Camels in Egypt: Population, Diversity and Genetic Identification Challenges

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ABSTRACT

Globally, camels are reaching almost 35 million head, most of them are domesticated in Africa, mainly in Somalia followed by Sudan. In Egypt, camels' population recorded 119,885 thousand head in 2019, and during the period of 1994-2019 their numbers showed increases and decreases. Egypt is depending on importing camels from Somalia and Sudan with lower exporting rate. In the past, camels were not giving the required attention in spite of their morphological and physiological features that allow them to live and produce in harsh environmental conditions. Nowadays, the scientific communities gave camels attention due to their incredible features, and recently many studies have applied to identify the genetic merit of camels and produce new breeds such as the Tulu (new breed in Turky). Therefore, this review will focus on camels' population and breeds worldwide and in Egypt with particular references to the studies that concern about camel genome.

Keywords: Camel, population, breeds, diversity

INTRODUCTION

The total number of camels is estimated to be about 35 million head worldwide, majority of them are domesticated in Africa (FAO, 2019). Indeed, camels have several unique morphological and physiological features that allow them to survive, adapt and produce in harsh environmental conditions. They have physiological adaptations that allow them to withstand long periods of time without any external source of water. They can drink as seldom as once every 10 days even under very hot conditions, and can lose up to 30% of its body mass due to dehydration (Gaughan, 2011). Camels have thick coat that reflects sunlight, and a shaved camel has to sweat 50% more to avoid overheating (Al Jassim and Sejian, 2015). It also insulates them from the intense heat that radiates from hot desert sand. Besides that, their long legs help them to endure the scorching desert sands. With all these incredible features, it must increase camel's role in facing the excite and coming circumstances, such as climate change, increased population growth rate and elevation in animals' protein demand. But, to maximize camel utilization, it should provide accurate data about camel production rate and genetic biodiversity. Based on the data of The Domestic Animal Diversity Information System (DADIS), there are 97 camel breeds all over the world, 5 of them are found in Egypt (Legesse, et al., 2018 and Sallam, 2020). In Egypt, the scientists applied many studies to identify the genetic makeup of camels (El-Soudy et al., 2008 and Mostafa et al., 2017). While, it is urgently to carry out more studies to uncover camel genome that can be used to determine the production traits, which considered the main way in strategies of camel genetic improvement (Sallam, 2020).

Camel Population

At global level, the total camel's number is ~ 35 million head according to FAO (2019). During the period from 1994 – 2019, Africa (horn of Africa) contributes about 84.9 % of total camels in the world (Figure., 1). The most popular countries (having more than one million head) in camels' production are Somalia, Sudan, Niger, Ethiopia, Kenya, Chad and Pakistan. Meanwhile, Asia shares about 15% of their total number at the same period **(**Fay, 2014 and FAO, 2020).

Somalia is ranking the first country in camel production followed by Sudan (Table, 1), and the lowest one is Mali, during the period from 1994-2019 according to the statistics of FAO (2020). Camel's growth rate is characterized by regular rate in countries as; Sudan, Somalia and Egypt.

Table (1). Top countries in camel production (head) during the period 1994-2019**.**

No	Country	Continent	Camel population
1	Somalia	Africa	6,941,115.27
2	Sudan	Africa	4,821, 500
3	Chad	Africa	4,171,616.73
4	Sudan (former)	Africa	3,164,055.56
5	Kenya	Africa	2,045,205.62
6	Niger	Africa	1,589,113.62
7	Mauritania	Africa	1,382,542.5
8	Pakistan	Asia	924,346.15
9	Ethiopia	Africa	733,005.81
10	Mali	Africa	728,004.12

The higher growth rate is found in; Algeria, Chad, Oman and Qatar, the lower one was recorded in China, Magnolia and India (Fay, 2014). As for Egypt, if you ask people about Egypt, they will mention pyramids, River Nile and camel, that means camel, is important sign for Egypt and play important role in milk and meat production in the pastoral communities (Bauer, 2018). According to data of FAO (2011), Egypt is the most important country in importing camels from Somalia and Sudan, and the lowest in exporting them (Figure, 2). Camel's populations in Egypt were fluctuated between increases and decreases starting from 1994 until 2019.

