GLYCEROL PERMEABILITY OF CAMEL AND HAMSTER ERYTHROCYTES

Naomi MEYERSTEIN
Research and Development Authority and Medical School, Ben-Gurion University of the Negev, Beer Sheva, Israel

and

Reuven YAGIL
Comparative Medicine, Medical School, Ben-Gurion University of the Negev, Beer Sheva, Israel

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1. Introduction

The permeability of erythrocytes to glycerol may be studied by following their hemolysis rate on suspension in 0.3 M glycerol. Erythrocytes of different species differ markedly in glycerol permeability, osmotic fragility and other permeability parameters [1,2]. They also differ in lipid composition [3]. A correlation between glycerol permeability and lipid composition has been found in whole cells and in model membranes [4,5]. However, there are several studies demonstrating that lipid composition, though affecting glycerol permeability of erythrocytes, is not the major factor [6,7].

The present work examines the correlation between lipid composition and glycerol permeability in two systems: a) in the erythrocytes of the hamster *(Mesocricetus auratus).* The lipid composition of these erythrocytes is known to change following heat acclimation [8]. These changes are controlled. Thus we can examine two possible lipid compositions in one species. b) in the erythrocytes of the camel (*Camelus dromedarius*), which are known for their striking osmotic stability under extreme conditions [9,10]. It has been found that their composition pattern does not differ much from that of other mammals [11].

As low osmotic fragility usually corresponds to low glycerol permeability [6], the camel may be expected to exhibit extremely low glycerol permeability. If however, lipid composition is the determining fact, the glycerol permeability would be similar to that of other mammals.

2. Materials and methods

Glycerol lysis time (GLT) was determined according to the methods of Gottfried and Robertson [6], by use of a Beckman D-U spectrophotometer. The rate of erythrocyte lysis was followed by measurement of the fall in turbidity of the reaction mixture; the blank contained water instead of 0.3 M glycerol. This blank, which is equivalent to 0.3% NaCl, produced complete hemolysis in the hamster erythrocytes, and, as expected, only partial hemolysis in the camel [9]. GLT_{50} was defined as the time required for 50 percent lysis of the erythrocytes [6].

Blood specimens. Camel and hamster blood was withdrawn into heparinized syringes, and the determination performed immediately. Hamster blood was obtained by intracardiac puncture, and that of the camel, was taken from the jugular vein. Human erythrocytes were examined at the same time, as control.

Heat acclimation. 12 healthy adult hamsters were randomly divided into two groups; the control group was maintained at room temperature (20–23°C) while the heat acclimated group was exposed to 35±1°C for at least 3 weeks. Relative humidity was 25–40%. The acclimation procedure was similar to that of previous studies [12].

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3. Results and discussion

With this test system, the hamster erythrocytes showed a hemolysis time curve similar to that of human erythrocytes, but more rapid, with an average GLT_{50} of 23.2±1.0 sec (fig.1). Heat acclimation of the hamsters induced a slightly quicker hemolysis – with GLT_{50} of 19.3±0.9 seconds. This difference was significant ($p < 0.02$).

When the glycerol lysis test was performed on the camel erythrocytes, an extremely slow hemolysis rate was found: GLT_{50} in the camels was 47 min, compared with GLT_{50} of less than 1 min in man and in the different hamsters. Several studies [6,13] suggest a close relationship between glycerol permeability and osmotic fragility: in hereditary spherocytosis there is both increased osmotic fragility and an accelerated glycerol lysis rate; similar results were found in vinblastin-treated erythrocytes, which simulate the effect of hereditary spherocytosis. At the other extreme, sickle cell anemia and thalassemia are characterized by both decreased osmotic fragility and low glycerol lysis time. However, the same authors also demonstrate that erythrocytes may have similar osmotic fragility but different glycerol lysis times [6].

As can be seen in fig.1 and fig.2, the general pattern is similar for both osmotic fragility and glycerol lysis time: the control hamster and man have similar values

