

# Erythrocyte glutathione concentrations and the correlations with packed cell volume, haemoglobin and plasma ascorbic acid concentrations in Nigerian Wadara cattle

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## Key words

Cattle - Wadara zebu - Glutathione - Erythrocyte - Haematocrit - Haemoglobin - Ascorbic acid - Blood plasma - Nigeria.

## Summary

The mean erythrocyte glutathione (GSH) concentrations of Nigerian Wadara zebu cattle ( $n = 32$ ) was  $43.9 \pm 11.7$  mg/dl RBC or  $1.96 \pm 0.57$  mg/gHb. The erythrocyte GSH values expressed in these two units were positively correlated ( $r = 0.85$ ) to one another. The packed cell volume (PCV) and haemoglobin (Hb) concentrations were positively correlated ( $r = 0.59, 0.52$ ) to the erythrocyte GSH values. The frequency distribution indicated that 37.5 % and 90.6 % of the values were less than 40 and 60 mg/dl RBC, respectively. The mean plasma ascorbic acid concentration was  $0.7 \pm 0.2$  mg/dl. Weak insignificant correlations ( $r = -0.01, -0.36$ ) were observed between erythrocyte GSH and plasma ascorbic acid concentrations. Therefore, the erythrocyte GSH values were significantly affected by PCV and Hb values, but not by plasma ascorbic acid concentrations.

## INTRODUCTION

The normal erythrocyte glutathione (GSH) concentrations of Nigerian zebus (Sokoto Gudali) and Ndama cattle in relation to packed cell volume (PCV) have been reported (6). No attempt had been made earlier to express erythrocyte GSH in Nigerian cattle in relation to haemoglobin (Hb) concentrations. It has been reported that high ascorbic acid concentrations in samples reduced GSH determinations (4). There is no available report of the plasma ascorbic acid concentrations in Nigerian cattle. It may be necessary to ascertain whether plasma ascorbic acid concentrations could affect GSH determinations in cattle. The purpose of this work was to evaluate the erythrocyte GSH concentrations in Nigerian Wadara cattle, a type of zebu in the Sahel region of the North-Eastern part of the country. The relationship of GSH values to PCV, Hb and plasma ascorbic acid concentrations were assessed.

## MATERIALS AND METHODS

Thirty-two apparently healthy Wadara (zebu) cattle of both sexes aged 8 months to 5 years and weighing about 60-300 kg were

used. Twenty-two of them were located on the University of Maiduguri farm and ten were presented for slaughter at the Maiduguri abattoir. The animals were maintained mainly by grazing.

Blood samples (5 ml) were collected from each animal during the cold harmattan season and placed in a container with EDTA as anticoagulant. PCV and Hb concentrations were determined by the microhaematocrit and cyanmethaemoglobin methods, respectively. GSH was estimated in whole blood using 5,5'-dithiobis-(2-nitrobenzoic acid) method (2), and erythrocyte GSH concentrations were calculated from PCV and Hb concentrations. Blood samples were centrifuged at 3000 g for 5 min and the plasma was collected and used for ascorbic acid estimation according to the dinitrophenyl hydrazine method (9).

The data were summarized as means  $\pm$  standard deviations (SD). Correlation coefficients between parameters were computed (3).

## RESULTS

The data on PCV, Hb, blood and erythrocyte GSH and plasma ascorbic concentrations in Nigerian Wadara cattle are summarized in table I. The frequency distribution of erythrocyte GSH values is presented in table II. Erythrocyte GSH concentrations of 53.1 % of the cattle were between 40 and 59 mg/dl RBC, respectively. Correlation coefficients in the relationships of blood and erythrocyte GSH with PCV, Hb and plasma ascorbic acid concentrations are presented in table III. Blood and erythrocyte

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Table I

Packed cell volume, haemoglobin, plasma ascorbic acid, blood and erythrocyte glutathione concentrations in Nigerian Wadara cattle

| Parameters                   | Mean $\pm$ SD   | Range     |
|------------------------------|-----------------|-----------|
| PCV (%)                      | 32.6 $\pm$ 9.5  | 20-54     |
| Hb (mg/dl)                   | 9.2 $\pm$ 2.2   | 4.6-13.2  |
| Plasma ascorbic acid (mg/dl) | 0.7 $\pm$ 0.2   | 0.4-1.0   |
| Blood GSH                    | 15.0 $\pm$ 7.5  | 6.3-31.3  |
| Erythrocyte GSH (mg/dl RBC)  | 43.9 $\pm$ 11.7 | 21.7-60.1 |
| mg/gHb                       | 1.96 $\pm$ 0.57 | 0.9-3.1   |

