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PHOSPHORUS, MAGNESIUM, AND pH IN BOVINE BLOOD SERUM NORMALLY, AFTER PARTURITION, AND IN PARTURIENT PARESIS

By

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A paper (1) appearing at about the same time as this one, deals with the calcium and protein concentrations in bovine blood serum normally, after parturition, and in parturient paresis. Determinations were also made of the phosphorus (total and inorganic) and magnesium content of blood serum and the pH of blood serum. The results of the latter studies will be reported here.

For data on the composition, the collection and the analysis of the material the reader is referred to the above-mentioned paper (1) and to an earlier publication (2), in which the analytical methods used in the present study are described.

The analytical results were treated statistically as described in the said paper (1) for calcium and protein, and they are reported here in Table 1; the results for different age-classes are shown in Table 2.

RESULTS AND DISCUSSION

Total phosphorus is low in cows after normal calving in comparison with non-calving cows, and still lower in parturient paresis. The decrease after normal calving is noted for both inorganic and organically bound phosphorus. The still greater decrease that occurs in parturient paresis, however, involves mainly inorganic phosphorus, while the organically bound fraction is only slightly lowered. In a previous work (2) it was found that the phosphorus content falls with increasing degree of

Table 1.
Analytical results in groups, and F-values at comparison between group values, all according to the text.

Comparison between groups no.	Group	Number of cases	Total P Mean \pm ϵ mg. per 100 ml.	Inorganic P Mean \pm ϵ mg. per 100 ml.	Organic P (calculated) Mean \pm ϵ mg. per 100 ml.
	1	60	14.09 \pm 0.32	6.04 \pm 0.13	8.05 \pm 0.31
	2	60	9.98 \pm 0.20	4.95 \pm 0.16	5.03 \pm 0.09
	3	47	6.35 \pm 0.28	1.79 \pm 0.21	4.56 \pm 0.17
1 and 2; F		120	115.55***	29.64***	80.47***
2 and 3; F		107	79.60***	122.52***	6.36*
1 and 3; F		107	299.11***	262.16***	74.66***

Comparison between groups no.	Group	Number of cases	Mg Mean \pm ϵ mg. per 100 ml.	pH Mean \pm ϵ
	1	60	2.59 \pm 0.03	7.65 \pm 0.01
	2	60	2.74 \pm 0.05	7.65 \pm 0.01
	3	47	2.67 \pm 0.11	7.66 \pm 0.01
1 and 2; F		120	5.58*	
2 and 3; F		107	0.24	2.58
1 and 3; F		107	0.72	1.17

severity of the disease, but that this change is limited to the inorganic phosphorus. The probable explanation of both these phenomena is that the greater part of the organic phosphorus is bound in stable complex compounds and, therefore, is not released when the content of inorganic phosphorus falls. This contrasts with the observations on the calcium content, which have been reported earlier (1, 2), namely, that both the free and the bound calcium fraction was lowered in parturient paresis, and that both fractions decrease with increasing severity of the disease. The explanation of this is that the bound calcium is to the greater part bound in unstable complex compounds and, hence, is released when the content of free calcium decreases. The physiologically active phosphorus is also to a great part organically bound, while physiologically active calcium is, at least to the greater part, present as free calcium ions.

The magnesium level in the material reported here is higher in parturient paresis than in non-calving cows. This difference has earlier been demonstrated by several authors, for instance,

Table 2.
Analytical results in age-classes (parturition ordinals) according to text, and F-values at comparison between age-classes.

Table 2 a.
Organic P, mg. per 100 ml.