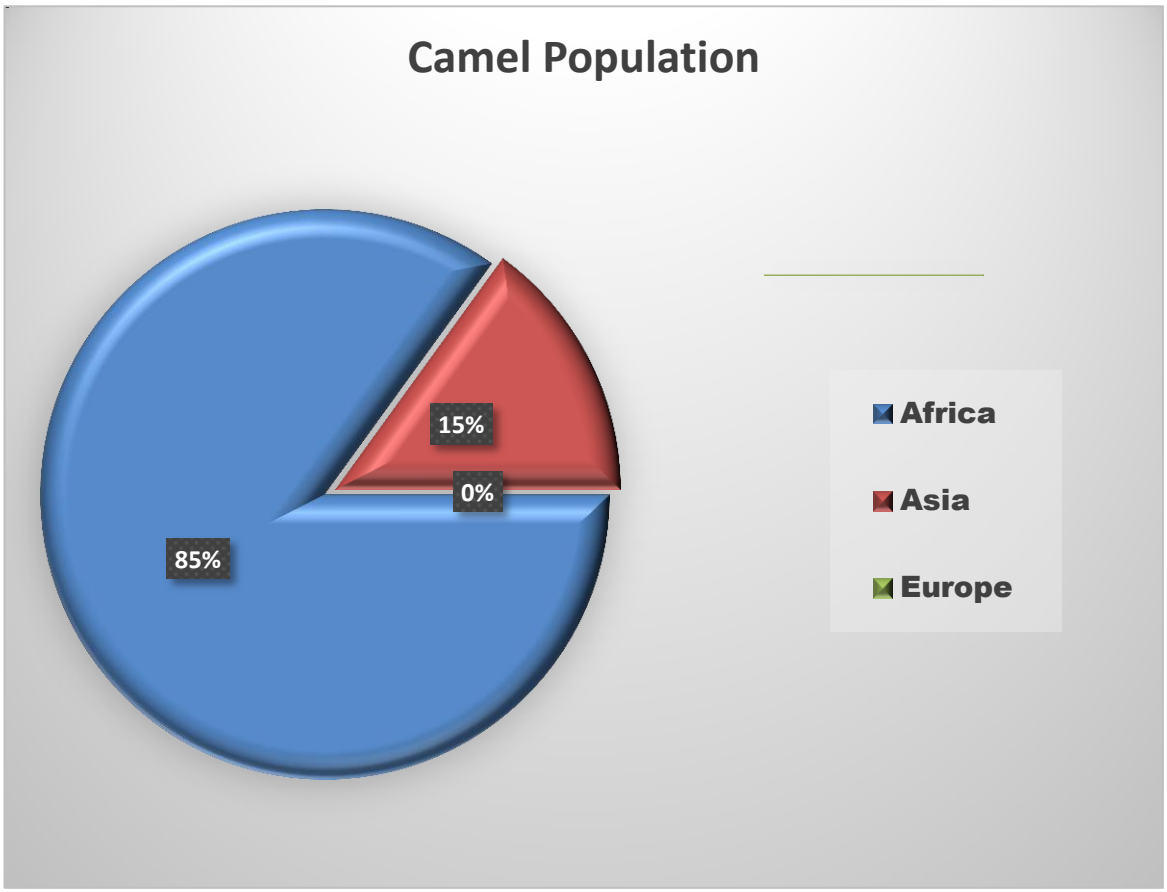
