
Dairy productivity potential of camels

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While it is recognized that the camel has the ability to produce more milk than the cow in similar conditions, camel milk productivity is not well known. Data from the literature are scarce, mainly issued from observations in research stations, and more rarely from pastoral areas where performance monitoring is not common. Elsewhere, the data are not homogeneous among the authors: mean daily yield, total yield per lactation, herd average... Therefore comparisons are not easy. Furthermore, there is a high variability of reported productions which leads to suppose a potential for selection on that criterion. This selection is possible but rarely achieved except in the Soviet Union period for dromedary and Bactrian camels.

The world production of camel milk was officially estimated at 1.3 million tons in 2002. However, according to the high level of self-consumption and the individual potential, this production could probably be higher (i.e. 5.4 million tons). The individual production varies between 1 000 and 12 000 litres per lactation according to some sources. The lactation curve is similar to bovine with a better persistence. The lactation length is very variable (from 8 to 18 months in general), i.e. longer than that for dairy cattle in similar conditions. Obviously, the feeding and seasonal conditions have an impact on those performances. Some intensified systems found in many places showed good prospects in camel milk production to supply populations from arid lands.

Key words: camel milk production, genetic variability and lactation characteristics, climatic and feeding factors, parity, health.

For the general public, for funding agencies and policy makers, the camel is poorly associated to high productivity, except for packing and racing activities. The potential for meat and milk production is not known for this species. This misunderstanding could be attributed to two factors:

1. in the past, camel dairy production was mainly destined for self consumption or, in case of extra production, for giving to the poorest or to guests;

Summary

Introduction

2. on literature basis, a few references are available in the international scientific community, even if recent data are more reliable than in the past.

The published results on camel dairy production come mainly from observations achieved in experimental stations, and more rarely from pastoral zones. In fact, it is quite difficult to perform dairy production monitoring in traditional farming systems where animals are usually submitted to high mobility. Elsewhere, the measurement procedures are rarely mentioned or set up in a standard manner and can change among authors. Moreover, the available publications give some results as daily average quantities, total lactation yield or year yield, herd average, after camel calf suckling or not. Therefore the comparisons between authors are not easy. Finally, even if camel scientists and producers are able to attribute a high dairy potential to the camel, further investigations are necessary to propose an objective outcome of this potential. The oldest reference on camel dairy production is dated 1854 (Gouhaux, 1854). Since then, the number of references on this subject has not exceeded one hundred papers and most of them came from the soviet literature in the fifties and sixties, poorly available for international scientific community (Saint-Martin, 1990).

The world camel milk production

Cow milk represents approximately 85% of the entire milk produced and consumed in the world. The she-camel production has a marginal position (less than 2%), far behind buffalos or sheep and goats. With a world camel population 70 times less important than the cattle population, this difference should not be surprising. According to FAO statistics, camel milk production in the world, both for dromedaries and Bactrian camels, was 1 283 672 tons in 2002 (Table 1).

It should be noted that, first, these data were not complete because data from Central Asia and from some countries in Near- and Middle-East are missing. Second, a gap can be observed between the estimated population and the stated production, as for example in Sudan, where the camel population is half of the Somalian population, milk production is 10 times lower.

A different assessment could be proposed by the extrapolation of the expected production for a she-camel. The world camel population is around 20 million heads (this number is probably under-estimated), the proportion of lactating camels is around 18% (Hjort af Ornäs, 1988) and the mean production could be estimated at 1 500 litres per year. So, the world production could be estimated at 5.4 million tons from which 55% is taken by young camels. In fact, there is strong uncertainty concerning the world camel milk production, all the more as an important part of this milk is removed from the market sector.

Table 1. Camel milk production in the world, comprehensive of dromedaries and Bactrian camels, in various countries in 2002.

Country	Production (MT)
Afghanistan	8 100
Algeria	8 000
Saudi Arabia	89 000
China	14 400
Djibouti	5 900
Arab Emirates	33 400
Eritrea	5 100
Ethiopia	22 450
Iraq	672
Kenya	25 200
Libya	2 000
Mali	54 900
Morocco	3 900
Mauritania	21 500
Mongolia	1 000
Niger	10 800
Qatar	13 300
Somalia	850 000
Sudan	82 250
Chad	21 800
Tunisia	1 000
Yemen	9 500
Total	1 283 672

(Source: FAO, 2002).

