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BIOCHEMICAL CHANGES IN THE PLASMA OF PREGNANT CROSSBRED SOWS (*SUS DOMESTICUS*)

Peter C. Ozegbe*, Michael A.S.E. Nssien and Olusola A. Oke.
Department of Veterinary Anatomy, University of Ibadan, Ibadan, Nigeria. ***E-mail:*** *library@kdl.ui.edu.ng; uivetmed@steineng.net*

Target Audience: Reproductive biologists, animal breeders, farmers, veterinarians, animal scientists.

ABSTRACT

The plasma concentrations of Na, K, Cl, HCO_3, inorganic PO_4, Ca, urea, creatinine, uric acid, total protein, albumin, globulin, albumin/globulin ratio (A:G), cholesterol and triglycerides of Large White x Landrace x Hampshire sows were determined during oestrus, first, second and third trimesters of pregnancy and lactation. The plasma level of each parameter during oestrus was compared with the levels in the other phases. Plasma concentrations of globulin, total protein and creatinine increased during the first trimester (at least $P<0.05$) while the A:G decreased ($P<0.01$). The plasma concentrations of lipids, globulin, creatinine and Na were increased significantly while A:G decreased very significantly during the second trimester ($P<0.05$ and $P<0.01$ respectively). Plasma Na concentration increased during the third trimester ($P<0.01$) while the bicarbonate level declined post-farrowing ($P<0.05$). Plasma cholesterol and triglycerides were positively and very significantly correlated throughout pregnancy. Uric acid was positively, albeit non-significantly, correlated with lipids during pregnancy and lactation but negatively correlated with lipids during oestrus. Monitoring plasma concentrations of A:G, total protein, total globulin, cholesterol, triglycerides, creatinine, Na and HCO_3 might be useful in pregnancy diagnosis and monitoring in a pig herd.

Key words: Biochemical changes, plasma, pregnant sows

DESCRIPTION OF PROBLEM

The literature is replete with data on maternal plasma/serum enzyme and hormone activities during pregnancy, labour and lactation. Data on serial studies of electrolytes, lipids, protein and non-protein nitrogen (NPN) during pregnancy are sparse. Rajagopalan and Raja (1) and Kaiser and Cummings (2) determined the concentration of a few electrolytes and proteins in the sow and ewe, respectively, as pregnancy advanced.

*Author for correspondence

Plasma electrolytes are important for maintaining osmotic equilibrium, water balance, bone metabolism, muscle contractility and acid-base relationships. The level of plasma proteins is a reflection of the balance of protein synthesis and catabolism. These parameters, along with enzymes and hormones might be useful tools in the effective diagnosis and monitoring of pregnancy.

MATERIALS AND METHODS

Seven adult female Large White x Landrace x Hampshire pigs of known gestational age were used. The animals were selected from a pig farm in Ibadan and were fed a common diet. Water was supplied *ad libitum*. The sows were dewormed with Piperazine about two weeks to their being served.

Blood samples were drawn from the ear vein of each sow into boi plasma concentration of the specific parameter during pregnancy or lactation.

Y= mean plasma concentration during oestrus

RESULTS AND DISCUSSION

The mean, standard error of mean, range, correlation coefficient and relative rate of change observed in this study are shown in Tables 1, 2 and 3.

Progressive hypernatraemia was observed during the trimester of pregnancy but the rate declined rapidly towards normal after farrowing. The second and third trimesters' concentrations were significantly higher than that of oestrus ($P<0.05$ and $P<0.01$, respectively). A non-significant hyperchloraemia ($P<0.05$) was observed as pregnancy and lactation advance and was highest during the second trimester.

Hypokalaemia was observed during lactation and throughout gestation ($P<0.05$) with the lowest value occurring during the second trimester. The maternal calcium remained essentially low but with a slight increase during the second trimester. The plasma concentration of inorganic phosphate was below reference value throughout pregnancy and lactation. The lowest concentration was observed during the first trimester of pregnancy while the plasma concentration of bicarbonate remained relatively constant during the first two trimester and then declined during the third trimester and lactation periods when compared to the oestrus.

The post-farrowing concentration of HCO_3^- was significantly different ($P<0.05$) from that of the oestrus. The plasma concentration of creatinine increased significantly ($P<0.05$) during the first 60 days of gestation and then declined to, and below the value observed for the oestrus during the third trimester and lactation.

The urea nitrogen, creatinine and uric acid concentration were increased during the first 60 days post-service but then declined during the last trimester and lactation with the exception of uric acid which showed an upward trend at lactation. The increased plasma level of creatinine was significant ($P<0.05$). The plasma total protein was significantly high during the first trimester ($P<0.05$). This increased concentration was maintained, though non-significantly, as pregnancy and lactation progressed.

