Atoui et al. (2017) in Tunisian local goat and Tesema et al. (2017) in Ethiopian goats who reported heavier birth weight for kids born single. In contrast, Singh et al. (1990) reported a non-significant differences between birth weights of single, twins and triplets in the local and crossbred Indian kids. The differences in weights between different types of birth might be attributed to the intrauterine environment where more nutrients are available to the single kid, more space as well as lack of competition may improve growth and increase the birth weight of single born kid. The reduced birth weights of twins and triplets born kids should be corrected and compensated by extra managerial care such as longer periods of suckling before milking the extra milk. Moreover, the farmers should maintain the body weight of dams during mating and pregnancy by improving the feeding and managerial condition in order to improve kids’ birth weight (Tesema et al., 2017). In agreement with previous studies that recorded a non-significant effect of kidding season on birth weight of Emirati goats (Al-Shorepy et al., 2002) and on body weights at 6 months, 12 months and 18 months of Ethiopian goats (Dadi et al., 2008), our study recorded non-significant effects for season of kidding on the studied traits.

Regarding the factors affecting milk yield of Zaraibi goat breed, the results of this study showed that T>C SNP of α-LA gene had a significant effect on milk yield, with the individual goats carrying T/T genotype yielded more milk than T/C ones. In goats, Dettori et al. (2015) recorded similar results to those in our study, with significant associations between two SNPs in α-LA gene with daily milk yield in Italian Sarda goats. By contrast, Alkass and Merkhan (2011) reported non-significant associations between two SNPs in α-LA gene exon I and exon III with milk yield in Australian dairy goats (Zamuner et al., 2020) and in Murciano-Granadina Spanish goats (Pleugeuzieux et al., 2015). By contrast, Alkass and Merkhan (2011) reported non-significant association between litter size and...
milk yield of Iraqi goats. The physiological mechanisms during pregnancy in addition to the suckling reflex might explain why the does with three kids yields more milk than single and twins (Mech et al., 2008). Milk yield of Zaraibi goats in the current study was significant and higher at the first month of lactation stage, probably due to the increase in the number and efficiency of secretory cells at this lactation stage. Our results were in agreement with those reported by Mahmoud et al. (2014) in Sudanese Damascans goats, and El-Tarabany et al. (2018) in Egyptian Baladi goats who reported that the highest and significant milk yield were recorded during the first stage of lactation. On the contrary, Idamokoro et al. (2017) reported non-significant differences at different lactation stages in South African goats.

In conclusion, Damascus goats of this study showed a significant and heavier body weight than Zaraibi, indicating that this imported breed still expresses its genetic potential under the Egyptian environmental conditions. The current study showed that litter size and lactation stage played significant roles in the profitability of Zaraibi goats through their effect on milk yield. Zaraibi goats with the highest milk yield were recorded for does with three kids and at the first month of lactation stage. Kids born single were heavier than twins and triplets at age of birth, so that twins and triplets born kids should be compensated by extra managerial care. Our results suggested that the T/C SNP of the α-LA gene significantly affected milk yield in Zaraibi goats. Such a polymorphic locus may be useful as a marker in assisted selection programs for the improvement of milk yield in the Zaraibi goats. Further cataloging of the Egyptian goats’ α-LA gene and further studies on the possible genetic association of this gene with functional properties of whey, whey products and milk renneting in goats are eagerly anticipated.

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Statement of conflict of interest

The authors have declared no conflict of interest.

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