The estimations of camel milk yield available in the literature mention the quantities produced per lactation or year. In most of the cases, the authors do not specify if these yields include or not the part taken by the young camel which represents about 40% of the entire production, sometimes even 75% under certain conditions. Lastly, the number of milkings may change depending on the circumstances and the producer's practices, and could have an effect on the whole production (Knoess, 1977). When the number of milkings changes from 2 to 3 per day, the daily increase of milk production could be 28.5% (Kamoun, 1995). So, a high variability is described in the literature and comparisons are not easy.

The milk potential of camels

Africa

Northern-Africa

In Africa, references can change between 1 000 and 2 700 litres depending on the studies, the considered breeds and the farming system. For example, in Tunisia (Kamoun *et al.*, 1990), the extreme values reported in experimental conditions vary between 942 and 3 300 litres for a lactation length between 190 and 404 days. In Libya, Hermas (unpublished data) reported milk yields between 320 and 2139 kg at the Al-Assa station with a mean standard production (305 days of lactation) corresponding to 1 016 kg. Araba *et al.* (1998) conducted a study on Maghrebi camels from Morocco and reported a milk yield of 935 litres in 305 days. In Egypt, Yagil (1982) reported different results from several observations with a dairy yield between 1 500 and 4 000 litres. In Egypt, dams maintained on irrigated pasture could yield 15 to 35 litres milk/head per day, while yield was 3 to 5 litres on desert range (El-Badawi, 1996).

Horn of Africa

In Ethiopia, milk yield of five Dankali camels kept on natural pastures was recorded over a period of 12 months. Mean yield per head was 1 123 litres. The peak yield of 404 litres was obtained at day 56 (Richard and Gérard, 1989). This quantity is comparable to that reported by Dessalegne (1985) in South Ethiopia with the Somali breed, i.e. 1 045 litres for 430 days. Former studies performed in Ethiopia by Knoess (1977) reported a mean daily yield of seven camels milked twice daily: 6.6 litres, i.e. approximately 2 000 litres for a standard lactation. Field (1979) estimated daily milk yield of camels in North Kenya at 21 litres in the second week of lactation, falling between 4.8 and 2.2 by the sixteenth week of lactation. In this country, the observations on the Somali breed reported by Karue (1998) were between 1 614 and 2 151 litres, with an average of 1 876 kg for the herd. Gebre-Mariam (1987) stated that average daily milk yield of Somali camels ranged between 5 and 6 litres. Hashi (1993) found that Somali camels produce on average 800 to 3 600 litres during lactation from 9 to 18 months. Kaufman (1998) analyzed the three camel husbandry systems of the Rendile, Gabra and Somali pastoralists in Northern Kenya. Considering different proportions of poor, average and good yielding camels in the herds, average milk off take per lactation was 1 096, 1 400 and 1 581 litres for the Rendile, Gabra, and Somali respectively. In two traditional camel calf management systems in Kenya involving 42 multiparous lactating Somali camels, the total milk yield was 2 956 litres in the group with camels separated from calves, and 2 441 litres in the control group (Simpkin *et al.*, 1997). An average of 6 litres milk yield per camel per day under the feedlot system was reported by Ibrahim (1990). For Schwartz (1992), yield of Somali and Kenyan dromedaries ranges from 1 300 to 2 500 litres, but with good grazing their yield may even exceed 3 000 litres.

In Nigeria, from data monitored in a pastoral area, Saley and Steinmetz (1998) estimated the annual milk yield at 1 760 litres with two milkings and at 2 400 litres with three, the young camel taking 50% of the whole quantity. The milking quantity of the Azbin camel in Nigeria was estimated at 1 187 kg for 366-day lactation length and 1 417 kg when the young camel sampling was included (Chaibou and Faye, 2003). In Chad, observations in a pastoral area (Ganda and Buron, 1992) put forward a mean dairy yield of 2 280 litres for 12 months. In Mauritania, Martinez (1989) reported mean values from 3.1 to 4.3 litres per day in peri-urban camel farms with a mean yield of 684 litres in 6 months between the 3rd and 8th lactation month, the first three months being totally let to the young camel.

West Africa

In Asia, extreme values between 650 and more than 12 000 litres are reported, the dromedary camels having a better milk potential than the Bactrian ones, but there is a lack of available references for this last breed. In Central Asia, crossbreeding strategies between *Camelus dromedarius* and *Camelus bactrianus* aim at improving milk production.