Table II

Frequency distribution of erythrocyte glutathione concentrations in Nigerian Wadara cattle

| Erythrocyte GSH (mg/dl RBC) | Number of cattle (%) |
|-----------------------------|----------------------|
| 20-39                       | 12 (37.5 %)          |
| 40-59                       | 17 (53.1 %)          |
| 60-79                       | 3 (9.4 %)            |

GSH were positively correlated with PCV and Hb. Correlation coefficients in the relationship of erythrocyte GSH expressed in mg/dl RBC and mg/gHb with PCV ( $r = 0.59$ ) and Hb ( $r = 0.52$ ), respectively, were comparable. Erythrocyte GSH expressed in both types of units were positively correlated ( $r = 0.85$ ) with one another. There was a concurrent positive correlation ( $r = 0.78$ ) between PCV and Hb. Plasma ascorbic acid concentrations showed weak insignificant ( $P > 0.05$ ) correlations with blood ( $r = -0.35$ ) and erythrocyte ( $r = -0.01, -0.36$ ) GSH concentrations.

## DISCUSSION

The mean erythrocyte GSH concentration of  $43.9 \pm 11.7$  mg/dl RBC in the Wadara zebu cattle was significantly ( $P < 0.05$ ) lower than  $73.4 \pm 23.5$  mg/dl RBC previously reported in Nigerian zebu (Sokoto Gudali) cattle (6), and also lower than  $96.1 \pm 14.9$  (7) and  $72.0 \pm 18.1$  mg/dl RBC (1) reported in cattle from outside Nigeria.

The range of values in Wadara zebu was 21.7-60.1 mg/dl RBC as compared to 40.8-127.3 mg/dl RBC in Sokoto Gudali zebu (6) and 40-113 mg/dl RBC in Australian cattle (1). Although the frequency distribution of erythrocyte GSH values in Gudali zebu was positively skewed with mode at 40-59 mg/100 ml RBC, only 40 % of the population had values less than 60 mg/dl RBC (5). In contrast, 90.6 % of the Wadara zebu had GSH values less than 60 mg/dl RBC. Also, 37.5 % of the Wadara zebu had GSH values less than the lower limit of 40 mg/dl RBC reported in other cattle (1, 6).

The positive correlation between erythrocyte GSH concentrations and PCV in Wadara zebu ( $r = 0.59$ ) was similarly reported in other Nigerian cattle ( $r = 0.58$ ) (6). However, the significantly ( $P < 0.05$ ) higher PCV in Wadara zebu ( $32.6 \pm 9.5$  %) compared to the PCV in Sokoto Gudali zebu ( $24.7 \pm 4.1$  %) (6) did not

Table III

Correlation coefficients ( $r$ ) in the relationship of blood and erythrocyte glutathione concentrations with packed cell volume, haemoglobin and plasma ascorbic acid concentrations in Nigerian Wadara cattle

| Parameters                          | $r$   | t-test     |
|-------------------------------------|-------|------------|
| Blood GSH vs. plasma ascorbic acid  | -0.35 | $P > 0.05$ |
| Blood GSH vs. PCV                   | 0.92  | $P < 0.01$ |
| Blood GSH vs. Hb                    | 0.81  | $P < 0.01$ |
| PCV vs. Hb                          | 0.78  | $P < 0.01$ |
| Erythrocyte GSH:                    |       |            |
| mg/dl RBC vs. mg/gHb                | 0.85  | $P < 0.01$ |
| mg/dl RBC vs. PCV                   | 0.59  | $P < 0.01$ |
| mg/dl RBC vs. blood GSH             | 0.85  | $P < 0.01$ |
| mg/dl RBC vs. plasma ascorbic acid. | -0.01 | $P > 0.05$ |
| mg/gHb vs. Hb                       | 0.52  | $P < 0.05$ |
| mg/gHb vs. blood GSH                | 0.91  | $P < 0.01$ |
| mg/gHb vs. plasma ascorbic acid     | -0.36 | $P > 0.05$ |

predict a higher erythrocyte GSH in Wadara zebu, indicating that the correlations were exclusive for the different populations. Therefore, at the same PCV, Wadara zebu would be expected to have lower erythrocyte GSH concentrations than Sokoto Gudali zebu. Further studies would need to be carried out to find out whether the lower GSH values in Wadara zebu might be related to an intraerythrocytic supply of substrates for GSH synthesis or to the activities of GSH metabolizing enzymes or to other factors.

