Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2017; 5(4): 906-909

Received: 26-05-2017
Accepted: 27-06-2017

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A review of genetic and biological status of Iranian two-humped camels (*Camelus bactrianus*), a valuable endangered species

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Abstract
Camelus bactrianus is a species with a history of several thousand years ago and according to the authentic documents, the main origin of this species is Iran. In the meantime, Bactrian camels (*Camelus bactrianus*) is a valuable animal considered as genetic and biological capital. Unfortunately, the population of these animals has been declining in recent years so that right now there are only 150 camels in the country and it can be claimed that the only habitats of this Valuable species in Iran, is Ardabil Province. Iranian two-humped camels have a native type with fluffy and fleshy breed with grayish tan to light white and its male and female heights are 185 and 180 centimeters. Molecular studies using microsatellite markers have shown that the Bactrian camels, despite very small population size, have still acceptable genetic diversity and the extension of this genetically valuable species in the country could be prevented by proper management and breeding programs. Also the PIMA technique (PCR Isolation of Microsatellite Arrays) has a good application for the isolation and identification of microsatellite markers of Bactrian camels and this method is a useful tool to conduct population genetics studies and identity Bactrian camels. The conducted Phylogenetic studies have shown that Bactrian camels have the highest percentage of similarity in terms of genetic relationship in camelidae family and has minimum genetic distance with domesticated Bactrian camels and has the lowest similarity and maximum genetic distance with *lama* species.

Keywords: Iranian two-humped camels, biological status, extinction

1. Introduction
Camels are classified as under: Class: mammals, Order: Artiodactyla, Sub-Order: Tylopoda and Family: Camiladae. There are two genera in this family including *Camelus* genus (camels in ancient world) and *lama* genus (camels in the new world, camels without hump). The *Camelus* genus includes two species: *Camelus dromedarius* (dromedary) and Bactrian camels (*Camelus bactrianus*) [2].

a) The economic importance of camels
Camel is known around the world as a resistant, low demand and high potential species [1]. The husbandry of which is increasing due to the importance of developing food items, shortage of pastures and unique animal products compared with other animals. Iran is a region that has undergone fewer genetic changes in livestock and poultry and camels are more subject to this issue. Camels economic figures include high bearing strength, adaptability to harsh environmental conditions, motility and long marching and the ability to produce various products such as meat and wool and it has been interested by the researchers due to its surprising physiological and anatomical structure [1]. Camel meat is similar to beef. Camel milk is also rich in vitamin C which doubles the these animal's milk importance. Other camels products are wool and hair the amount of which is higher in alpaca hump-less camels (*Lama* genus) and it is economically important. The Bactrian camels wool is more than the single humped camels and their wool and hair is used to weave tents, carpets, ropes, blankets and so on [1].

b) The number of camels in the world
Studies conducted in Iran show that during the past years in our country the Bactrian camels are grown more than the dromedary but over time because of more adaptability of dromedary with the climatic conditions [1]. This species is brought to Iran from the Arabian countries and

the Bactrian camels are replaced by them. According to the World Food Organization (FAO), there were 24,644,228 camels in the world 85% of which have been living in Africa (equal to 20,969,015 camels). Iran's share of the total number of camels in the world was 150,000 dromedaries that form 0.56% of the total population of the world's camels [8]. The pasture area in Iran is more than 30 million hectares that in the current situation only 0.25 of the capacity is used [1]. Dromedaries in Iran were mostly living in the southern, south-eastern and central provinces in Iran but the main and only Bactrian camel's breeding center in Iran is in Ardabil province and it is very important in this case [1].

c) Distribution and biological pattern of Bactrian camels in Iran

Bactrian camel is cloven footed and has two humps in his back. This animal is either domestic or wild (*Camelus bactrianus ferus*). The domestic species lives in steppe regions of Central Asia and in some parts of these countries with Bactrian camels [11]. *Camelus bactrianus* is a species with a history of several thousand years the origin of which is Iran according to the documents [15].