Asia

In India, at the Bikaner station, Khanna *et al.* (1998) reported a mean yield of 1 655 litres (5.5 litres per day) in dromedary camels, but observations between 2 000 and 6 000 litres were reported in a review paper (Khanna, 1986). According to Ranjhan (1997), a dromedary may produce 8 to 10 litres of milk daily. In Pakistan, Yasin and Wahid (1957) found that well-fed and well-managed dromedaries produced 9 to 14 litres of milk daily and 2 722 to 3 629 litres in a lactation period of 16-18 months, while under desert conditions the average lactation yield varied from 1 134 to 1 588 litres of milk in 9 months. Knoess *et al.* (1986) collected data on lactation yields of seven dromedaries in Punjab and reported a mean daily yield of 18.7 litres, i.e. 5 695 litres for a standard lactation. Yagil (1982) reported that production in Pakistan was between 1 350 and 3 600 litres per lactation according to diverse publications. Schwartz (1992) reported that heavy camels of Pakistan and India may produce up to 12 000 litres of milk per lactation. In a camel survey conducted in Balochistan (Pakistan), total lactation yield ranging from 1 250 to 3 650 litres was found, with an average of 1 800 litres (Jasra and Aujla, 1997). According to Iqbal (1999), mean milk yield of the Punjabi camel was found to be 4 260 litres.

India and Pakistan

In the Arabian Emirates, the average milk yield is set around 2 000 litres per lactation (Quandil and Oudar, 1984). Sohail (1983) reported that, on average, Arabian camels can produce up to 2 275 litres of milk per year. Shareha (1985) reported in Syria 7.3 to 12.2 litres daily when the udder was completely milked. According to Qureshi (1986), a camel may produce on average 8 to 20 litres of milk daily, but under intensive

Near and Middle-East

management conditions it may produce from 15 to 40 litres daily. In Kuwait, a good, a medium and a poor milker can produce 9 030, 3 185 and 805 litres respectively in 350 days (Ibnoaf, 1987). In Saudi Arabia, the average milk yield ranges from 2.4 to 7.6 litres daily (Basmaeil and Bakkar, 1987). El-Naggar (1998) reported that the camel can yield about 2 700 to 3 666 litres per lactation.

Central Asia and China

In Turkmenistan (Saparov, unpublished results), precise measurements showed that the Arvana camel, recognized for its milk potential, may produce 5 000 to 6 000 litres per lactation. Yagil (1998) asserted that a yield up to 8 200 litres, even 12 000 litres, may be possible under intensive conditions. Bactrian camels seem to have a lower milk potential. The average milk yield is only 800 to 1 200 litres. In China, the total lactation yield varies between 500 and 1 254 litres (Xhao, 1994).

Finally, available data on camel milk production potential at world level are partial and the proposed estimations are often approximate, especially concerning Africa. However, the productivity potential of camels seems higher than that of cows in similar climatic and feeding conditions. In Ethiopia for example, *Afar* pastoralists who breed cattle and camels simultaneously, got an average daily milk yield of 1-1.5 litres from the *afar* cow and 4-5 litres from the *Dankali* camel. According to Schwartz and Dioli (1992), in the Horn of Africa milk productivity related to live animal weight was higher in camels (250 kg/Tropical Livestock Unit/year) than in small ruminants (220 kg) and zebu cattle (100 kg).

Genetic variability and lactation characteristics

Genetic variability seems very important and allows to suppose high possibilities for selection. In Somalia for example, the *Hoor* breed may produce 8 litres per day for 8-16 months lactation i.e. around 2 000 litres per lactation. The *Sifdaar* breed may produce 6 litres on average for 12 months (1 550 litres per lactation), while the *Eydimmo* breed is able to produce 4 litres only for 6-12 months, i.e. a production of 1 000 litres per lactation (Herren, 1993). In India, comparisons were conducted in the Bikaner station between the *Bikaneri*, *Kachchi* and *Jaisalmeri* breeds with mean yields of 4.19, 3.94 and 3.72 litres respectively (Sahani *et al.*, 1998). Potential of milk production was reported on 4 phenotypes of Arabian camels for three consecutive lactations and the milk yield was compared. The *Malhah* breed produced the most milk (9.33 kg per head), followed by the *Wadhah* breed (8.94), the *Safah* breed (8.13) and the *Hamrah* breed (6.83). A maximum of 18.3 and 14 kg per head was observed in the *Malhah* and *Wadhah* breed respectively (Ismail *et al.* Mutairi, 1998).