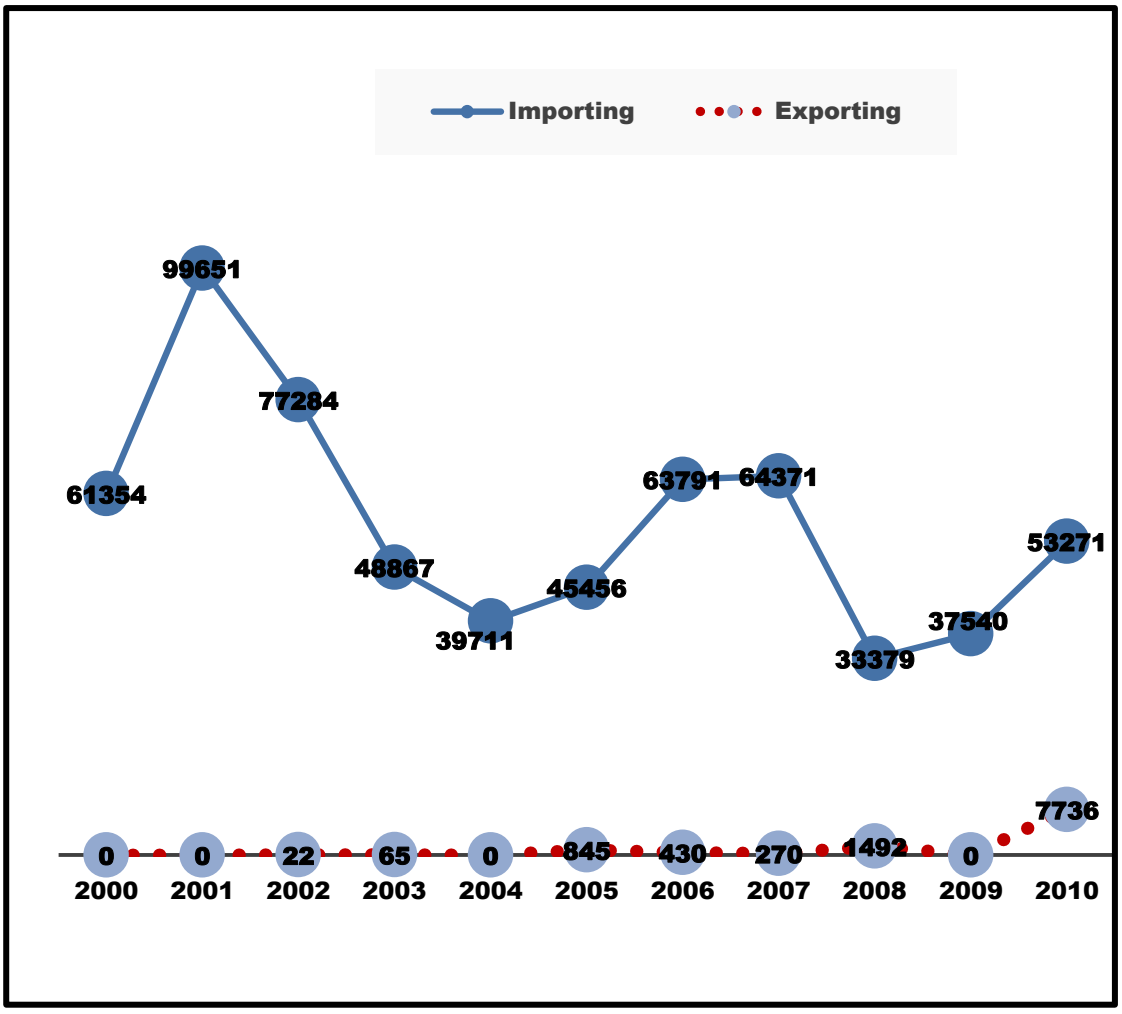


