

## Evaluation and Comparison of Hematocrit, Hemoglobin and Iron Rate in Maternello-Placento-Fœtal Goats Complex at Lubumbashi in Tropical Area

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### ABSTRACT

Packed cell volume, hemoglobin and iron rate were obtained from 54 whole blood samples, hemolysed whole blood and serum of 9 maternal-placental-fœtal complex (MPFC) of goats from Lubumbashi.

Packed cell volume obtained after centrifugation and hemoglobin rate by Sahli method were respectively:  $40,89 \pm 3,8\%$  and  $7,56 \pm 1,05\%$  in the maternal blood,  $33,14 \pm 5,75\%$  and  $6,69 \pm 0,66\%$  in the placenta blood and  $30,22 \pm 3,46\%$  and  $6,53 \pm 0,75\%$  in the fœtus blood.

The serum and hemolysed whole blood iron rate values obtained from colorimetric test by spectrophotometer, were respectively,  $86,47 \pm 9,13 \mu\text{mol/l}$  and  $7,16 \pm 9,88 \mu\text{mol/l}$  in the maternal blood,  $21,68 \pm 5,01 \mu\text{mol/l}$  and  $0,54 \pm 0,52 \mu\text{mol/l}$  in the placenta blood and  $29,25 \pm 12,37 \mu\text{mol/l}$  and  $2,32 \pm 4,19 \mu\text{mol/l}$  in the fœtus blood.

The globular iron rate being the difference between the serum and the total iron were respectively  $79,29 \pm 14,58 \mu\text{mol/l}$ ,  $21,13 \pm 4,98 \mu\text{mol/l}$  and  $26,92 \pm 14,47 \mu\text{mol/l}$ .

Statistically, in general, the maternal parameters were significantly higher than those in placenta and fœtus.

If placenta and fœtal hemoglobin is comparable, and fœtal packed cell volume low, all the fœtal iron rates are significantly higher than placenta iron rates.

By considering the whole iron in CMPF, in the pregnant, the iron rate is 62,9% in the maternal compartment, 15,7% in the placenta and 21,2% in the fœtal compartment.

Hemoglobin rate obtained locally, being anemic type, the supplement with iron to goats during pregnancy is important.

**Key words:** Packed cell volume, Hemoglobin, Iron rate, Maternal-placental-fœtal complex.

### RESUME

L'hématocrite, le taux d'hémoglobine et les teneurs martiales étaient obtenus à partir de 54 échantillons du sang total, sang total hémolysé et sérum de 9 complexes maternello-placento-fœtal (CMPF) des chèvres à Lubumbashi.

L'hématocrite dosé par la microcentrifugeuse et le taux d'hémoglobine par la méthode de Sahli étaient respectivement de  $40,89 \pm 3,8\%$  et  $7,56 \pm 1,05\%$  chez les mères,  $33,14 \pm 5,75\%$  et  $6,69 \pm 0,66\%$  dans les placentas et de  $30,22 \pm 3,46\%$  et  $6,53 \pm 0,75\%$  chez leurs fœtus.

Les teneurs martiales du sang total hémolysé et du sérum dosées par la méthode colorimétrique à l'aide de spectrophotomètre étaient respectivement de  $86,47 \pm 9,13 \mu\text{mol/l}$  et  $7,16 \pm 9,88 \mu\text{mol/l}$  chez la mère, de  $21,68 \pm 5,01 \mu\text{mol/l}$  et  $0,54 \pm 0,52 \mu\text{mol/l}$  dans les placentas et de  $29,25 \pm 12,37 \mu\text{mol/l}$  et  $2,32 \pm 4,19 \mu\text{mol/l}$  pour les fœtus.

Le fer globulaire, écart entre fer sanguin total et fer sérique était chez les mères, placentas et fœtus respectivement de  $79,29 \pm 14,58 \mu\text{mol/l}$ ,  $21,13 \pm 4,98 \mu\text{mol/l}$  et  $26,92 \pm 14,47 \mu\text{mol/l}$ .

