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THE EFFECT OF AGE ON THE COMPOSITION OF BLOOD OF BEEF AND DAIRY CATTLE

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OPSOMMING: DIE INVLOED VAN OUDERDOM OP DIE SAMESTELLING VAN BLOED VAN VLEIS- EN MELKBEESTE

Ondersoek is ingestel na die verwantskap tussen bestanddele in die bloed van vleis- en melkbeeste en hul ouderdom. Die eksperimentele groep het bestaan uit 12 Afrikanerkoeie met hul kalwers en 12 Frieskoeie met hul kalwers. Die bloedmonsters is elke 14 dae geneem en is ontleed vir 13 bestanddele. Ouderdom het die samestelling van die bloed beduidend beïnvloed. Kreatinien, globulien, haemoglobien, rooibloedselle, nie-proteïenstikstof, glukose, alkaliese fosfatase en anorganiese fosfaat in die bloed het statisties beduidend verskil tussen jong, volwasse en ou koeie. Die bestanddele van die bloed van die kalwers van beide rasse het beduidend hoër waardes getoon as die bloedbestanddele van hul moeders ten opsigte van rooibloedselle, nie-proteïenstikstof, glukose, alkaliese fosfatase en anorganiese fosfaat. Die bloed van die Frieslandkalwers het ook statisties beduidend hoër waardes as dié van hul moeders getoon ten opsigte van haemoglobien, kalium en natrium.

SUMMARY

The relationship between the blood constituents of beef and dairy cattle and their age was investigated. The experimental group comprised 12 Afrikaner cows and their calves and 12 Friesian cows and their calves. Blood samples were drawn every fortnight and analysed for 12 constituents. Age influenced the composition of blood significantly. Creatinine, globulin, haemoglobin, erythrocytes, N.P.N., glucose, alkaline phosphatase and inorganic phosphorus in blood differed significantly between young, mature and old cows. The blood of calves in both breeds exhibited significantly higher values than the blood of their dams for erythrocytes, N.P.N., glucose, alkaline phosphatase and inorganic phosphorus. The blood of the Friesian calves also showed significantly higher values over that of their dams for haemoglobin, potassium and sodium.

Results of investigations reported in the literature have shown that the rate and character of body increase varies with age (Brody, 1945; Hammond, 1957; Maynard & Loosli, 1962). The age of the animal can thus also contribute to the variations which occur in the composition of blood. It is evident, therefore, that a standard blood picture must consist of a series of values corresponding to different ages. They are of great importance in studies in connection with the response of animals to a specific treatment like retardation, ration or ailment.

In view of the above the present experiment was carried out. Blood samples were drawn from animals of different age groups and the levels of various blood constituents determined. Afrikaner and Friesian cattle were used in this study.

Procedure

Material

(a) Twelve Afrikaner cows with their calves. Four cows were four years of age, four were seven to eight years and four were more than ten years old.

(b) Twelve Friesian cows with their calves comprising approximately the same age-groups as the Afrikaner cows.

Methods

1. *Treatment*

The management of the Afrikaner herd was essentially that of a typical ranching beef herd. The cows received no supplementary feed and the calves were weaned at approximately 205 kg live weight or eight months of age.

The management of the Friesian herd was that of a typical intensive dairy herd. The cows were individually fed on a concentrate ration in accordance with their production. The calves were individually fed and allowed to run in paddocks during the day.

2. *Recording of data*

Seventeen blood samples, taken at intervals of 14 days, were obtained from each animal. The first sample was taken approximately 14 days after parturition in the case of the cows and 14 days after birth in the case of the calves. Samples were taken in the early morning.

3. *Chemical analyses*

The following blood constituents were determined by methods described by Oser (1965). The original texts were studied and modifications applied as was suggested by later authors. Haden's modification of the Folin & Wu (1919) precipitation of whole blood was used:–

1. Creatinine in blood ..... Folin & Wu (1919)
2. Serum albumin ..... Howe (1921) and others
3. Serum globulin ..... Howe (1921) and others
4. Haemoglobin in blood by means of a calibrated Fisher Electro-Hemometer.
5. Erythrocyte counts by means of a haemocyto-

meter using a 3% sodium citrate solution.

6. N.P.N. in blood ..... Folin & Wu (1919)
7. Urea nitrogen in blood ..... Karr (1924) & Looney (1930)
8. Glucose in blood ..... Folin & Wu (1920)
9. Serum alkaline phosphatase Fiske & Subba Row (1925)
10. Phosphorus in serum ..... Fiske & Subba Row (1925)
11. Calcium, sodium and potassium were determined flame photometrically (Oser, 1965).