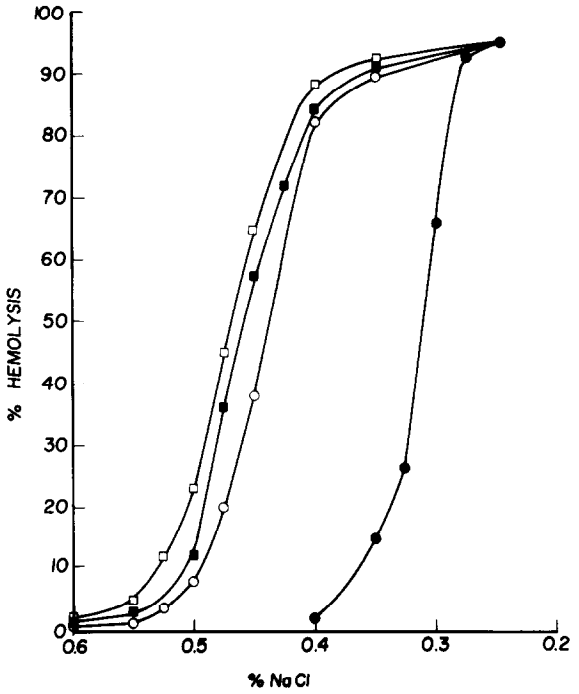

Fig.2. Osmotic fragility in camel (–●–) and man (–■–) and in hamsters, under control conditions (–○–) and after heat acclimation (–□–).

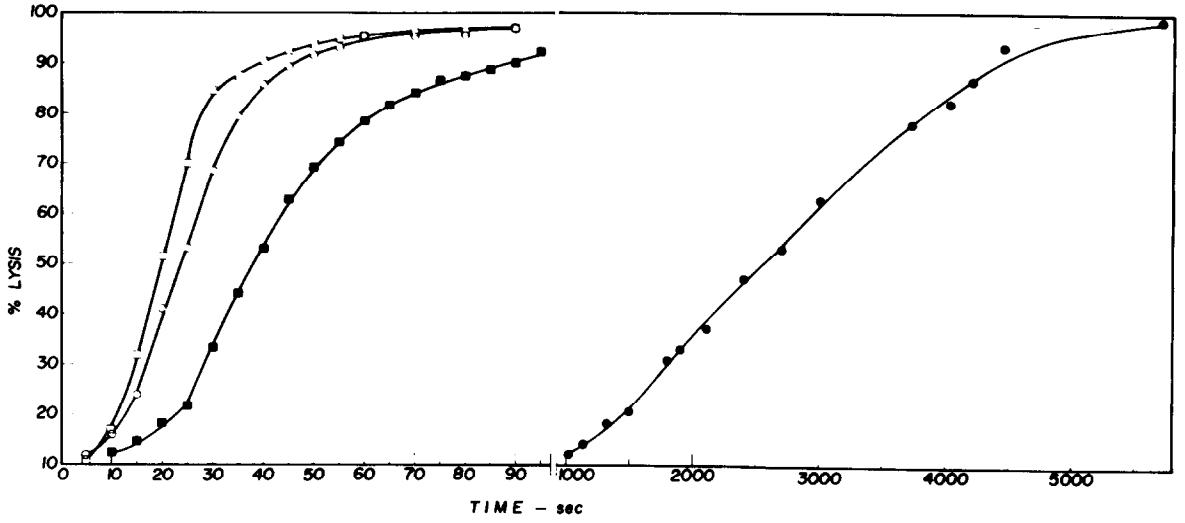

Fig.1. Glycerol hemolysis time curves in camel (–●–), man (–■–), control hamsters (–○–) and heat acclimated hamsters (–□–).

in both tests; heat acclimation of the hamsters induces shortening of the glycerol lysis time (i.e. glycerol permeability is increased) and increases the osmotic fragility. The camel erythrocyte, which has been shown to display striking osmotic stability, also has a remarkably prolonged glycerol lysis time.

Lipid-composition and glycerol lysis time. Glycerol permeability has been related to lipid composition of whole erythrocytes in different species [14], as well as in adult and fetal human erythrocytes [5]. However, in different mammalian species [7] as well as in clinical disorders [6], no definite correlation was found between glycerol permeability and erythrocyte lipid composition.

This study has shown that heat acclimation augments glycerol permeability significantly in the hamster erythrocyte. It has been shown that heat acclimation of hamsters also induces definite changes in lipid composition: the ratio of cholesterol to phospholipids was lowered, there was a lower content of phosphatidyl choline and sphingomyelin, and a marked decrease in linolenate content in the lipids [8]. This could suggest a definite correlation between lipid composition and glycerol permeability. However this was not the case with the camel: While the lipid content of the camel's erythrocyte has been found to be similar to that of other mammals [11] we have demonstrated its uniquely low glycerol permeability. This low glycerol permeability is in accord with the extremely low osmotic fragility [9,10]. These erythrocytes also differ in shape (oval instead of discs [15]) and in their amazing resistance, in vitro, to hypertonic and hypotonic solutions [16] as well as to in vivo dehydration and rapid rehydration.

Study of the camel erythrocyte suggests, therefore, that although lipid composition may play a role in glycerol permeability, it is not the major factor.

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