Meanwhile Iranian two-humped camels are extremely valuable livestock that reside in Iran, Ardabil Province (Moghan and Meshginshahr). Bactrian camel has always had a special place among the Moghan and Azerbaijan nomads, because this animal carries their means of live during winter and summer through the highlands of Sabalan Mountain [3]. Unfortunately, today with the arrival of motor vehicles in the lives of nomads, the population of this species has declined sharply [14]. Despite the efforts made to protect this valuable species, Bactrian camel's population in Iran has declined, so that, right now there are less than 150 Bactrian camels in Iran (Ardabil province) [3].

Bactrian camel in terms of anatomical features is an animal that has long hair and strong body and its male and female heights are 185 and 180 centimeters. The average live weight of the this animal is about 460 kg. The hump thickness is 35-40 cm that the overweighed Bactrian camels have more than 100 kg fat [3]. It is also a highly adaptable and resistant animal that is capable to withstand the temperatures -30to30 °C [5].

According to the above, the economic optimization of this genetic reservoir and the ability to maintain it is possible only if there is sufficient knowledge and right genetic information regarding Iranian Bactrian camels through different genetic tests and known methods and it seems that knowing and maintaining this rich genetic source requires further studies in this field.

Considering this fact, the Iranian two-humped camels (*Camelus bactrianus*) are valuable and endangered animal species, Study and compilation of the results of different researches on the current situation of this species, is an essential element in planning for generation multiplication and increasing the number of this species in Iran and preventing of its extinction. Therefore, the publication of this article, can be very effective step in helping to authorities about maintaining of these Iranian camels.

2. Biological, morphological and protection studies

Abarghany *et al*. [1], studied the morphological, biological, reproductive (maturity, age at first calving, calving interval, mating, birth weight, calving season, duration of pregnancy, duration of breastfeeding, etc.) distribution, production, nutrition and so on related to Bactrian camels (in Ardabil). Bactrian camels' biometry includes morphological traits such as: chest circumference, abdominal circumference, body length, height at withers, abdominal width, ground to hump height, the height of humps, the base of the hump, humps' semicircular, hip width, neck length, snout circumference and the head length [1].

The results of morphological studies showed that all Bactrian camels in the province are fluffy and fleshy breed with light to dark brown (33.5%), dark brown (25%), ocher (20.8), ocher to dark brown (25%), gray-brown (4.2%) and white to gray-brown (4.2%). of course, there are less white Bactrian camels [1]. The pure camel wool is unknown, but the overall product (wool+hair) is 8.46+2.56 kg on average and 15 and 4.5 maximum and minimum annually and the overall product (wool + hair) in mature male camels is more than female camels [1].

About 79.2% and 20.8% of Bactrian camels mate in winter and winter/spring (April only) respectively. Minimum and maximum duration of pregnancy in female camels is estimated as 12 and 13 months. On the other hand the age of first pregnancy in female Bactrian camels is 4 years old that have been pregnant at age 3 years old [1]. The percent of stillbirths, miscarriages, twinning and infertility is estimated is estimated zero in all herds. Female Bactrian camel's birth weight is 48-30 kg and this is estimated as 32-50 kg in males. Bactrian camels' breastfeeding duration is 9-12 months. Basically, Bactrian camel produces little milk all of which is used by the baby camel and consumption amount is unknown. So no milking occurs in Bactrian camels. The age of onset of grazing in baby camels is between the age of 1 to 3 months [1].

In the biometric study the mean and standard deviation of the biometric attributes of male and female camels (separately) was studied in six groups (under one year, one year, two years, three years, four years and five years (up). Analysis of variance showed that the effect of five age groups in Bactrian camels (other than below 1 year old) is significant on all biometric traits, except the distance between the two humps (P<0.05). Also comparing the means with Duncan test shows that in the majority of biometric traits there was a significant difference between the age groups 1 year and five years (up) and the rest of groups (P<0.05). But no significant difference was observed between the age groups of two, three and four years old (P>0.05). Researchers found almost the same results regarding the male camels [1].

It should be noted that in 2010, the project to convert Bactrian camel's fetus to Uterus of female dromedary was accomplish which is considered as an important step towards increasing the proliferation of this valuable species (from Iranian Student's News Agency (ISNA), Address: www.isna.ir).