Statistiquement, d'une manière globale, les paramètres maternels étaient significativement supérieurs à ceux du placenta et fœtus.

Bien que l'hémoglobine placentaire et fœtale fût comparable, l'hématocrite fœtal faible, toutes les teneurs martiales fœtales étaient significativement supérieures aux teneurs martiales placentaires.

En considérant le fer total du complexe, chez une gestante, la teneur du fer est de 62,9% dans le compartiment maternel, de 15,7% dans le placenta et de 21,2% dans le compartiment fœtal.

Le taux d'hémoglobine obtenu localement étant du type anémique, la supplémentation en fer des chèvres pendant la gestation est nécessaire.

**Mots clés:** hématocrite, hémoglobine, teneur martiale, complexe maternello-placento-fœtal.

## INTRODUCTION

The goat is a family animal. It is bred for the production of meat, of milk but also as solution to the social problems<sup>11</sup>.

The goat breeding is economically advantageous because of the rusticity, prolificity and its nutrition simplicity<sup>7</sup>. His economical profits and low feed cost is mainly due to his prolificity, the goat being known for twin and nontwin gestation<sup>12</sup>. During his gestation, water, metabolites, energetic substrates and minerals such as iron are transferred to the foetus via the placenta which is known as synthesis, catabolism, and storage organ<sup>1, 8</sup>.

According to Dennis and al.<sup>3</sup>, iron is a part of red blood cells, thus packed cell volume and hemoglobin depend on it. Packed cell volume values varying between 20 and 30 % and hemoglobin between 8 and 13,5g % have been given by Siliart and Nguyen<sup>14</sup>. So far, nothing has been said about placental and foetal hemoglobin and packed cell volume.

As far as serum and globular iron rate and whole blood are concerned, what we read in literature seems to deal with other species such as cattle<sup>5</sup>, sheep<sup>2</sup>, horse<sup>13</sup>, but still nothing dealing with the above values in goat placenta and foetus. We therefore wanted to know whether these values could change in the maternal-placental-foetal complex.

The interest of this work is to calculate values of packed cell volume, hemoglobin rate and iron rate in the maternal-placental-foetal complex. Our hypothesis is that high variations of the above values are expected in the complex.

The aim of this work is to determine packed cell volume, hemoglobin and iron rate values in the whole blood, hemolysed whole blood, the serum and in the red blood cells of the maternal-placental-foetal complex of the goats living in tropical regions.

## Area, animals, materials and methods

**Area:** this research has been done from blood samples of goats slaughtered in Mzee Kabila market in Lubumbashi tropical region in Democratic Republic of the Congo. The dosage of packed cell volume and hemoglobin has been done in the laboratory of physiology whereas the dosage of iron in the laboratory of biochemistry service of the Faculty of Veterinary Medicine of Lubumbashi university.

**Animals:** for the work to be done, we used whole blood collected with anticoagulant (EDTA) and sera from 9 maternal-placental-foetal complexes from pregnant goats slaughtered in Mzee Kabila market.

**Materials :** 27 samples (9 for the pregnant goats, 9 for placenta and 9 for their foetus) from whole blood collected with anticoagulant, were used to determine packed cell volume value, hemoglobin and iron rate values after hemolysis. Serum samples of the same complexes served to determine the serum iron rates. Equipments like syringes, knives, collection tubes, refrigerator, centrifuge and EDTA as anticoagulant have been used for blood collection, serum extraction, hemolysis and sample storage.

Sahli hemoglobinometer, his adnexa and HCl(0,1N) was used for getting hemoglobin concentration whereas Pasteur's pipette and microcentrifuge were used for determining hematocrit. Iron concentration was calculated by using the iron kit recommended by the Belgian laboratory Cypress Diagnostic.

## MATERIAL AND METHODS

**Animals choice:** the 9 maternal-placental-foetal complexes have been picked from pregnant slaughtered goat whose foetus was at least 15 cm long.