Figure (1). Camel population in Africa, Asia and Europe (FAO, 2020).



Figure(2). Imported and exported camels in Egypt during the period 2000-2010 according to FAO (2011).

Highest stock of camels was at 2006 and 2017, recorded 148.000 and 155,713 head (Figure, 3). After that, in 2007 a huge drop was noticeable, the stock reached to 83.000 and retained to rise in 2009 (137,112). During the period from 2011 to 2017camels stock increased steadily, elevated from 136,930 to 155,713. A sudden decline in 2018 was recorded, then retained to rise in 2019 (85,293 and 119,885, respectively). Generally camel stock in recent years were lower than the recorded at years 2006, 2011 and 2017. The previous mentioned data (according to FAO, 2020) cleared that, camel's production is unstable and its recent growth rate is declining. This decline could be related to the reduction in land specific for camel breeding and absence or meager of selection program for this breed. Therefore, this animal with his superior features needs more attention and interest from the scientists in various universities and agricultural centers to collaborate and enhance their reproductive and productive performance, which will be reflected positively on the economic of animal protein production.

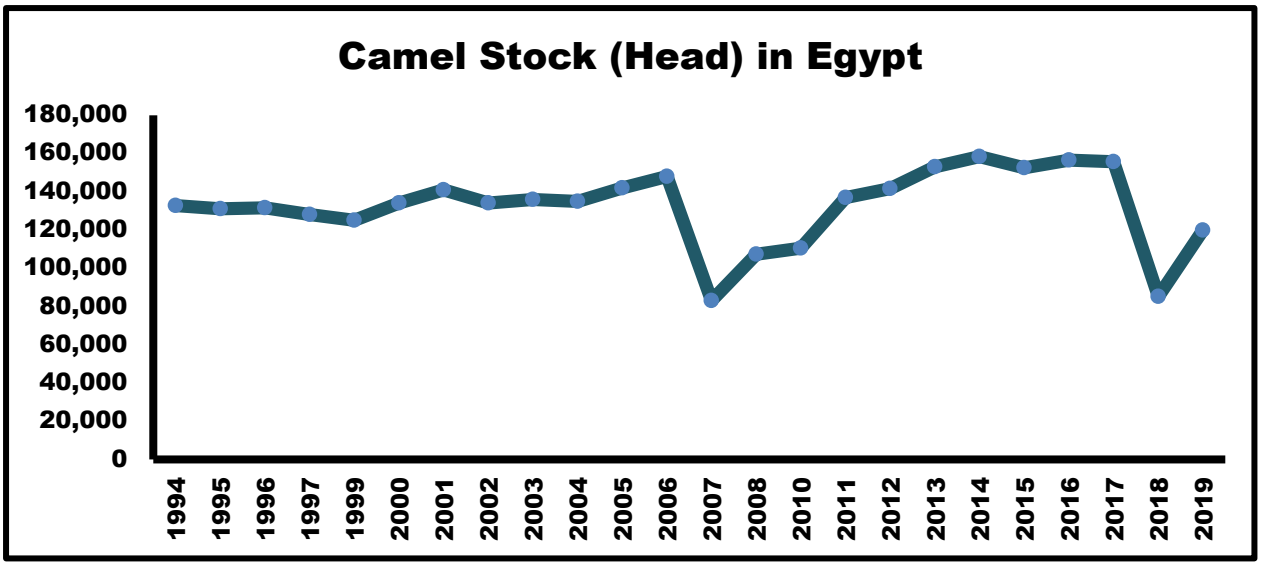


Figure (3). Camels stock in Egypt (FAO, 2020)

Camel Breeds

In Egypt, there are five breeds (Photo, 1), Falahi (Baladi), Somali, Sudani Maghrabi and Mowalled, that hybrid between Maghrabi and Baladi breeds (Ashour and Abdel-Rahman, 2022). They distributed in many regions such as; Nile Delta (Sharkia), Deseret regions (Matrouh) and Oases (New Vally). They are multipurpose animals (Table, 2) used for milk and meat production, wool production, transporting, tourism (in Pyramids). Additionally, camels are contributing in solving the unemployment problem, poverty alleviation and economic variegation (Sallam, 2020).

