

# Blood protein polymorphism in the one-humped camel (*Camelus dromedarius*) in Morocco

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## Key words

Dromedary - *Camelus dromedarius* - Blood protein - Catalase - Polymorphism - Morocco.

## Summary

Two hundred and seventeen serum samples and 117 hemolysate samples were obtained from 217 one-humped camels (*Camelus dromedarius*) from Morocco and analyzed by polyacrylamide gel electrophoresis for albumin (Alb), postalbumin (Pa) and transferrin (Tf) and by starch gel electrophoresis for catalase (Cat). Only the last system exhibited polymorphism with the estimated frequencies of 0.325 and 0.675 for Cat<sup>F</sup> and Cat<sup>S</sup>, respectively.

## INTRODUCTION

Several blood and milk protein systems have been studied in the dromedary (*Camelus dromedarius*). Some of them revealed genetic variability: albumin (Alb), haptoglobin (Hp) (2), haemoglobin (Hb), X protein,  $\beta$ -lactoglobulin ( $\beta$ -Lg) (1), transferrin (Tf), glucosephosphate-isomerase (GPI: EC 5.3.1.9.), acid phosphatase (AP: EC 3.1.3.2.), phosphoglucomutase (PGM: EC 2.7.5.1.), 6-phosphogluconate dehydrogenase (PGD: EC 1.1.1.43.) (4) and malic enzyme (ME: EC 1.1.1.40.) (6).

In 1988, Penedo *et al.* (8) reported the polymorphism of 5 electrophoretic systems: post-albumin (Pa), Tf, Cat, PGD and GPI for llama (*Lama glama*) and alpaca (*Lama pacos*).

In this report, the authors present evidence for electrophoretic variation of the catalase system of the dromedary in Morocco. No variation was found for albumin, postalbumin, and transferrin systems.

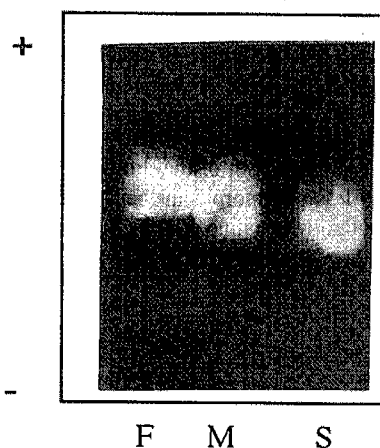
## MATERIALS AND METHODS

Analyses were carried out on 217 dromedaries from Guelmim, an area in the southern region of Morocco, at the western edge of the Sahara desert. Random samples in herds were taken from each dromedary in two 10 ml vacuum tubes: one containing an anticoagulant (lithium heparin) to collect red cells and the other dry to obtain serum.

Polyacrylamide gel electrophoresis (PAGE) (3, 8) was used to analyze albumin, postalbumin and transferrin systems in 217 sera. Starch gel electrophoresis (SGE) (5) was used to analyze the catalase system in 117 hemolysate samples.

## RESULTS AND DISCUSSION

Of the four systems studied, only the catalase was found to be polymorphic (figure 1). Three phenotypes were observed in this system; their distribution and allelic frequencies are shown in table I.



**Figure 1:** photograph of starch gel electrophoretic pattern showing the three phenotypes of catalase in dromedaries in Morocco.

Allelic frequencies were calculated as:

$$\text{Cat}^{\text{F}} = 2(\text{FF}) + (\text{FS}) / 2\text{N} = 2 \times 16 + 44 / 2 \times 117 = 0.325$$

$$\text{Cat}^{\text{S}} = 2(\text{SS}) + (\text{FS}) / 2\text{N} = 2 \times 57 + 44 / 2 \times 117 = 0.675$$

The expected phenotypes were calculated from allelic frequencies as follows (the heterozygote phenotype FS is also designated as M. It has an intermediary activity area between F and S):

$$\text{FF} = (\text{Cat}^{\text{F}})^2 \times \text{N} = (0.325)^2 \times 117 = 12.36$$

$$\text{FS ou M} = 2 \times (\text{Cat}^{\text{F}}) \times (\text{Cat}^{\text{S}}) \times \text{N} = 2 \times 0.325 \times 0.675 \times 117 = 51.33$$

$$\text{SS} = (\text{Cat}^{\text{S}})^2 \times \text{N} = (0.675)^2 \times 117 = 53.31$$

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Table I

Distribution and allelic frequencies of catalase types in dromedaries in Morocco

Phenotypes	n observed	n expected	Frequencies
FF	16	12.36	Cat <sup>F</sup> = 0.325
FS or M	44	51.33	Cat <sup>S</sup> = 0.675
SS	57	53.31	
<b>Total</b>	<b>117</b>	<b>117</b>	

$$\chi^2 = 2.372$$

The  $\chi^2$  test was used to check the panmixia of the population under study (Hardy-Weinberg's law). At a 5 % threshold, the  $\chi^2$  table gives a 5.991 value for ddl = 2. The  $\chi^2$  observed (2.372) is very much below the  $\chi^2$  limit. The hypothesis of the genetic balance of the population studied by the catalase system cannot be rejected (5 % risk).

As in the horse (5), the llama, the alpaca and the guanaco (8), the three observed phenotypes, F, FS or M and S, suggest that the Cat system in the dromedary is also controlled by two codominant genes: Cat<sup>F</sup> and Cat<sup>S</sup>.