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**Blood collection:** 54 blood samples have been collected by puncturing jugular and placenta big veins. 4 to 5 ml from 8 to 10 of fresh blood, have been put in collection tubes with and without anticoagulant. 2 ml of serum have been extracted from blood without EDTA after centrifugation. Hemoglobin concentration and hematocrit have been determined from EDTA free blood.

**Iron concentration determination:** Hemolysed blood by machanic action, freezing and unfreezing and serum have been used for determining serum and total iron concentrations through spectrophotometer by

using ferrosine calometric method recommended by Cypress Diagnostic laboratory. Globular iron concentration is the difference between serum iron concentration and total iron concentration.

**Statistic evaluation :** we calculated standard deviations, averages, variances by classic methods ; student test allowed us to compare averages and 2010 Excel software version helped establish the correlation between studied parameters. Differences have been declared significant at 0,05% threshold. Iron conversion factor in  $\mu\text{mol/l}$  is 0,179.

## RESULTS

Results have been summed up in the 5 following tables

**Table I: hematocrit (%), hemoglobin concentration (g %), serum, total and globular iron concentrations ( $\mu\text{g/dl}$ ) of mothers (pregnant goats)**

No	Hematocrit	Hemoglobin	Serum iron	Total iron	Globular iron
1	35	7	79,37	533,33	453,96
2	38	7,8	6,05	400,61	394,61
3	40	8	1,79	493,20	491,41
4	45	7,4	32,28	481,48	449,2
5	40	7	44,17	557,03	412,86
6	45	10	16,14	461,81	445,67
7	40	7,6	4,48	475,30	470,82
8	40	6,4	5,38	523,45	518,07
9			170,85	421,60	250,75
N	45	6,8	9	9	9
M $\pm$ S	9	9	40,06 $\pm$ 55,22	483,09 $\pm$ 51,02	443,04 $\pm$ 81,47
Iron ( $\mu\text{mol/l}$ )	40,89 $\pm$ 3,48	7,56 $\pm$ 1,05	7,17 $\pm$ 9,88	86,47 $\pm$ 9,13	79,29 $\pm$ 14,58
%			8,2	100	91,6

Legend: N=number, M=average, S= Standard deviation

The analysing results from this table it shows that hematocrit is 40,89 $\pm$ 3,48% and hemoglobin 7,56 $\pm$ 1,05g% for the mothers (pregnant goats) having higher iron level in red blood cells ( 91,6%) than they do in the serum (8,2%)

**Table II: hematocrit (%), hemoglobin concentration (g %), and serum, total and globular iron concentrations (µg/dl) of placentas**

No	Hematocrit	Hemoglobin	Serum iron	Total iron	Globular iron
1	34	7	2,34	175,43	173,09
2	40	8	0,42	84,79	84,37
3	35	7	5,00	100	95
4	21	7	0,42	112,88	112,46
5	35	6	1,27	98,24	96,97
6	31	6,6	2,98	142,10	139,12
7	40	6,2	9,90	122,80	112,9
8	30	6,6	2,55	111,69	109,14
9			2,55	242,36	139,81
N	32	5,8	9	9	9
Met S	9	9	3,05±2,93	121,14±28,04	118,10±27,83
Fer µmol/l	33,14±5,75	6,69±0,66	0,54±0,52	21,68±5,01	21,13±4,98
%			2,5	100	97,5

After studying this table we notice that 33,14±5,75% is the average value of hematocrit and hemoglobin is 6,69±0,66g%, and finally the iron level in the red blood cells is higher (soit 97,5%) than it is in placenta serum (2,5%, almost absent).