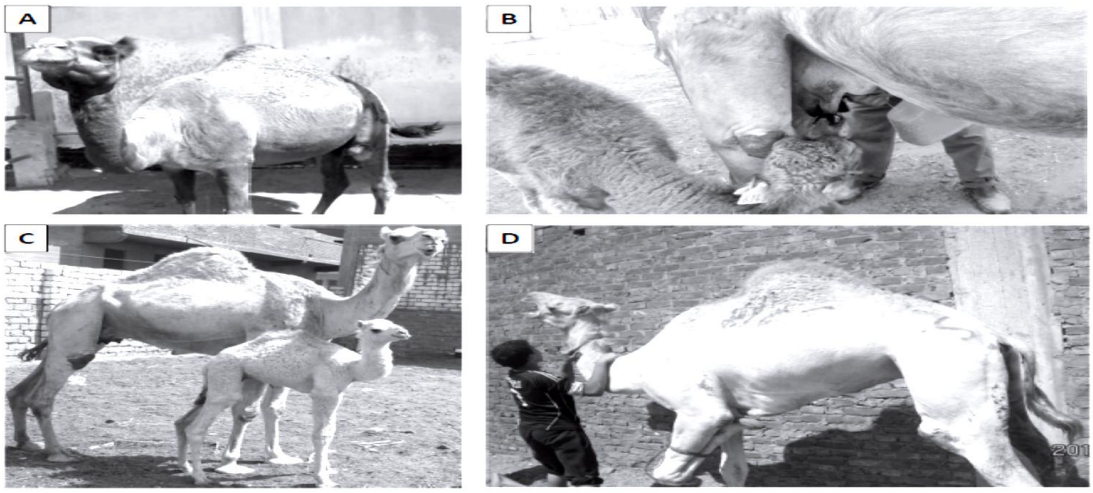


Photo (1). Egyptian dromedary camel breeds; A: Maghrabi, B: Hand milking of Maghrabi during calf sucking C: Sudani, and D: Somali. (**Ramadan and Miho, 2017).**

Table (2). Camels as multipurpose animal.

Purpose of use	Breed
Transporting	Falahi (Baladi)
Racing	Somali + Sudani
Meat and milk production	Maghrabi

Camels in Egypt are suffering from low reproductive efficiency due to late puberty, for example; Abdel-Aal et al. (2012) compared the reproductive and productive performance of two breeds in different governorates. Maghrabi (in New Vally and Matrouh) and Sudani (in Sharkia, Aswan and Aboramad-Halaieb-Shalateen triangle), they found that reproductive efficiency (age at first mating, conception rate and No. services for conception) and productive performance (milk

production, calf birth weight and calf weaning weight) were higher in Sudani than Maghrabi. They attributed their results to that, in Sharkia and Aswan governorates the breeders offered the green fodders which might have the positive role in enhancing productive efficiency. Furthermore, rearing camels in harsh environment such as Matrouh has negative impact on reproductive and productive performance.

Camel species and camel diversity.

As mentioned previously, the vast majority of camels (in different countries) are reared by pastoralists. They are depending on camel milk production especially during dry season, when other ruminants are not able to produce milk. This explain that, most of slaughtered camels are males more than females and they slaughtered young ages not only to get meat with high quality, but also to allow more milk for sale. Camel species are not classifying as other animal species, they classified according to ethnic group and geographical regions they are raised in. According to database of DADIS, there are 97 camel breeds in the world (Legesse et al., 2018).

At global level, few reports that describe the phenotypic diversity in different camel breeds. For example, in Kenya, there are three types of camel breeds; Somali, Turkana and Rendille (Gabbra) breeds (Table, 3), the breed Somali is owned by the Somalin people in northeastern of Kenya.

Table (3). Body weight and milk production of camel breeds in Kenya.

Breed	Adult female weight (kg)	Adult male weight (kg)	Milk yield (kg)
Somali	500-600	600-600	5-8
Turkana	350	400-500	2-3
Gabbra	350-450	400-500	3-4

Abdallah and Faye (2012) cleared that, there are 12 breeds in Saudi Arabia differ in their color coat, named with, Zangeh, Sahli (the coat is red), Saele, Majaheem (Mallah, with black color coat), Waddah, Homor, Aouadi, Awrk, Hadhana, Asail (colored by yallow), Sofor and Saheli. The female in Sahli, Awrk, Aouadi and Shageh breeds, are characterized with medium udder. While, Asail breed has narrow chest and small udder size and the best types in udder development are, Shaele, Waddah, Mallah and Sofor. Concerning male camel, both of Asail and Shaele has thin leg and neck, and they are suitable in racing but the Saheli one had thick nick. Meanwhile, Majaheem, Sofor, Waddah and Homor classified as big size breed and the biggest one is Sageh type.

In Tunisia, Chniter et al. (2013), described the phenotypic measurements of Maghrabi breed in different region on the southern of Tunisia. They found that, Maghrabi camels with big body size were domesticated in areas of Geoudi, Guiloufi and Merzougui, located in Kebili region. The smaller one was in the region of Medienin. This means that, the geographical distribution and their tribal differentiation have considerable effect on body measurements in Maghrabi camels. Furthermore, Bactrian camels in; China, Magnolia and Russia were genetically described by Ming et al. (2017). They reached to, the wild and domestic Bactrian camels do not have same maternal origin. Moreover, the Bactrian camels in India (in Ladak region) was recently morphologically described by Makhdoomi et al. (2013). They measured body length, distance between eyes, ear and face length and finally the distance between two humps. In general, the higher body measurements were recorded in male than female Bactrian camel, for example, neck length was higher in male than female about 40%. However, distance between eyes were wider in females than males, some of their study results are illustrated in Table (4).

