Camel genetic resources in Morocco

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Introduction

In the kingdom of Morocco, the camel (*Camelius dromedarius*) is considered as an important national resource that deserves to be protected and not neglected. The reason is that camel husbandry contributes largely to the socio-economic life of herders in large part of the country, especially in the desert areas. In addition, camel husbandry has a considerable role in providing subsistence and transport for the Saharan population, in spite of the observed reduction of the number of camels during the last two decades.

In Morocco, the number of camels is estimated at 150 000 heads (survey of 1998) with 106 200 females at the age of reproduction. 58% of camels are found in the southern Saharan regions and 26% in the east-west band from Ouarzazate to Figuig passing by Rachidia. In these regions of Morocco, camel livestock plays a considerable role among the population activities, being the main factor of production, consumption and source of income for the herders. The number of herders is estimated at 19 000. Meat production averaged 5 000 tons in 2000, which is maintained constantly during the last decade.

Key words: identification, characterisation, Guerzni type, Marmouri type, Khouari type, genetic markers, milk production,

Research background

Since 1985, several camel development programs have been developed by the Ministry of Agriculture in order to improve the productivity of this species in the regions of high concentration. The aim of these development programs was to improve meat production efficiency while milk production efficiency was also considered in some urban regions where the demand for milk is very high (Lahyoune, Boujdour and Dakhla). The camel production development programs were supported by research studies in laboratories and fields conducted by specialized institutions, particularly the Institut Agronomique et Vétérinaire Hassan II with a financial contribution of the Ministry of Agriculture. The research program focuses mainly on topics dealing with nutrition, reproduction, diseases and production parameters of different varieties of camels found in Morocco. The laboratory Research studies are conducted at the specialized labs of the Institut Agronomique et Vétérinaire Hassan II and the field research studies are performed at the

Camel Research and Development center created by the Ministry of Agriculture at Lahyoune (south of Morocco) to do research studies in the field under the Saharan environment.

Identification and characterization of Moroccan camels

Methodology

The present work was carried out in all Moroccan regions where the camel herding was practiced. It included data on surveys made with camel herders and determination of morphologic and genetic criteria.

1. Surveys. The aim of the surveys with herders was to bring out the different criteria (color, size, productivity and endurance) used to identify the camel varieties and to figure out the possibility of a better utilization of these criteria.
2. Morphometric measurements. These measurements, made on the body of the animal, included:
   - Shoulder height.
   - Body length.
   - Body girth (abdominal, thoracic and at the hump).
   - Coxal width.
   - Head length.

   The data collected were compared to the survey data and then processed in order to come up with a formula that allows identification of the different camel breeds.
3. Genetic markers. This technique is based on the determination of protein markers in the blood cells and plasma. It was used to make genetic separation or grouping of the different camel varieties identified through the morphometric studies.

Description of the phenotic characteristics

The skin was mainly dominated by the brown colour (from light to dark). However, there was a minority with a white skin, while some individuals were albinos. Different colours of the ear were found on the same skin. The main skin colours which were used to differentiate between the types of camels are showed in the photos.

Morphologic measurements

The majority of camels measured have a shoulder height of less than 180 cm, indicating that this group of camels belong to the draught and transportation type, since the ride camel has a shoulder height of more than 180cm, especially in males. Body length of measured camels averaged 134 cm and coxal width averaged 41 cm. These measurements did not allow distinguishing between the groups of camels. Body girths (abdominal, thoracic and at hump) were well correlated with body weight and the best correlation was obtained with the hump girth:

$$BW(kg) = 2.96 \times HG\ (cm) - 282.76;\ r^2 = 0.86.$$

The morphologic measurements were helpful in estimating body weight and in distinguishing the 2 types of the camel population: the Marmouri type (20%) and the Guerzni type (60%). The crossing between the two types has given a third type named Khouari (20%).