**Table III: hematocrit (%), hemoglobin concentration (g %), and serum, total and globular iron concentrations (µg/dl) of foetuses**

No	Hematocrit	Hemoglobin	Serum iron	Total iron	Globular iron
1	27	6	72,31	93,56	21 ,25
2	24	7	1,59	92,98	91,39
3	30	7	6,07	277,77	271,70
4	35	7	22,47	167,83	145,36
5	31	6	0 ,42	225,14	224,72
6	35	8	11,82	225,75	113,93
7	30	6	1,17	117 ,54	116,37
8	30	5,8	0,74	126,07	125,33
9			0,42	244,44	244,08
N	30	6	9	9	9
M et S	9	9	13,00±23,44	163,45±69,13	150,45±80,86
Fer en µmol/l	30,22±3,46	6,53±0,75	2,32±4,19	29,25±12,37	26,92±14,47
%			7,9	100	92,1

Analysis of the above table shows 30, 22±3, 46% as hematocrit value and an hemoglobin value of 6, 53±0,75g%. It clearly reveals that iron concentration is much higher (soit 92, 1%) in red blood cells than in foetuses sera (soit 7, 9%).

**Table IV Hematocrit general averages (%), hemoglobin concentration (g%), Hemolysed blood iron, serum iron and globular iron ( $\mu\text{mol/l}$ )**

categories	Hematocrit	Hemoglobin	Total iron	Serum iron	Globular iron
Mothers	40,89±3,48	7,56±1,05	86,47±9,13	7,17±9,88	79,29±14,58
Placentas	33,14±5,75	6,69±0,66	21,68±5,01	0,54±52	21,13±4,98
Foetuses	30,22±3,46	6,53±0,75	29,25±12,37	2,32±4,19	26,92±14,47

The above table is showing how much higher the maternal values are than placentas and foetuses. Though placenta hemoglobin level is as same as foetus, this table outlines the superiority of both placenta hemotacrit and iron concentration over foetus.

**Table V: correlation between studied hematological and biochemical parameters**

Categories	Hct/SFe	Hb/SFe	SFe/GFe	SFe/SFe	Hct/Hct	Hb/Hb	Hct/Hb
Mothers	0,22	- 0,36	- 0,84				0,34
Placentas	0,46	- 0,35	0,02				0,09
Foetuses	- 0,11	- 0,11	- 0,07				0,38
Mothers/placentas				0,22	- 0,59	0,20	
Mothers/foetuses				0,21	0,78	0,90	
Placentas/foetuses				0,23	0,71	0,44	

Legend : Hb =hemoglobin, Hct=Hematocrit, SFe=serum iron, GFe=Globular Iron, maHbt=maternal Hemoglobin, FoetHb=fetal Hemoglobin, matSFe=maternal serum iron, foetSFe= fetal serum Iron

The examination of this table shows that the correlation is positive between maternal and foetal hemoglobin, and negative between serum and maternal globular iron, but averagely positive between maternal and foetal hematocrit, placental and foetal hematocrit. It is negative between maternal and placental hematocrit. Finally this table reveals that the correlation is weakly negative or positive, almost null between all the studied parameters.

### DISCUSSION

This discussion is about hematocrit, hemoglobin concentration, and iron concentration in the whole blood, hemolysed whole blood, serum and red blood cells of 9 maternello-placento-foetal complexes of pregnant slaughtered goats in Mzee Kabila market.

### HEMATOCRIT AND HEMOGLOBIN

Displayed results in table I, II, III, IV outline the following average values about hematocrit and hemoglobin level in the maternello-placento-foetal complex : 40,89±3,48% and 7,56 ± 1,05g % in the pregnant goat, 33,14 ± 5,75 % et 6,69 ± 0,66g % in the placenta and 30,22 ± 3,46% et de 6,53 ± 0,74 g % for the

foetus. Statistical comparison shows that hematocrit and hemoglobin levels are higher in the mothers than they are in placentas and foetuses, and placenta hematocrit is higher than foetus' though they hemoglobin concentration are comparable.

The following local values of hematocrit : 40,89±3,48% in the mothers, 33,14 ± 5,75 % in the placenta and 30,22 ± 3,46% for foetus are higher than 27,5±0,7%, as average value but less than 59,4±6%, average value found by Ndoutamia and Ganda<sup>9</sup> in the goats in Tchad.