The Cat<sup>F</sup> allele seems to be more prevalent in the camelids of South America than in the dromedary (8).

No polymorphism was observed for the Alb, Pa (postalbumin) and Tf systems. This is in agreement with the findings of Van de Weghe *et al.* (10), Di Stasio *et al.* (1), Penedo and Juneja (9) and Penedo and Fowler (7). However, Khanna and Tandon (4) described, without specifying the variants, the presence of six phenotypes within the Tf system in the dromedary of India. Likewise, Elamin and Saha (2) described six atypical heterozygote variants of the albumin system in dromedaries in the Sudan.

In conclusion, this study confirms what has already been reported on biochemical polymorphism of the dromedary, in that *Camelus dromedarius* has less polymorphism than the camelid species of the new world within which nine protein systems and four enzyme systems revealed a genetic variability (7).

## Résumé

**Ouragh L., Bengoumi M.** Le polymorphisme des protéines sanguines chez le dromadaire (*Camelus dromedarius*) au Maroc

Deux cent dix-sept sérums et 117 hémolysats de dromadaires du Maroc (*Camelus dromedarius*) ont été analysés respectivement par électrophorèse en gel de polyacrylamide pour trois systèmes, l'albumine (Alb), la post-albumine (Pa) et la transferrine (Tf) et par électrophorèse en gel d'amidon pour le système catalase (Cat). Seul ce dernier système a montré une variation génétique avec des fréquences respectives de 0,325 et 0,675 pour les allèles Cat<sup>F</sup> et Cat<sup>S</sup>.

**Mots-clé :** Dromadaire - *Camelus dromedarius* - Protéine sanguine - Catalase - Polymorphisme - Maroc.

The fact that a genetic variability of the Cat system, considered until now to be monomorphic (7), is described here, spurs on the need to explore other systems of the dromedary in Morocco, notably those showing a polymorphism in dromedaries of other African countries (Hb, Hp) and camelids of South America (Esterase D: EsD, GPI and PGD).

## Acknowledgements

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## REFERENCES

- DI STASIO L., CRISTOFORI F., SARTORE G., 1983. Phenotypic variation in blood and milk of the Somali camel. *Anim. Blood Groups Biochem. Genet.*, **14**: 225-228.
- ELAMIN F.M., SAHA N., 1980. Blood protein polymorphism in the one-humped camel (*Camelus dromedarius*) in the Sudan. *Anim. Blood Groups Biochem. Genet.*, **11**: 39-41.
- GAHNE B., JUNEJA R.K., GROLMUS J., 1977. Horizontal polyacrylamide gradient gel electrophoresis for the simultaneous phenotyping of transferrin, post-transferrin, albumin and post-albumin in the blood plasma of cattle. *Anim. Blood Groups Biochem. Genet.*, **8**: 127-137.
- KHANNA N.D., TANDON S.N., 1985. A note on electrophoretic studies on certain blood proteins and enzymes in Indian camels. *Indian vet. J.*, **62**: 343-345.
- KELLY E.P., STORMONT C., SUZUKI Y., 1971. Catalase polymorphism in the red cells of horses. *Anim. Blood Groups Biochem. Genet.*, **2**: 135-143.
- OTCHOM B.B., NOUR S.M., 1989. Rapport sur le stage de formation en génétiques des populations, Laboratoire de Zoogéographie (Projet : étude génétique des populations de dromadaires au Tchad). Montpellier, France, Université de Montpellier III.
- PENEDO M.C.T., FOWLER M.E., 1992. Parentage verification in camelids. In: Proc. 1st Int. Camel Conf., Doubay, United Arab Emirates, 2-6 février 1992, p. 285-287.
- PENEDO M.C.T., FOWLER M.E., BOWLING A.T., ANDERSON D.L. and GORDON L., 1988. Genetic variation in the blood of llamas, llamas glamas, and alpacas, llamas pacos. *Anim. Genet.*, **19**: 267-276.
- PENEDO M.C.T., JUNEJA R.K., 1989. Polymorphic plasma post-albumin (Po) of llamas and alpacas identified as Gc protein. *Anim. Genet.*, **20**: 221-223.
- VAN DE WEGHE A., VAN ZEGEREN A., BOUQUET Y., 1982. The vitamin D binding protein in domestic animals. *Comp. Biochem. Physiol.*, **73B**: 977-982.

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## Resumen

**Ouragh L., Bengoumi M.** Polimorfismo proteico sanguíneo en el camello de una joroba (*Camelus dromedarius*) en Marruecos

Se obtuvieron doscientas diecisiete muestras de suero y 117 muestras hemolisadas a partir de 217 camellos de una joroba (*Camelus dromedarius*) en Marruecos, las cuales se analizaron mediante electroforesis en gel de poli(acrilamida para albúmina (Alb), post albúmina (Pa) y transferrina (Tf) y mediante electroforesis en gel de levadura para catalasas (Cat). Solamente este último sistema demostró polimorfismo con las frecuencias estimadas de 0,325 y 0,675 para Cat<sup>F</sup> y Cat<sup>S</sup>, respectivamente.

**Palabras clave:** Dromedario - *Camelus dromedarius* - Proteína sanguínea - Catalasa - Polimorfismo - Marruecos.