In general, Asian breeds are considered to have a higher milk potential than African breeds. In that field, However, information is partial. Some breeds may be considered as milk breeds, but selection pressure was low in camel species. Variability within the same breed is probably very high, which allows to suppose a possible improvement of milk potential in some breeds.

The shape of the lactation curve in dairy camels is comparable to that of cows (Richard and Gérard, 1985). The peak occurs at 2-3 months and may reach 5 to 6 litres for a total lactation yield between 1 800 and 2 000 litres, 8-10 litres when the total lactation yield is 3 000 to 3 500 litres. The persistence coefficient which expresses the ratio between the milk yield at month +1 on the previous month is high, generally up to 80%, according to available data.

Lactation length may vary between 8 and 18 months. It seems to depend on certain practices such as the milking or suckling frequency. Milking frequency could be two to six times daily (Dioli *et al.*, 1992). The milk down induction necessitates the presence of the young camel at the teat. This presence contributes to the maintenance of milk production of the dam. As for the cow, the biggest part of expelled milk during milking or suckling has a cistern origin rather than alveoli cells origin. So, the milk way down may be obtained by the beginning of suckling by the young or by oxytocin injection (Balasse, 2003). Other subterfuges could be proposed by the farmers in case of stillbirth or calf mortality, such as the introduction of a puppet covered with the camel calf skin or the adoption or vaginal blowing (Bernus, 1992).

Feeding plays an important role on lactation length and yield. Under good feeding conditions, the lactation length may increase from 8-12 months up to 16-18 months. Anyway, the differences between breeds could sometimes be attributed to differences in feeding conditions rather than to strictly genetic factors. The duration of lactation depends also on the dam's gestation status. First, lactation could inhibit ovarian activity and then delay reproduction time. Second, the end of gestation may lead to a milking refusal for the dam. Generally, the lactation length increases with the calving interval. However, lactation and gestation are not incompatible.

Variation factors in camels are similar to those reported in other species. Some data are available in the scientific literature (genetic, quality and quantity of available feed, milking frequency, parity, health status).

Some variation factors

Camels depend on natural resources most of the times. The feeding availability is generally linked to the climatic conditions (heat, humidity) which have obviously an effect on milk production. The difference in milk yield according to the calving season could be up to 50%: milk performances are lower at the end of the dry season than in the rainy season (Khanna, *et al.* 1998). Milk yield does not seem to be affected by water shortage. In Israel, Yagil and Etzion (1980) observed a continuing production in camels after 10 days of dehydration followed by an *ad libitum* drinking and then another 10-day period of dehydration. In a previous observation, 6 camels continued to produce 6 litres per day during the hot season with once a week watering (Yagil *et al.*, 1979).

Effect of climatic and feeding factors

Effect of parity

As for other dairy animals, milk yield in camels tends to increase with parity. However, although the lactation length could be important, data are scarce and limited to very small consecutive lactation. According to Ismail and Al Mutairi (1998), the maximum may be reached at the second or third lactation.

Effect of health status

Most of the parasites (trypanosoma, internal parasites, ticks and mange) may have a cross reaction with milk yield. In pastoral zones, the use of classical veterinary inputs for parasitic disease prevention contributes to an increase of 65% in milk production (Simpkin *et al.*, 1997).

Conclusion

The contribution of the camel to the world milk supply is marginal but essential for human populations in arid and semi-arid areas; on the one hand, for satisfying the human needs in communities culturally attached to camel products and contributing to food safety, on other hand, for stimulating the local economy by the maintenance of an agricultural activity in marginal desert areas. However, available data on the camel's production potential are not sufficient. The great variation in camel milk production may be attributed to the methods employed to determine yield (Khan and Iqbal, 2001). Further investigations and probably standardisation of the methods are necessary to point out the importance of camel milk production for the food security of desert areas in the world. The international scientific community has to turn its attention to a good performance control of dairy production in camels. Specific tools for dairy yield monitoring are necessary. The LASER software set up by CIRAD-EMVT could be a possible tool for performance monitoring in camel herds as it has been tested in some arid countries (Juanes and Faye, 2001).

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