Table (4). Body measurements in male and female Indian Bactrian camels.

Parameters	Male	Female
Shoulder height	2.4	2.2
Hump girth	2.5	2.4
Weight	672	587

In the same context, Lamo et al. (2020) pointed to the limited studies that concern with the morphological features of Indian Bactrian camels. While, few studies were established for dromedary camels. They confirmed the impotency of these studies to evaluate the differences between camel breeds and to apply selection programs for breeds with superior characteristics. In addition, this breed needs urgent morphological studies such as, skin thickness and hump size due
to their vital role in camel adaptability to cold environment. Because these two parameters are depending on the subcutaneous fat, which considered the non-glucose suppler for required energy. They added, camels have hematological ability to adapt to environmental conditions. Camels have higher hemoglobin concentration, more erythrocytes and higher percentage of packed cell volume (PCV) to accomplish biological functions. Likewise, camel erythrocytes can expand more in cases of hydration in comparison with normal conditions. Similarly for leukocyte which increase in their count and morphological changes in neutrophils in band and segmented cell are boost camel immunity. They concluded that, there are morphological and hematological variations between camel breeds, and they attributed these differences to breed diversity and environmental conditions.

In Ethiopia, camels have a vital role in socio-economic status in the pastoralist communities. A bout 8 breeds, Jigjaga, Issa, Borena, Kerreyu, Hoor, Ayden, Liben and Afar, in three different regions were morphologically and genetically analyzed by Legesse et al. (2018). They stated that, only two breeds (Afar and Borena) are already reported in FAO and they failed to analyze the other five breeds morphologically. Additionally, they cleared the current genetic available data are not enough to differentiate the eight aforementioned breeds and suggested for further studies on Ethiopian camel breeds.

Ishag et al. (2011) mentioned that, camels in Sudan are, Rashaidi, Lahwee, Anafi, Bishar, Kabbashi, Maganeen, Shanbali, Kenani, Maalia and Butana (Photo, 2), and these breeds are distributed all over the Sudanese area. Additionally, these camels have same morphological features (except; Rahaidi and Anafi breeds) such as large size with heavy body weight and their color is varying between brown, yellow and grey. But, body measurements (shoulder height, heart girth) are significantly differed according to camel breed.

Photo (2). Kenani male camel Rashaidi female camel (Ishag et al., 2011).

For example, Rashaidi, Bishari and Butana breeds have lower heart girth, while the breed of Maalia recorded higher measurement in heart girth. So, these phenotypic variations in Sudanese camel are related to genetic difference between them. This lead to the necessity to create deep genetic studies to identify each breed and help in creating specific genetic programs for camel breeds.

In Turkey, hybridization between Bactrian and dromedary camels had been applied to get camels with larger size used in event named with wrestling that recognized during winter season in Izmer, Turkey (Yilmaz et al., 2015 and Diolo, 2020). The same was in Kazakhstan, but the main target of this hybridization is, to get animals have the ability to produce more milk, meat and more adapted to environmental conditions (Diolo, 2020). In Turkey, they named first generation (F1) by Tülü, (Photo,3) their male named with Besrek and the name of Maya was for female, and they have

same morphological characteristics of dromedary camels (Yilmaz et al., 2015). The Tvasi, is the name camels resulting from crossbreeding between maya female and male of Bactrian camels. Moreover, they mated male of Tülü, with female of dromedary camel to get camels called teke. They succeed in creating different crossbreeding between generations F1 and F2 to get F3 that called kertelez.

Photo (3). Morphological features of Tülü camel in. Turkey

Same crossbreeding system had been done in Kazakhstan and they get camels named with nar (name of male camel), nar-maya (name of female camel), jarbal (results from breeding between male and female camels of F1, which characterized with poor body measurements, so it is not recommended to mate male and female of F1 together). Generally, in both Turkey and Kazakhstan, the main objective of this hybridization is to keep Bactrian camels breed and optimize their productivity especially that, they have the ability to adapt and produce efficiently in Asian areas more than dromedary camels (Diolo, 2020).