As far the local hemoglobin levels are concerned, 7,56 ± 1,05g % in the mothers, 6,69 ± 0,66g % in the placenta and 6,53 ± 0,74 g % for foetuses are far less than 9±1,1g% and 12±1,3g% found in goats by Ndoutamia and Ganda<sup>9</sup>. Their are also inferior to 10 à 11g %, value found by Siliart and Nguyen<sup>14</sup>.

The superiority of maternal hemoglobin and hematocrit, could on one hand be linked to intense erythropoiesis and hemoglobinogenesis for meeting the mother and foetus oxygen needs, on the other to maturity of the mother's bone marrow, number and size of foetal red blood cells, B12 vitamin,

folic acid levels and erythropoietin levels in the mother and foetus<sup>4</sup>.

Significantly high hematocrit value in the placenta could be due to oxygen storage role of this organ for the foetus needs. The anemia type hemoglobin concentration, comparable between placenta and foetus is presumably due the weak erythropoiesis capacity of the foetus on one hand and to iron deficiency anemia in the mother.

### IRON CONCENTRATIONS

Results from table I, II, III, IV show for hemolysed whole blood, serum and red blood cells of MPFC, the following respective values : 86,47±9,13µmol/l, de 7,17±9,88 µmol/l et de 79,29±14,58 µmol/l for mothers, 21,68±5,01µmol/l, de 0,54±0,52 µmol/l et de 21,13 ± 4,98 µmol/l for placentas, 29,25±12,37µmol/l, 2,32±4,19 µmol/l and 26,92 ± 14,47 µmol/l for foetuses of. Considering 137.4 µmol/l as the average value of MPFC, iron concentrations are 62,9%, 15,7%, 21,2% respectively in the maternal, placental and foetal compartments. Statistical comparison shows that the iron concentration in mothers are higher than in placentas whose concentration are superior to foetuses<sup>7</sup>.

Being unable to compare our data with other's as far as irons concentrations are concerned, we can notice that 7,17±9,88, 0,54±0,52 and 2,32±4,19 µmol/l respectively iron concentration in the mothers, placentas and foetuses, are inferior to iron serum level of pregnant sows (16,61±0,96 µmol/l), large whight (13,08±1,80) µmol/l and local breed piglets (8,80 µmol/l) observerd by Ngoie et al (2016).

### IRON RATE

The results presented in tables I, II and III and IV show that the iron rate of the hemolysed whole blood, serum and red blood cells of CMPF are on average respectively 86,47 ± 9.13 µmol/l, 7.17 ± 9.88 µmol/l, and 79,29 ± 14.58 µmol/l in the mothers, 21.68 ± 5.01 µmol/l, 0.54 ± 0.52 µmol/, and 21.13 ± 4.98 µmol/l in placenta and 29.25 ± 12.37 µmol/l, 2.32 ± 4.19 µmol/l, and 26.92 ± 14.47 µmol/l for foetuses. By considering the total mean

value of the MPFC of 137.4 µmol/l, the iron rate are in the range of 62.9% in the maternal compartment, 15.7% in the placental compartment and 21.2% in the foetal compartment.

The literature at our disposal does not offer us the opportunities to find international reference iron values and to establish comparison with locally obtained levels on the goat. However, the average serum iron levels of 7.17 ± 9.88 for mothers, 0.54 ± 0.52 µmol/L for placenta and 2.32 ± 4.19 µmol/l for foetuses were below the average serum iron levels of 16.61 ± 0.96 µmol/l, 13.08 ± 1.80 µmol/l, and 8.80 µmol/l, respectively, on pregnant sows, large white piglets, and common-breed piglets by Ngoie et al.<sup>10</sup>. They are far below the minimum values of 12.53 µmol/l observed in cattle by Gustav<sup>5</sup>, of 17.9 µmol/l observed by Blood and Henderson<sup>2</sup> in sheep, 40.50 µmol/l in equines by Rajakoski et al.<sup>13</sup>, 8.9 µmol/l In humans by Dennis et al.<sup>3</sup>. Our total values found in the Goat Maternello-placento-foetal complex are far superior to 20.24 ± 1.50 µmol/l, 18.58 ± 2.14 µmol/l, and 15.12 ± 1.68 µmol/l total iron advanced by Ngoie et al.<sup>10</sup> in sows Pregnant, large white piglets and common breed piglets.