Table 1: Plasma biochemistry

	Oestrus	Trimester			Lactation
		1	2	3	
Na (mMol/L)	122.5±2.63 (117 – 127)	129.2±4.31 (120 – 143)	131.75±1.8* (129 – 137)	132.8±1.5** (127 – 135)	125.5±1.6 (121 – 128)
K (mMol/L)	9.28±3.9 (4.6 – 20.9)	6.42±0.9 (4 – 8.6)	5.55±0.23 (5.2 – 6.2)	7.9±1.8 (5.1 – 15)	7.68±0.85 (5.6 – 9.7)
Cl (mMol/L)	95.25±3.9 (86 – 104)	96.4±3.6 (83 – 104)	107.5±4.8 (99 – 119)	97.2±2.1 (89 – 100)	98.25±0.48 (97 – 99)
HCO_3	22.25±.75 (21 – 24)	23±2.5 (18 – 32)	22.75±2.6 (18 – 30)	19.6±1.2 (15 – 22)	20.25±0.25* (20 – 21)
Ca (mg/dL)	11.25±.25^{abc} (11 – 12)	18.4±3.9^{a} (11 – 30)	19.5±3.9^{a} (14 – 31)	10.6±0.4^{ab} (10 – 12)	10.25±0.25^{c} (10 – 11)
BUN (mg/dL)	0.38±0.05 (0.3 – 0.5)	1.1±0.26 (0.4 – 1.8)	1.28±0.3 (0.8 – 2.1)	0.38±0.037 (0.3 – 0.5)	0.33±0.025 (3 – 4)
Creatinine (mg/dL)	8.38±0.14 (8.1 – 8.7)	8.34±0.35 (7.1 – 9.3)	8.7±0.29 (8.1 – 9.5)	7.78±0.32 (7.1 – 8.6)	8.18±0.36 (7.1 – 8.7)
Uric acid (mg/dL)	2.83±0.47 (2.2 – 4.2)	3.28±0.35 (2.4 – 4)	3.68±0.39 (2.9 – 4.6)	2.48±0.54 (1.6 – 4.6)	3.28±0.44 (2.2 – 4.2)
T. protein (G/L)	5.78±0.09 (5.6 – 6)	6.93±0.4 (5.8 – 8.1)	6.85±0.78 (2.2 – 3.6)	6.06±0.47 (4.6 – 7.5)	5.85±0.12 (5.7 – 6.2)
Albumin (G/L)	3.45±0.12 (3.1 – 3.6)	3.36±0.13 (3.1 – 3.8)	2.95±0.29 (2.6 – 5.3)	3.32±0.26 (2.4 – 4)	3.43±0.17 (3.1 – 3.8)
Globulin (G/L)	2.33±0.19 (2.1 – 2.9)	3.6±0.33** (2.7 – 4.6)	3.9±0.58* (2.6 – 5.3)	2.74±0.24 (2.2 – 3.5)	2.43±0.18 (1.9 – 2.7)
A : G	1.52±0.15 (1.07– 1.71)	0.76±1.15** (0.96 – 0.08)	0.79±0.08** (0.55– 0.91)	1.21±0.07 (1.1 – 1.42)	1.45±0.19 (1.15– 1.38)
Cholesterol (Mg/dL)	52.75±6.13 (40 – 66)	137±34.7 (62 – 220)	123.5±29* (67 – 189)	64.2±2.33 (58 – 71)	65.5±4.7 (56 – 77)
Triglyceride (Mg/dL)	30.5±4 (20 – 40)	72.6±17 (35 – 115)	76.6±15* (42 – 110)	41.6±4 (27 – 52)	41±10 (27 – 52)
Inorg. PO_4 (Mg/dL)	6.25±0.13 (1.4 – 6.5)	3.64±0.66 (2.3 – 5.7)	4.73±0.31 (4.2 – 5.6)	4.94±0.44 (3.7 – 6.2)	4.85±0.7 (3.2 – 6.2)

Mean ± SEM (range) * P<0.05: **P<0.01: Means with different superscripts along same row are significant different (P<0.05)

Table 2: Rate of change in the mean concentrations of the various plasma components relative to their level at oestrus (%)

Parameter	Trimesters of Pregnancy			Lactation
	1	2	3	
Na	5.5	7.6	8.4	2.5
Cl	1.2	12.9	2.1	3.1
K	-30.8	-40.2	-14.8	-17.2
Ca	-0.48	3.9	-7.1	-2.4
Inorg. PO_4	-41.8	-24.4	-21	-22.4
HCO_3	3.4	2.3	-11.9	-9.0
Total protein	20.5	18.6	4.9	1.3
Albumin	-2.6	-14.5	-3.8	-0.7
Globulin	54.8	67.7	17.9	4.3
A : G	-37.1	-48.2	-20.3	-4.6
BUN	63.6	73.3	-5.8	-8.9
Uric acid	16.1	30.1	-12.2	15.9
Creatinine	189.5	235.5	0	-14.5
Cholesterol	159.7	134.1	21.7	24.2
Triglycerides	138	151.6	36.4	34.4

Table 3: Correlation between mean plasma concentrations of uric acid, cholesterol and triglycerides.