- *Guerzni Type*. This is the heavy type, which makes up the majority of camels maintained by nomads. It is a pack camel with small size, teak skin, abundant ear and well-developed hump. A mature animal weighs about 400 – 500 kg. Females have small mammary glands but are more adapted to harsh environments.
- *Marmouri Type.* This is the type that is used for riding. It is lighter in body weight, with long legs, a well-developed neck, and a small hump. It has a thin skin with less abundant ear. Females have well-developed mammary glands but they are very sensitive to harsh environments.
- *Khouari Type.* This is the product of crossing between Guerzni males and Marmouri females. The Khouari type has morphological and physiological characteristics similar to the Marmoury type.

Genetic markers

A limited number of studies were performed by looking at some genetic markers in the blood that can separate between dromedary types. Some genetic markers were tested and the information collected was not convincing. The blood groups were not identified in dromedaries; it seems that most camelids of Africa and Asia belong to the same group (B) while small camelids of South America showed six blood groups: A, B, C, D, E and F.

Studies on biochemical polymorphism, especially protein polymorphism, showed a very small genetic variation between dromedary types. No differences were observed on some blood enzymes such as: D-esterase, isomerase gluco-phosphatase, dehydrogenase phosphoglutanate and some blood proteins such as: Albumin, Transferin, and protein transporting Vit D. Some variations in hemoglobin and beta-lactoglobin were detected in dromedaries of different types of Somalia and other variations in albumin and haptoglobin were reported in the Sudanese dromedaries. Concerning catalase, opposed opinions are reported in the literature. In India, no polymorphism of milk protein was detected but differences between breeds were observed in phosphatase and amylase of milk. These results may indicate that dromedaries have very few genetic variations of blood markers of protein origin, which makes this animal very special when compared to other domestic species. The use of DNA typing, based on molecular biology, remains the best technique to detect genetic differences between dromedary types or breeds.

Performances of milk production in the two main types of dromedaries found in Morocco

Camel production was known as an extensive production based on grazing large areas with poor vegetation. However, with urbanization and high demand for camel products, herders developed new intensive systems for fattening and milk production. These systems require daily feed supplies. Therefore, and with the absence of specific feeding standards for lactating camels, cattle nutrients requirements were used instead. Studies dealing with nutrient requirements of camels at maintenance and fattening (Guerouali *et al.* 1992) showed estimates of feed conversion coefficient different from those reported for cattle. The aim of this work was to estimate the coefficient of transformation of nutrients into milk of the two type of camels and to compare growth rates of calves belonging to the Marmouri and Guerzni dromedaries.

Materiel and methods

Eight lactating camels (4 Marmouri and 4 Guerzni) with an average weight of 450 kg and an average age of 8 years were used. Camels were housed individually and fed a ration composed of 65% forages and 35% concentrate distributed in two equal meals per day (Table 1). The ration was analysed and estimated to correspond to 2.5 maintenance energy requirements (Guerouali *et al.* 1993) with 17% of crude proteins. All animals had free access to drinking water. The camels were adapted to the respiratory gas collection chamber and to the milk production estimation technique prior to the experimental period. The experimental design was based on the continuous measurement of the oxygen consumption for 24 h at the peak of lactation. Oxygen consumption was determined by flush through indirect calorimetry and energy expenditures were estimated by the equation developed by Mclean (1972):

$$HP = O_2 \text{ consumption} \times 4.89$$

Milk production was estimated by weighing the offspring before and after suckling (for 15 min) three times per day for three successive days. Milk energy was estimated from daily milk production and the energy concentration of camel milk (3.46 MJ/kg) as it was estimated by Guada *et al* (1985). Metabolizable energy intake was estimated from the amounts

Table 1. Dry matter, metabolizable energy and crude proteins of the feeding ration fed to lactating camels.