The significant superiority of maternal iron levels on placenta and foetus would be due to the dietary intake and mobilization of hepatic ferritiques reserves by the mother to combat the physiological disasters of Iron deficiency anemia already present.

The superiority of maternal globular levels observed would be related to the superiority of maternal hematocrit and hemoglobin, by intense erythropoiesis and Hemoglobin fabrication to meet the double maternal needs and Foetal.

The superiority of all foetal iron levels in relation to those of the placentas, testifies that the placenta is a place of transfer for certain nutrients and storage for other<sup>8,10</sup>.

In the mothers, for a total iron rate of 86.47µmol/l, the serum iron represents only 8.2% and globular iron 91.7%. This distribution shows that maternal serum iron is

intensely mobilized and directed towards foetal needs, the foetus being a priority<sup>8</sup>.

For the foetuses, with a total iron rate of 29.25  $\mu\text{mol/l}$ , the serum iron corresponds to 7.9% against 92.1% in red blood cells, whereas at placental level, for overall blood iron rate of 21.68, the serum iron corresponds to 2.5% and globular iron Corresponds to 97.5%, this placental serum iron confirms that the placenta is an iron transitory organ for foetal needs.

### CORRELATION

The examination of table V shows that the correlation is positive excellently or 0.90 between maternal and foetal hemoglobin, it is excellently negative or -0.84 between the serum and globular maternal iron, but moderately positive or 0.78 and 0.71 Between maternal and foetal hematocrit and Between placental and foetal hematocrit, respectively; It is also moderately negative or -0.59 between maternal and placental hematocrit. It also reveals that the correlation is weakly positive or negative, almost zero between the other parameters studied.

This positive excellently correlation between maternal hemoglobin and foetal hemoglobin or 0.90 to be explained by the fact that the need for foetal oxygenation is satisfied with the maternal hemoglobin level. The need for foetal oxygenation is both a function of the degree of oxygen transfer via maternal hemoglobin<sup>8</sup>.

The higher negative trend of the correlation of either -0.84 between serum and globular iron levels in the mother would be explained by the fact that maternal serum iron is transferred to the foetus for its needs via the placenta, and is also directed towards the maternal needs. It is established that foetal iron is exclusively maternal in Origin and is transferred by active means<sup>6</sup>, whereas maternal serum iron is of food, hemolytic or mobilization of hepatic iron for the physiological needs of the mother<sup>10</sup>.

The moderately positive correlations of 0.78 between maternal and foetal hematocrit as well as 0.71 between placental and foetal hematocrit would be explained by

the fact that the foetal oxygenation needs are met by the mother, and thus the increase Oxygen-foetal needs entrains the increase in its hematocrit and therefore the hematocrit of its mother and placenta. The average negative correlation of 0.59 between maternal and placental hematocrit was due to the age, size, and needs of the foetus. As the fetus is a priority, the higher it increases in volume, its physiological needs also increase to the detriment of the mother.

### CONCLUSION

The determination of hematocrit, hemoglobin, and iron rate in the Maternello-placental-fetal goat complex in Lubumbashi showed that all of these parameters are significantly higher in the mother compared to the parameters placental and foetal correspondents; And that placental hematocrit is also higher than that of the foetus, their hemoglobin level is comparable while all foetal iron levels remain significantly higher than the corresponding placental values.

Compared to the different relationships, the correlation is positive excellently or 0.90 between maternal and foetal hemoglobin, it is negative excellently either -0.84 between the serum and globular maternal iron, but moderately positive or 0.78 and 0.71 between maternal and foetal hematocrit and between placental and foetal hematocrit, respectively, it is also moderately negative or -0.59 between maternal and placental hematocrit. But it is weakly positive or negative, almost zero between the other parameters studied.

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