In Algeria, Meghelli et al. (2020) informed the importance of camel's production in Algeria and other countries. They studied the morphological features of two different camel breeds (Nail and Sharaoui) by measuring live weight, head and neck length, neck girth, tail and body length, chest height, coat and eye color. They found that, Sharaoui camels have brown eyes, while 41.8% of Nail camels have brown eyes and the rest of them (58.18%) have black one. The two populations were differed in their body measurements, Sharaoui camels have higher recodes than Nail breed, especially in wither height and thoracic circumference.

In Egypt, as mentioned previously, there are five camel breeds in Egypt, Sudani, Somali, Mollawed, Falahi and Maghrabi. Since 1950s, Egypt exporting camels mainly from Sudan and Somalia, also, from Kenya, Ethiopia, Eritrea and Chad, via Sudan (Kadim et al., 2013). Unfortunately, their geographical distribution in Egypt is not well studied, except Abdel-Aal et al. (2012) who cleared that, Maghrabi breed is the main one in New valley and the only one in Matrouh governorates. Meanwhile, Sudani is the only breed in Aswan and the main one in Sharkia. Additionally, camels in Egypt are suffering from lack genetic and morphological studies. Only few searches in recent years were concerning about the genetic criteria in camels, and this is pointed to the urgent need for more studies. Because, omics technology is an important era that gives us information concerning genetic selection, identification and molecular markers, in order to improve animal productivity (growth, milk and meat production adaptability to environmental change) and subsequently human health. (Othman et al., 2016).

Ismail et al. (2006) studied protein polymorphism for the characterization of four camel breeds in Egypt. They found that homogeneity ratios calculated from protein fingerprinting patterns were 10, 16.7, 50 and 37.3% for Maghrabi, Sudany, Falahy and Mowalled breeds, respectively. El-Seoudy et al. (2008) characterized three Egyptian camel breeds (Sudani, Falahi and Maghrabi), using different molecular genetic criteria including native protein, isozyme and ISSR-PCR analysis. They stated that major blood proteins are albumin and γ, ß and α globulin, these protein fractions in camels divided into slow and fast α globulin and albumin. They found the γ globulin has three bands with relative mobility 0.17, 0.41 and 0.44 in Sudani and Falahi breeds, while, in Maghrabi breed had extra band appeared with relative mobility 0.33, which considered as marker for Maghrabi breed. So, the similarity between Sudani and Falahi camel breed in analyzed blood protein cleared that, both breeds

belong to same cluster. They added that, presence of different amplified DNA segments in the studied breeds could be used as genetic markers for each breed. Furthermore, using technique of mitochondrial DNA (mtDNA) can be useful to differentiate between camel breeds. El-Seoudy *et al.* (2008) found that the polymorphism in the three breeds using DNA was lower in Maghrabi breed (17.4%) and in highest Falahi followed by Sudani (41,7 and 40.9%, respectively). Abo-Elazm (2009) identified some camel breeds depending on biochemical genetic fingerprinting of each breed using protein polymorphism, as well as randomly amplified polymorphic DNA and simple sequence repeats. Additionally, Schulz et al (2005) and Mahrous et al. (2011) illustrated that, using techniques such as Random Amplified Polymorphism DNA (RAPD) or DNA fingerprint using mini or micro-satellites appear more powerful and useful in detecting genetic variations in camel breeds. Cherifi et al. (2017) compared the genetic structure between Algerian (Azawad, Rguibi, Targui) and Egyptian camels breeds (Falahy, Maghrabi, and Sudani) by collecting blood samples from 6 regions in Egypt and 7 in Algeria. They used multi alleic Short Tandem Repeat (STR) markers and recognized that, Maghrabi breed was diffred from the two other breeds (Falahi and Sudani). They attributed that, to the geographic origin, Maghrabi is from the coastal North-West of Africa), Sudani is from Sudan and Falahi is reared in Upper Egypt. And they pointed to the weak of genetic variations in the Algerian and Egyptian camel breeds. El-Kholy et al. (2016) studied the myogen factor 5 (MYFS) that protein is associated with muscle development and ancoded with MYF5 gene[25]. They found that gene appeared on the nucleotide number 377. Additionally, they studied 2 parts in gene of growth hormone, and found, 3UTR (Untranslated Region, which linked to neck length) and 5UTR (linked to meat characteristics (all studies that created on
Egyptian camels are summarized in Table (5).