4. *Statistical analyses*

The data were analysed statistically by computing analyses of variance.

Results

The blood composition of the cows

In order to determine the difference between age-groups for the percentage of constituents of blood, mean values for each specific age-group were calculated. The average for each age-group in the Afrikaner cows is given in Table 1.

Table 1

The average composition of blood of Afrikaner cows of different age groups

	Young cows	Mature cows	Old cows	L.S.D. P <0,05	L.S.D. P <0,01
Creatinine (mg/100 ml)	1,54	1,38	1,28	0,13	0,17
Albumin (g/100 ml)	3,10	3,32	3,05		
Globulin (g/100 ml)	2,49	2,70	2,81	0,22	0,29
Haemoglobin (g/100 ml)	13,04	12,39	12,48	0,40	0,52
Erythrocytes (mill/mm^3)	9,15	8,25	8,83		
N.P.N. (mg/100 ml)	34,21	36,53	31,77	2,44	3,22
Glucose (mg/100 ml)	37,86	37,18	31,87	3,36	4,43
Alkaline phosphatase (Units/100 ml)	5,10	5,33	6,44	0,92	1,21
P (mg/100 ml)	7,02	7,08	6,14	0,69	0,91
Ca (meq/1)	8,32	8,06	8,00		
Na (meq/1)	130	129	130		
K (meq/1)	8,62	8,57	8,69		

From Table 1 it can be seen that the levels of the blood constituents determined vary amongst the different age-groups. These differences were tested for significance by computing the analyses of variance. In the blood of the Afrikaner cows the percentage creatinine, globulin, haemoglobin, N.P.N., glucose, alkaline phosphatase and inorganic phosphorus differed significantly.

The young cows showed the highest values for creatinine, haemoglobin and glucose whereas the old cows showed the highest values for globulin, alkaline phosphatase and inorganic phosphorus. The mature cows showed the highest value for N.P.N. followed by the young cows.

The mean values of the blood constituents for each age-group in the Friesian cows are given in Table 2.

Table 2

The average composition of blood of Friesian cows of different age groups

	Young cows	Mature cows	Old cows	L. S. D. P < 0,05	L. S. D. P < 0,01
Creatinine (mg/100 ml)	1,47	1,41	1,33	0,07	0,09
Albumin (g/100 ml)	3,05	3,25	2,85		
Globulin (g/100 ml)	3,09	2,77	3,36		
Haemoglobin (g/100 ml)	10,73	10,60	9,90	0,26	0,34
Erythrocytes (mill/mm^3)	7,32	7,00	6,41	0,29	0,39
N.P.N. (mg/100 ml)	33,07	34,16	32,27		
Glucose (mg/100 ml)	39,45	42,12	38,75		
Alkaline phosphatase Units/100 ml	2,90	4,58	3,94	0,81	1,70
P (mg/100 ml)	7,75	8,06	7,16		
Ca (meq/1)	7,48	8,00	7,44		
Na (meq/1)	128	130	125		
K (meq/1)	7,29	7,90	7,30		

The difference in the concentration of blood constituents in the case of the Friesian cows was not as significant as in the case of the Afrikaner cows. The creatinine, haemoglobin, erythrocytes and alkaline phosphatase were the only constituents to show significant differences. Of these the young cows showed the highest values, except for alkaline phosphatase where the mature cows showed the highest values.

The blood constituents and age of calves

To establish the effect of age on the composition of blood of calves, the difference in percentage concentration of the constituents during one month of age and eight months of age were tested by means of an analyses of variance test. Potassium was the only constituent to show

a highly significant (F = 30,5**) lower concentration at eight months of age than at one month of age.

The blood constituents of cows and calves

In order to illustrate the difference in blood composition of the experimental animals, the average composition of their blood is given in Table 3.