Parturition ordinal	Group 1		Group 2		Group 3	
	Number of cases	Mean $\pm \epsilon$	Number of cases	Mean $\pm \epsilon$	Number of cases	Mean $\pm \epsilon$
2	1	9.3	1	6.2	1	5.3
3	3	7.03 \pm 0.84	3	5.20 \pm 0.42	5	5.18 \pm 0.42
4	9	8.86 \pm 0.93	9	5.57 \pm 0.13	5	4.70 \pm 0.36
5	12	8.32 \pm 0.71	12	5.24 \pm 0.21	5	4.50 \pm 1.13
6	12	7.82 \pm 0.87	12	4.78 \pm 0.21	5	4.26 \pm 0.32
7	9	7.88 \pm 0.67	9	4.51 \pm 0.24	9	4.78 \pm 0.45
8	6	7.53 \pm 0.95	6	4.85 \pm 0.27	9	4.17 \pm 0.28
9	5	8.22 \pm 1.17	5	5.02 \pm 0.27	7	4.44 \pm 0.31
10 and higher	3	7.37 \pm 0.78	3	4.93 \pm 0.34	1	4.4
Comparison	Number of cases	F	Number of cases	F	Number of cases	F
	60	0.30	60	2.26*	47	0.41

Table 2 b.
pH

Parturition ordinal	Group 1		Group 2		Group 3	
	Number of cases	Mean $\pm \epsilon$	Number of cases	Mean $\pm \epsilon$	Number of cases	Mean $\pm \epsilon$
2	1	7.67	1	7.62	1	7.68
3	3	7.68 \pm 0.02	3	7.67 \pm 0.01	5	7.65 \pm 0.02
4	9	7.64 \pm 0.01	9	7.66 \pm 0.01	5	7.68 \pm 0.01
5	12	7.66 \pm 0.02	12	7.64 \pm 0.01	5	7.65 \pm 0.03
6	12	7.65 \pm 0.01	12	7.63 \pm 0.02	5	7.62 \pm 0.02
7	9	7.64 \pm 0.02	9	7.63 \pm 0.01	9	7.67 \pm 0.01
8	6	7.67 \pm 0.01	6	7.68 \pm 0.02	9	7.69 \pm 0.01
9	5	7.65 \pm 0.02	5	7.63 \pm 0.01	7	7.66 \pm 0.01
10 and higher	3	7.66 \pm 0.02	3	7.66 \pm 0.00	1	7.77
Comparison	Number of cases	F	Number of cases	F	Number of cases	F
	60	0.33	60	1.22	47	2.35*

Sjollema (7). Our study, however, shows a raised level of magnesium after normal calving as well, in fact, even higher than in parturient paresis, for which reason a high content of magnesium cannot be regarded as a phenomenon characteristic of parturient paresis only.

Earlier, *Moodie et al.* (6) found that the magnesium level is raised after normal calving, and *Hayden* (3) compared the magnesium content in normal cows with that in cows with parturient paresis and found that in the latter case it was only slightly raised. But a direct comparison between the magnesium content after normal calving and that in parturient paresis, does not seem to have been made earlier.

Sjollema (8) and *Klobouk* (5) were the first to point out that the ratio between calcium and magnesium, which is low in parturient paresis, is of great importance in the development of the paretic or comatose condition. The most important ratio would, in fact, be that between free calcium ions and free magnesium ions, the physiologically active fractions of the substances. This ratio, too, is possibly low in parturient paresis, but we have as yet no possibility of investigating this matter, because, though the content of free calcium ions may be available for analysis, the content of free magnesium ions is not.

In the afore-mentioned study (1) of the calcium and protein concentrations it was shown that a change in the calcium-binding capacity of protein probably occurs at normal calving and that further changes in this capacity, though of a different nature, probably occur in parturient paresis. It was pointed out that such changes may occur if some other substance competes with calcium for the positions on the protein and the content of that substance is altered. Now, magnesium is exactly a substance that may be thought to be bound to protein in about the same way as calcium, and it is therefore possible that the raised magnesium level at calving may be at least part of the explanation of the change of the calcium-binding capacity of protein normally at calving. On the other hand, it would hardly have anything to do with the further change of this capacity that occurs in parturient paresis.

In the material presented here the pH was found to be the same in all the three groups. In a different material the results can be different, as was found by us in another study (2).