Ration composition	Fresh matter (kg)	Dry matter intake (kg)	Metabolisable energy intake (Mj)	Crude proteins (g)
Ground barley	3	2.64	34.40	363
Sun-flower meal	1	0.90	6.11	380
Wheat straw	2	1.80	15.23	70
Alfalfa fodder	30	4.10	33.51	999
Total	46	10.44	89.25	1 812

of feed consumed and their digestibility and metabolizability was taken from the literature (INRA, 1988). The amount of MEI of all lactating camels was comparable during the peak of lactation and was estimated to average 89.25 Mj/d. Energy Balance (EB) of camels was calculated by subtracting Total Heat Production (THP) and milk energy (LE) from metabolizable energy intake (MEI):

$$EB = MEI - (THP + LE).$$

Results and discussion

All feeds offered to lactating camels were consumed except some perturbations in alfalfa intake and metabolizable energy intake averaged 88.25Mj/d in the Guerzni type and 90.25 in the Marmouri type (Table 2). Total heat production of camels, averaging 59.17Mj/day, did not change significantly with the camel type. This amount of heat production was about twice the amount reported in camels at maintenance (Guerouali *et al*. 1993) indicating that the physiological stage of lactation is at least twice demanding in energy expenditures compared to the maintenance stage.

Milk production in Marmouri was significantly higher than in Guerzni camels and averaged 5.95 ± 0.48 kg /camel/day (Table 3). Higher camel milk production was reported in the Malhah (9.3 kg/d) and Wadhah (8.94kg/d) breeds in Saudi Arabia (Basmail *et al*, 1994) and lower milk production (3.6kg /d) was reported in Niger (Saley *et al*. 1994). Energy contents of camel milk, estimated from its composition, averaged

Table 2. Metabolizable energy intake (Mj/d) and total heat production (Mj/d) in camels at the peak of lactation.

Camel identification	Metabolizable energy intake	Total heat production
Guerzni type		
A	85.6	50.68
B	87.4	59.34
C	88.7	53.95
D	91.3	63.17
Mean	88.25	56.785
SD	2.40	5.56
Marmouri type		
E	93.6	63.29
F	89.2	64.9
G	90.5	59.49
H	87.7	58.52
Mean	90.25	61.55
SE	2.5	3.04

Table 3. Milk production and its energy concentration in lactating camels.

Camels identification	Milk production (kg/d)	Milk energy (Mj/d)
Guerzni		
A	5.83	20.19
B	5.62	19.48
C	5.2	18.11
D	5.58	19.36
Mean	5.5575	19.29
SE	0.23	0.75
Marmouri		
E	6.2	21.4
F	5.94	20.54
G	6.53	22.48
H	6.76	23.24
Mean	6.3575	21.915
SE	0.313	1.028

3.46 Mj/kg and had more energy than cow milk (3.02 Mj/kg) and goat milk (3.16 Mj/kg) but less energy than ewe milk (4.52 Mj/kg). Lactating camels received an amount of MEI corresponding to 2.5 times that for maintenance energy requirement and showed a positive energy balance at the peak of lactation with about 9.5 Mj of daily tissue energy deposition (Table 4). This energy partition of lactating camels was different from that commonly observed in dairy cattle which usually have a negative energy balance at the peak of lactation. In fact, at the peak of lactation, high producing dairy cows can mobilize daily up to 1.5 kg of lipids and 200g of proteins from their body reserves to satisfy their needs for milk production (INRA, 1988). Lactating camels, however, showed body reserve conservation and even development at the time when the animal was in high demand of energy for milk production

This conservation process might be one of the adaptation strategies of the camel for surviving under difficult conditions in the desert. With the development of an intense camel production system (modern camel farms) and a genetic selection, it is possible to have an improvement in milk production in the lactating camels through body reserves mobilization as it was experienced in dairy cattle (Chupin *et al.* 1993). With lower milk production and total heat production, the Guerzni type showed more body tissue energy retention when compared to the Marmouri type. The energy balance was more positive in the Guerzni type with 12.18Mj/d than in the Marmouri type with 7.79 Mj/d. The efficiency coefficient of utilisation of MEI for milk production was estimated based on the following considerations:

Table. 4. Energy balance in lactating camels at the peak of lactation.