The values of erythrocyte GSH expressed in mg/dl RBC and mg/gHb were positively correlated ( $r = 0.85$ ) and thus the latter unit could also be exclusively used in research. The erythrocyte GSH values in mg/gHb were similarly positively correlated ( $r = 0.52$ ) with Hb values. The expressions of erythrocyte GSH in relation to packed red cells or Hb concentrations were directly proportional, perhaps because of the simultaneous positive correlation ( $r = 0.78$ ) of PCV and Hb concentrations.

There was a positive correlation ( $r = 0.85, 0.91$ ) between erythrocyte and whole blood GSH values, which implied that interpretation of erythrocyte GSH concentrations could be extrapolated from blood GSH concentrations in healthy cattle.

The weak and insignificant negative correlations between blood or erythrocyte GSH and plasma ascorbic acid concentrations showed that plasma ascorbic acid concentrations were not likely to significantly influence GSH values. Plasma ascorbic acid concentrations in the cattle were adequate for normal individuals (10). Under stress conditions when large amounts of ascorbate are released into circulation (8) there might be a tendency for blood GSH values to decrease because of weak negative correlations ( $r = -0.35$ ).

## CONCLUSION

Wadara zebu had lower erythrocyte GSH values than those reported for other Nigerian cattle and the various correlations with PCV, Hb and plasma ascorbic acid concentrations represent new data, which could be relevant in future basic research in Nigeria.

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**Résumé**

**Igbokwe I.O., Bah G.S., Obagaiye O.K., Saror D.I., Esievo K.A.N.** Concentrations du glutathion érythrocytaire et ses corrélations avec l'hématocrite et les concentrations d'hémoglobine et d'acide ascorbique du plasma chez les bovins Wadara nigerians

Les concentrations moyennes de glutathion érythrocytaire chez les bovins zébus Wadara nigériens (n = 32) étaient de  $43,9 \pm 11,7$  mg/dl de globules rouges ou  $1,96 \pm 0,57$  mg/gHb. Les valeurs du glutathion érythrocytaire exprimées dans ces deux mesures ont montré une corrélation (r = 0,85) l'une envers l'autre. L'hématocrite et les concentrations d'hémoglobine sont corrélés (r = 0,59, 0,52) avec les valeurs du glutathion érythrocytaire. La répartition des fréquences a montré que 37,5 p.100 et 90,6 p.100 des valeurs étaient respectivement inférieures aux 40 et 60 mg/dl de globules rouges. La concentration moyenne de l'acide ascorbique du plasma était de  $0,7 \pm 0,2$  mg/dl. De faibles corrélations non significatives (r = -0,01, -0,36) ont été observées entre les concentrations du glutathion érythrocytaire et de l'acide ascorbique du plasma. En conséquence, les valeurs du glutathion érythrocytaire étaient affectées de façon significative par celles de l'hématocrite et de l'hémoglobine, mais pas par celles de l'acide ascorbique du plasma.

**Mots-clés** : Bovin - Zébu Wadara - Glutathion - Erythrocyte - Hématocrite - Hémoglobine - Acide ascorbique - Plasma sanguin - Nigeria.

**Resumen**

**Igbokwe I.O., Bah G.S., Obagaiye O.K., Saror D.I., Esievo K.A.N.** Concentraciones de glutathion eritrocitario y correlaciones con el hematocrito, la hemoglobina y las concentraciones de ácido ascórbico en plasma, en el ganado Wadara nigeriano

La concentración promedio de glutathion eritrocitario (GSH) en el ganado cebú Wadara nigeriano (n = 32) fue de  $43,9 \pm 11,7$  mg/dl RBC o  $1,96 \pm 0,57$  mg/gHb. Los valores de GSH eritrocitarios, expresados en estas dos unidades, se correlacionaron positivamente (r = 0,85) entre ellos. El hematocrito (PCV) y la concentración de hemoglobina se correlacionaron positivamente (r = 0,59, 0,52) con los valores de GSH eritrocitarios. La distribución de la frecuencia indica que 37,5 p. 100 y 90,6 p. 100 de los valores fueron menores de 40 y 60 mg/dl RBC, respectivamente. El promedio de la concentración de ácido ascórbico en plasma fue de  $0,7 \pm 0,2$  mg/dl. Se observaron relaciones débiles, no significativas (r = -0,01, -0,36), entre el valor de GSH eritrocitario y las concentraciones plasmáticas de ácido ascórbico. Por lo tanto, los valores de GSH eritrocitario fueron afectados significativamente por el hematocrito y la hemoglobina, pero no por las concentraciones de ácido ascórbico en plasma.

**Palabras clave** : Ganado bovino - Cebú Wadara - Glutathion - Eritrocito - Hematocrito - Hemoglobina - Acido ascórbico - Plasma sanguineo - Nigeria.