Table (5). Summary of some studies concerning genetic criteria in Egyptian camel breeds.

References	Main objective of the study	Camel breed
El-Soudy et al. (2008)	Differentiate between Egyptian camel breeds by measuring Native protein profile, and isozyme system using ISSR-PCR	Sudani, Falahi and Maghrabi
El-Kholy et al. (2016)	Studied myogen fator 5 (MYF5) by using single Nucleotide Polymorphism (SNP)	Egyptian dromedary camels
Othman et al. (2016)	Identify 2 genes of casein in camel milk using specific PCR primers for each gene	Maghrabi
Mostafa et al. (2017)	Studied the genetic relationship between 3 Egyptian dromedary camel breeds using genetic analysis (Native plasma protein and RAPD primers	Sudani, Falahi and Maghrabi
Othman et al. (2017)	Determine cytochrome b using PCR primer specific for these genes	Baladi, Sudani, Somali, Mowalled
El-Soudy et al. (2018)	Studied the genetic diversity in Egyptian camel breeds and their structure using Start Codon Targeted (SCOT) primers and 18 microsatellite (SSRs)	Baladi, Sudani, Somali and Maghrabi
Ramadan et al. (2018)	Tested the AR (androgen receptors) glutamine repeat and Monoamine oxidase (MAOA), these genes are related to behavioral traits, using Novel Test	Maghrabi , Sudani, Somali and Falahi
Abd El-Aziem et al. (2019)	Studied prior protein PrPs (small glycogen proteins), which involved in energy production, DNA replication and calcium metabolism. In addition, if there is any abnormalities in these proteins, may result in serious disease. They extracting genomic DNA from 80 Egyptian camels and using PCR primer specific for PrP.	Sudani, Somali, Maghrabi, Mowalled, Falahi
Nowier and Ramadan (2020)	Studied the polymorphism of 2126 A/G ß casein gene and its relation to camel milk composition using PCR-RFLb technique	Maghrabi

In conclusion, genetic improvement, molecular and biochemical characterizations of camel breeds are the first part for the prevention of germplasm erosion by cross breeding. They are also considered as important tools for the development of indigenous breeds. Moreover, the selection depending on molecular markers for camel population studies is an important tool for biodiversity.

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الملخص العربي

"الإبل في مصر: التنوع والتحديات والأهمية الاقتصادية"

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يبلغ تعداد الإبل عالميا نحو 35 مليون رأس، أغلبها في أفريقيا، خاصة في الصومال يليها السودان. وفي مصر سجل تعداد الإبل 119.885 ألف رأس عام 2019، في خلال الفترة 1994-2019 شهدت أعدادها تذبذبت بين الزيادة والنقصان. وتعتمد مصر على استيراد الإبل من الصومال والسودان ولكن معدل تصديرها للإبل منخفض جداَ. في الماضي لم تكن الإبل تحظى بالاهتمام المطلوب على الرغم من سماتها المورفولوجية والفسيولوجية المميزة جدا والتي تجعلها تستطيع أن تعيش وتنتج في الظروف البيئية القاحلة. أما اليوم فقد أولت المجتمعات العلمية الإبل الاهتمام اللازم بسبب سماتها المذهلة، ومؤخرا تم إجراء العديد من الدراسات لتحديد المزايا الوراثية للإبل وإنتاج سلالات جديدة مثل **Tulu** (والتي تم الحصول على هذا الجيل في تركيا). لذلك، هذا المقال سوف يركز على تعداد الإبل وسلالاتها في جميع أنحاء العالم وفي مصر خاصة مع الإشارة إلى الدراسات التي تتعلق بجينوم الإبل.

الكلمات الدالة: الإبل، التعداد، السلالات، التنوع