Camel identification	Metabolisable Energy intake (Mj/d)	Total heat production (Mj/d)	Milk energy (Mj/d)	Energy balance (Mj/d)
Guerzni				
A	85.60	50.68	20.19	14.73
B	87.40	59.34	19.48	8.58
C	88.70	53.95	18.11	16.64
D	91.30	63.17	19.36	8.77
Mean	88.25	56.79	19.29	12.18
SD	2.40	5.56	0.86	4.12
Marmouri				
E	93.60	63.29	21.40	8.91
F	89.20	64.90	20.54	3.76
G	90.50	59.49	22.48	8.53
H	87.70	58.52	23.24	5.94
Mean	90.25	61.55	21.92	6.79
SD	2.51	3.04	1.19	2.41

- Metabolizable energy intake can be partitioned into metabolizable energy for maintenance (MEm) estimated to average 32.40 Mj/d in 450 kg lactating camel (Guerouali *et al*, 1993) and metabolizable energy for production (MEP).
- MEP = MEI – MEm = 89. 25 – 32.40 = 56.85 Mj/d.
- Since the lactating camels were producing milk and at the same time gaining weight, metabolizable energy for production can also be partitioned into ME for milk production (MEL) and ME for body tissue deposition or growth (MEg). MEg was estimated from the amount of energy deposited in maternal tissue (estimated from the energy balance) and the efficiency coefficient of utilisation of ME for gain calculated in other studies (Guerouali *et al*, 1993) to average 61%. Metabolizable energy used for body tissue deposition

  MEg = 9.48 /0 .61 = 15.54 MJ/d.
- ME for milk production was determined as the difference between the ME used for production and the ME used for body tissue deposition.
- MEL = MEp – MEg = 56.85 – 15.54 = 41.31 Mj/d

The daily amount of milk energy in lactating camels was calculated at an average of 20.60 Mj/d and the ME used for milk production was estimated at 41.31 Mj/d on average. The efficiency coefficient of utilisation of ME for milk production (Kl) is defined as the ratio between the energy deposited in the milk and the ME used for milk production.

Kl (%) = 20.60 / 41.31 * 100 = 50 %.

Efficiency lactation of 50% is reported for the first time in camels and was lower than the efficiency reported in dairy cattle, varied around a mean value of 62% (Moe *et al.* 1972). Precise estimates of Kl for different species could not be averaged because of the significant effect of the diet composition and digestibility. Kl averaged 61% in cows fed low quality forages and 72% in cows fed high quality forages (VanEs, 1975). Kl varied from 51% to 66% in the same cows receiving diets of different composition (Hoffman *et al.* 1972).

Kl estimated in lactating camels was generally lower than most values of Kl reported for dairy cattle indicating that camels were less efficient in transforming MEI in milk energy. The determination of the efficiency coefficient of utilization of MEI for milk production allowed the estimation of energy requirements of lactating camels producing 5 kg of milk at 4% fat (Table 5).

Lactating camels averaging 500 kg required 65.3Mj ME for producing 5 kg of milk in comparison with 74.0 Mj of ME for lactating dairy cattle of the same weight and level of production. When partitions ME, camel and cattle required 33.9 and 44.2 Mj of ME for maintenance and 33.9 and 29.8 Mj ME for milk production respectively. Hence camels required 35% less ME for maintenance and 12% more ME for lactation than dairy cattle. The same trend was observed in camels weighing 600 kg and producing 5 kg of milk (70.0 Mj ME) compared to that (82.8 Mj ME) of dairy cattle of the same weight and level of production (Hoden *et al*., 1988).