In another action by Iranian Biological Research Center (IBRC), the Bactrian camel cells were produced in order to preserve animal genetic resources. In this project, a sample of Bactrian camel's ear tissue was prepared under aseptic conditions and fibroblast cells were produced after different experimental processes for the preparation of fibroblast cells. Living tissue's Fibroblast cells' storage *in vivo*, could provide the researchers with reliable source of DNA for years. Moreover, by differentiating these cells into gamete cells, it is possible to restore and replicate Iranian Bactrian camel in vitro conditions [15].

3. Molecular (genetic and phylogenetic) studies

In addition to morphological studies, estimates of genetic variation at the molecular level, have great importance to

manage of genetic resources for their sustainable use and protection and their breeding programs. Among the various genetic markers to study population genetics of a species, microsatellite markers are of very high importance [7].

For this purpose, Shah-Karami *et al*. [14], sampled 110 Bactrian camels in various parts of Ardabil province and after extracting DNA from their blood, the microsatellite sites were studied by seven pairs of microsatellite markers (YWLL08, VOLP67, LCA77, LCA63, LCA56 and LCA33) and they studied the genetic markers of the population using the relevant software. The conducted molecular studies showed that all loci, except LCA77 that was uniformed, had appropriate polymorphism. All studied loci also showed significant deviation from Hardy-Weinberg equilibrium (P<0.001). The average effective allele was 2.622±0.534, observed heterozygosis was 0.714±0.184, expected heterozygosis was 0.498±0.114 and polymorphism information content (PIC) was estimated as 0.557±0.237. On the other hand, the maximum (0.771) and minimum (0.165) heterozygosis level and the maximum (0.742) and minimum (0.151) PIC values between polymorphic sites were associated with LCA33 and VOLP67 [14].

In another study, Talebi *et al*. [19], studied the genetic features of Bactrian camel using the Microsatellite primers of new world camelidae femily. It is worth noting that in recent studies, specific microsatellite markers of new world camelidae are recommended as useful genetic tools to study the genetic diversity of the Old World Camelids. In this study from 85 camels, 9 pairs of microsatellite markers were analyzed for evaluating of the polymorphism in this population. A total of 31 alleles were observed and all loci were polymorphic except one. The average number of alleles and polymorphism information content (PIC) were evaluated as 3.4444 and 0.4726respectively. All of loci were deviated from Hardy-Weinberg equilibrium (P<0.05). Average expected heterozygosis was 0.5242 regardless of monomorphic loci [19].

In other phylogenetic analyses, Shahabi and Tahmourespour [16], studied the NADH3 and NADH4L of mitochondria genome of Bactrian camels. In this study, amplification of 971 bp of mitochondrial genome of Bactrian camel is done by specific primers and the obtained results by two different haplotypes based on a polymorphism loci are shown in the sequences [16].

In another study, using PIMA technique (PCR Isolation of Microsatellite Arrays), the methods based on RAPD markers isolations, identification and sequencing of Bactrian camel genome were conducted. Allelic diversity and performance indicators of these new loci were studied in 40 Bactrian camels. The number of observed alleles was 3-5 [5].

4. Discussion

Bactrian Camels have a native type with fluffy and fleshy breed, unknown milk productall of which is used by the baby camel. The annual production of wool and hair is 8.46 kg on average while Chapman [4] notes that Russias Bactrian camels produced 700-800 kg of milk in a lactation period and reported the recoverable amount of milk as 300 liters and the average annual wool production as 11.5 kg (Chapman, 1985). Also Dzhumagulov [6] reported the amount of milk produced by Bactrian camels as 1187 liters with the 5.5% fat [6]. This indicates that the Russia's Bactrian camel type is different from Iranian Bactrian camels type due to producing significant amounts of recoverable milk and wool production. Therefore the production traits of Russian Bactrian camel are higher than Iranian Bactrian camels.

Iranian two-humped camelsmate for the first time at age three which is consistent with Chapman. The average birth weight of male and female Iranian two-humped camels was 40.16 and 38.25 kg while it is 34.9 and 34.4 in China Bactrian camels [20], and it is 35kg in 35 kg in Russia Bactrian camels [4]. Thus the weight of Iranian camels newborn is higher than Russia and China camels.