		Oestrus		
		Uric acid	Cholesterol	Triglycerides
First trimester	Uric acid	1.000	-0.4047	-0.063
		0.0	0.5	0.9
	Cholesterol	0.8042	1.000	0.9074
		0.1	0.0	0.09
	Triglycerides	0.8268	0.996	1.000
		0.08	0.001	0.0
			Second trimester	
Second trimester	Uric acid	1.000	0.2131	0.3165
		0.0	0.7	0.6
	Cholesterol	0.3071	1.0000	0.9926
		0.6	0.0	0.01
	Triglycerides	0.4788	0.9622	1.0000
		0.4	0.01	0.0
			Lactation	
	Uric acid	1.0000	0.1407	0.4651
		0.0	0.8	0.5
	Cholesterol		1.000	0.9378
	Triglycerides		0.0	0.06
				1.0
				00

Plasma total globulin showed significant increase during the first and second trimester ($P<0.01$ and $P<0.05$, respectively) before progressively declining to almost the reference level. A slight reduction in the value of plasma albumin was observed throughout pregnancy and 30 days post-farrowing. The lowest rate occurred during the second trimester. The plasma A:G declined very significantly during the first 60 days of pregnancy ($P<0.01$) before rising to almost the level observed at oestrus. High plasma lipid was observed throughout pregnancy and post-farrowing. The plasma lipid concentration at the second trimester was significantly higher than that observed at oestrus ($P<0.05$).

Uric acid had non-significant correlation with both plasma cholesterol and triglycerides throughout oestrus, gestation and early lactation. The relationship was negative at oestrus but positive during lactation and pregnancy. Uric acid always had a more positive relationship with triglycerides than with cholesterol.

Cholesterol and triglycerides correlated positively with each other throughout the course of study although only the interactions during the gestational periods were significant (Table 3).

The pattern of reduction in the plasma concentrations of albumin, globulin and A:G observed in this work agrees with the reported findings in pregnant ewe and women (3, 4, 5). Our observed hyperproteinaemia with a decreasing rate of increase as pregnancy advanced agrees with the data presented by Kaiser and Cummings (2) which showed total protein peaking during the second trimester in the ewe, but disagrees with the uniformly agreed hypoproteinamia during pregnancy in women (3). Our total protein graph curve, however, is generally in agreement with those of other workers. Part of the discrepancy may be due to the much wider alterations in total globulin level during the gravid period in our sows. The alterations in plasma globulin may have resulted from increased alpha, beta and fibrinogen globulins (4) as well as production of colostrum, which is very rich in globulin (6).

The increased plasma calcium concentration during the second trimester agrees with Rajagopalan and Raja (1). But the decrease in value during lactation, first and third trimester differs from their observation. The fall during pregnancy and lactation is due to functional demand (7) since calcium is transported against a concentration gradient from maternal blood to that of the foetus (8).

The elevated plasma concentration during the first 60 days of gestation agrees with the observation of Glawischnig *et al.* (9), although they did not specify the period of pregnancy under study while the subsequent decrease at late pregnancy confirms the findings of Brzostowski *et al.* (10). Latner (7) stated that non-protein nitrogenous substances decreased during the first six months of pregnancy and increased subsequently in women. In contrast, we observed decreased NPN during the third trimester of pregnancy with only the uric acid increasing subsequently.

Our observed low phosphate level agrees with Rajagopalan and Raja (1) in the sow and Kaiser and Cummings (2) in the ewe. Some of the observed reduction in plasma inorganic phosphate and calcium could be accounted for at least by parathyroid gland hyperplasia and secretory hyperactivity, which occur in pregnancy and lactation (7).

It is uniformly agreed that there is hypernatraemia during pregnancy (2. 7. 11) and our result concurs. The reason for the increase is unclear. Kleinman and Lorenz (11) suggested that it may be due to a resetting of the normal homeostatic mechanism regulating body water and sodium.

Although both the work of Glawischnig *et al.* (9) and ours noted that hypokalaemia occurs in the sow as pregnancy advances we further observed that the plasma potassium tends to rise slightly towards normalcy as pregnancy advances. This hypokalaemia may be as a result of the particularly high aldosterone production, which promotes K excretion and Na reabsorption in the renal tubule, during pregnancy (12). The two planes of relative stability that we observed in plasma bicarbonate concentration (a slight increase on/or before the second trimester and a slight decrease after the second trimester) were also discernible on the ewe data as presented by Kaiser and Cummings (2). Although Kaiser and Cummings (2) attributed their observed variation to either hyperventilation or hypoxia, in view of the chloride shift, this patterns appears to be one of the normal physiological adaptations during pregnancy.

The generalized lipidaemia observed in our work agrees with Russel (13) who noted that it develops with normal pregnancy in women. The triglycerides fraction shows the largest proportionate rise in the sow, similar to that in woman during the second and third trimesters of gestation and also lactation (14). The plasma cholesterol fraction was relatively more concentrated during the first trimester of pregnancy in the sow.

The closer association between uric acid and triglycerides than cholesterol in the sow agrees with the observation of Berkowitz (15) in human with coronary atherosclerosis.

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CONCLUSION AND APPLICATION

1. Pregnancy and lactation affected plasma biochemistry in the sows under investigation.
2. Plasma biochemical analysis may be recommended to farmers and breeders in the event of inability to perform "riding test" at the right time.

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