That age plays an important role in parturient paresis has been shown by, for instance, *Jönsson* (4). As regards the variation with age in the present material, the following facts were noted. With increasing age in the group of healthy calving cows the content of inorganic phosphorus showed a tendency to fall. The variation is probably significant. Corresponding values in the other two groups probably showed no such tendency; nor did the total phosphorus content and the content of bound phosphorus in any of the groups. The magnesium content did not show any significant variation with age in any group. In the group of paretic cows pH showed a probably significant variation with age, but in what direction it varied could not be ascertained (the number of cases in each age-class was too small). No similar variation could be detected in the other groups.

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SUMMARY

Determination of phosphorus, magnesium and pH was done on blood serum from normal cows in the non-calving period, from normal cows a few days after calving, and from cows with parturient paresis. The following results were obtained:

1. The total phosphorus content was lowered at normal calving and still lower in parturient paresis. The first-mentioned decrease, which accordingly is to be regarded as a normal phenomenon, was noted for both inorganic and organically bound phosphorus, while the additional decrease in parturient paresis involved only the inorganic phosphorus.

2. The magnesium content was as high at normal calving as it was in parturient paresis and, consequently, a high magnesium content is *not* a phenomenon characteristic of parturient paresis only.
3. The mean value for pH was the same in all the three investigated groups.
4. The content of inorganic phosphorus in the group of normal calving cows was lower in older cows than in younger ones.

ZUSAMMENFASSUNG

Phosphor- und Magnesiumgehalt sowie pH-Wert des Blutserums vom Rind unter normalen Verhältnissen, nach dem Partus und bei Paresis puerperalis.

Der Gehalt an Phosphor und Magnesium nebst pH-Wert wurde in Blutseren von Kühen ausserhalb der Kalbezeit, einige Tage nach dem Partus und bei Paresis puerperalis bestimmt, und zwar mit folgenden Ergebnissen:

1. Der totale Phosphorgehalt war bei normalem Partus erniedrigt und bei Paresis puerperalis noch weiter gesunken. Die erstgenannte Senkung, die folglich als ein normales Phänomen zu betrachten ist, umfasste sowohl anorganisch als auch organisch gebundenen Phosphor, während bei Paresis puerperalis der weiter erfolgte Abfall nur anorganischen Phosphor betraf.
2. Der Magnesiumgehalt lag bei normalem Partus gleich hoch wie bei Paresis puerperalis, und ein hoher Magnesiumgehalt des Blutes ist demnach *kein* für Paresis puerperalis charakteristisches Phänomen.
3. Der Mittelwert für pH war in allen drei untersuchten Gruppen derselbe.
4. Der Gehalt anorganischen Phosphors in der Gruppe normal kalbender Kühe war bei älteren Tieren niedriger als bei jüngeren.

SAMMANFATTNING

Fosfor- och magnesiumhalt samt pH-värde hos blodserum från nötkreatur under normala förhållanden, efter partus och vid paresis puerperalis.

Bestämning av fosfor, magnesium och pH har utförts på serum från normala kor utanför kalvningstiden, från normala kor någon dag efter kalvning och från kor med paresis puerperalis. Följande resultat erhöles:

1. Totala fosforhalten var låg vid normal kalvning och ännu lägre vid paresis puerperalis. Den förstnämnda sänkningen, som följaktligen får betraktas som ett normalt fenomen, omfattade både oorganisk och organiskt bunden fosfor, medan den ytterligare sänkningen vid paresis puerperalis omfattade endast oorganisk fosfor.

2. Magnesiumhalten var lika hög vid normal kalvning som vid paresis puerperalis, och en hög magnesiumhalt är alltså *icke* något för paresis puerperalis karakteristiskt fenomen.

3. Medelvärdet för pH var detsamma i alla de tre undersökta grupperna.

4. Halten oorganisk fosfor i gruppen normalt kalvande kor var lägre hos äldre kor än hos yngre.

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