According to molecular information obtained from genetic studies in Iranian two-humped camels, the total number of alleles in the population is 25 alleles with four common alleles in different loci with an average of 3.571 for each loci [14], which is within the reported average allele range for China and Mongolia Bactrian camels (3.58-4.75) [12]. However, in another study by He *et al*. [9]. The diversity and genetic structure of 10 Bactrian camels population was analyzed by 18microsatellite markers. 9 out of 10 populations were belonged to chines Bactrian camels and the other one was related to Mongolian Bactrian camels. The results showed that all 10populationsof the Bactrian camel had a rich genetic diversity with a total of 242 alleles at 18 loci. The mean number of alleles per locus was equal to 13.44 and the number of effective alleles was 4.18 [9]. According to He et. [9], in Bactrian camels of China, the genetic diversity richness of camels in that country based on the number of alleles is more than the limited population of Bactrian camels in Iran.

Based on the results of genetic studies [14, 19], all microsatellite loci have not been in Hardy-Weinberg equilibrium and presented a significant deviation from Hardy-Weinberg equilibrium. According to the low size population, expecting the imbalance in Hard- Weinberg equilibrium seems logical.

The heterozygosis level is the most common measure of genetic diversity in a population, reported as observed and expected heterozygosis [7]. In Talebi *et al*. [19], the average expected heterozygosis is 0.5242, excluding monomorphic loci, and the expected and observed heterozygosis is measured as 0.489 and 0.714 in Shahkarami *et al* (2012). In another study to evaluate the genetic structure by Hong-Wei *et al*. (2009), the genetic diversity and evalution of 254 samples of China and Mongolian Bactrian camels was analyzed by 16 microsatellite markers. The results of this study showed that there is a high heterozygosis degree in camels belonging to both populations. The average of observed and expected heterozygosis evaluated as 0.61 and 0.6211 [10].

In Spencer *et al* [17], study on United Arabic Emirates (UAE), Australia and African dromedary camels, the average expected heterozygosis was 0.531, 0.530 and 0.646 respectively [17]. In other two studies the average expected heterozygosis for Australia, Kenya, Pakistan, Saudi Arabia and the United Arabic Emirates dromedary cemels were estimated as 0.526, 0.545, 0.561, 0.547, 0.577 and 0.602 respectively [13, 18]. According to the information, it can be mentioned that the heterozygosis value of Iranian two-humped camels is almost is close to the heterozygosis value ofthe rest of the world camels. In general, the results of genetic studies of Iranian Bactrian camels indicate that Iranian Bactrian camel despite its small population size, still has acceptable genetic diversity and using proper management and breeding programs, it is possible to prevent the extinction of this valuable genetic resource [14, 19].

In case of the phylogenetic status of Bactrian camels, the analyzed mitochondrial sequences [16], were compared with the domestic and wild Bactrian camels sequence for the same position. The results showed that the sequence obtained from

domestic Bactrian camel is similar to the recorded sequences and has close genetic relationship. The results showed that Iranian Bactrian camel has the highest percentage of similarity in terms of genetic relationship in Camelidae family (99.8%) and has minimum genetic distance with domesticated Bactrian camels (0.02%) and has the lowest similarity (82.2%) and maximum genetic distance (0.2%) with *lama* genus species.

The use of microsatellite loci is one of the best ways to study the genetic structure of a species [7]. Given that the diversity of identified microsatellite loci by PIMA has a good efficiency to isolate and identify microsatellite markers of Iranian two-humped camels and the diversity of the new loci has been good [5]. This methods can be used as a good method to perform population genetics studies and identifying of Iranian Bactrian camels.

5. Conclusion

In general, high genetic diversity of Iranian Bactrian camels could help to preserve this valuable species. Creating the fibroblast cell lines of this animal and successful embryo transfering process of this species to dromedary camels, are other effective measures in recent years that can help to prevent the extinction of these valuable animals, because this livestock is a valuable and precious genetic reservoir that has adapted to the climatic conditions in thousands of years and due to morphological and molecular studies, this kind of animal is in suitable condition to increase the number of population and further improvement of production traits that the relevant authorities should take steps to maintain and increase the population of this animal by its genetic and morphological potential and prevent the extinction of this valuable species.

6. Acknowledgement

I thank the authors of the papers are used in this review article and from the ACECR, Ardabil branch for supporting of this scientific article.

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