Comparison of growth rate between Guerzni and Marmouri calf camels

In another trial, four ten-months-old calf camels of the Guerzni type were compared to other four of the Marmouri type receiving the same amount of feed. The young camels were weighed every week during a period of eight weeks and growth rate was determined (Table 6). The growth rate in the Guerzni type was significantly higher than the growth rate obtained in the Marmouri type indicating the potential of meat production in the Guerzni type.

Table 5. Daily energy requirements (expressed in mega joules and forage units) in lactating camels producing 5 kg of milk at 4% fat.

Body weight		Energy requirements*	
Kg	$Kg^{0.75}$	Mj/d	UF/d
300	72.1	55.0	4.8
350	80.9	57.7	5.0
400	89.4	60.3	5.2
450	97.7	62.8	5.5
500	105.7	65.3	5.7
550	113.6	67.7	5.9
600	121.2	70.0	6.1

*Energy requirements for maintenance and production of 5 kg of milk at 4% fat.

Table 6. Comparison of growth rate between calf camels from Guerzni and Marmouri types receiving the same feeding ration for period of two months.

Calf camels	Weight at 1st day(kg)	Weight at 56days (kg)	Weight gain (kg)	Growth rate (kg / d)
Guerzni				
A	180	195	15	
B	144	170	26	
C	150	177	27	
D	132	156	24	
Means	-	-	23	0.41 kg / d
SD				0.98
Marmouri				
A	133	152	19	
B	128	170	15	
C	155	177	22	
D	148	164	16	
Means	-	-	18	0.32 kg / d
SD				0.056

Conclusions

The Marmouri type showed higher milk production and a more negative energy balance when compared to the Guerzni type. But Guerzni showed more potential for meat production.
The efficiency coefficient of utilization of ME for milk yield (Kl) averaged 50% in the lactating camel and was lower than Kl reported in cattle. However, camels with lower MEm compared to cattle, required 12% less Metabolizable energy to produce 5 kg of milk at 4% of fat under harsh environmental conditions for dairy cattle.

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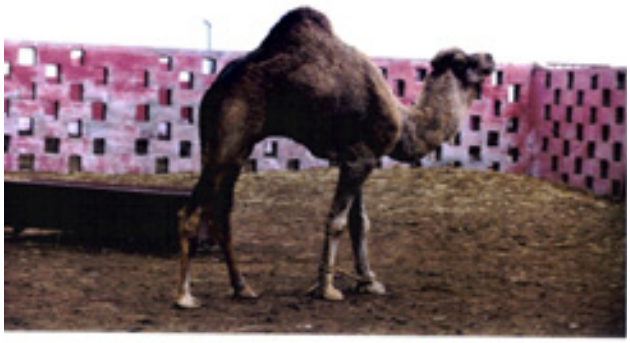

Figure 1. Guerzni type camel.

Figure 2. Marmouri type camel.

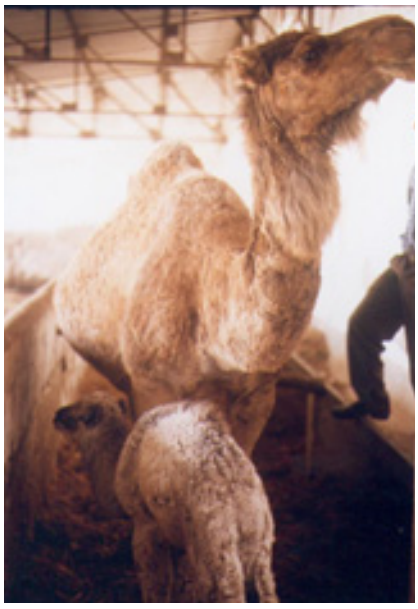

Figure 3. Khouari type camel.

Figure 4. Lasfar type camel.

Figure 7. Lazrag type camel.

Figure 5. Lakhdar type camel.

Figure 8. Labied type camel.

Figure 6. Lahmami type camel.

Figure 9. Dkhan type camel.

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