Table 3

Average composition of the blood and serum of beef and dairy cattle (Heyns, 1971)

	Afrikaner cows	Friesian cows	Afrikaner calves	Friesian calves
Creatinine mg/100 ml	1,40	1,40	1,34	1,34
Serum Albumin g/100 ml	3,16	3,05	3,19	2,88
Serum globulin g/100 ml	2,67	3,07	1,52	1,57
Haemoglobin g/100 ml	12,64	10,14	12,54	10,25
Erythrocyte m/mm^3	8,95	6,91	12,93	9,41
N.P.N. mg/100 ml	34,17	33,17	29,98	31,31
Glucose mg/100 ml	35,64	40,11	40,02	52,83
Alkaline phosphatase units/100 ml	5,62	3,81	10,23	6,64
P mg/100 ml	6,75	7,66	11,07	11,29
Ca meq/l	8,12	7,64	7,79	7,15
Na meq/l	130	128	133	130
K meq/l	8,63	7,50	8,67	8,29

From the data given in Table 3, it is evident that definite differences occur in the concentration of constituents between the blood of calves and that of their dams within each breed. In order to test the statistical significance of these differences between the blood composition of the dams and their calves, an analyses of variance test was applied. The values for each breed are listed in Table 4.

Table 4

"F" values for the differences between blood constituent values between cows and calves

	Afrikaners	Friesians
Creatinine	130,16**	5,24*
Albumin	0,111	2,94
Globulin	281,33**	481,76*
Haemoglobin	22,61**	0,84
Erythrocytes	426,47**	226,40**
N.P.N.	54,16**	10,85**
Glucose	11,43**	98,13**
Alkaline phosphatase	104,66**	62,88**
P	245,34**	133,06**
Ca	0,841	12.16**
Na	3,37	6,55*
K	2,79	41,16**

* Significant P < 0,05

** Significant P < 0,01

From Table 4 it can be seen that statistically significant differences occur between the levels of the various constituents in the blood of calves and that of their dams within each breed. In this respect there is a relatively close agreement between the two breeds. In both breeds the blood of the calves exhibits levels of glucose, N.P.N., erythrocytes, serum alkaline phosphatase and phosphorus which are highly significantly (P<0,01) higher than that in the blood of their dams. In addition, the Friesian calves show a highly significantly higher (P<0,01) level of potassium, and a significantly higher (P <0,05) level of sodium than their dams.

In both breeds there are two instances where the dams exhibit significantly higher values than their calves, namely in creatinine and serum globulin values. In addition, the calcium content of the serum of the Friesian cows was highly significantly higher (P<0,01) than that of their calves.

The serum albumin of the blood is the only constituent which does not show a significant difference between the calves and their dams in either breed.

Discussion

It is apparent that the age of the animal contributes to the variations which occur in the composition of blood. The higher haemoglobin values for young cows found in the present study are supported by the work of Mullick & Pal (1943), who reported a highly significant decrease of haemoglobin from 14,6 g/100ml in growing dairy cattle to 11,0 g/100ml in adult cattle, Duckworth & Ratray (1948), Holman (1956) and Creatorex (1957a, b) on dairy cattle. Brown (1961), who worked on Nguni cattle, reported no significant differences between cows and heifers of that breed, but found that the haemoglobin values of blood increased with age. This increase in haemoglobin content with age was further substantiated by the work of Arthaud, Schultze, Koch & Arthaud (1959) on beef cattle. Brookes & Hughes (1932), Beyers, Jones & Haag (1952) and Patterson, Shrode, Kunkel, Leighton & Rupel (1960) reported that age did not affect the level of haemoglobin in blood.

Most authors agree on the decrease of the red cell counts with age as found in the present experiment. A decrease was reported by Canham (1930), Mullick & Pal (1943), Duckworth & Ratray (1948), Rushoff, Johnston & Branton (1954), Holman (1956) who worked on Ayrshire cattle and reported values of 8 million at birth and 6 million in adult cows and Greatorex (1957 a,b) working on dairy cows. Howes, Hentges & Feaster (1960), working on Brahman and Hereford cattle and Luitingh (1962), who worked on beef steers, reported an increase in red cell count with age. Patterson *et al.* (1960), on the other hand, could not demonstrate an effect of age on red cell counts.

The decrease in the glucose value of blood with

age is in agreement with the reports in the literature. Mullick & Pal (1943) reported a highly significant decrease of glucose from 99,9 mg/100 ml in calves to 77,7 mg in adult cattle. McCarthy & Kesler (1956) who worked on dairy cattle reported a decrease in blood glucose level with age. Further evidence of a decrease with age is given by Anderson, Gayley & Pratt (1930), who reported a decrease in glucose content from 105 mg in the calf to 51,2 mg in the adult animal, Hodgson, Riddel & Hughes (1932), who worked on the blood of Friesland and Jersey cattle in the Philippines, reported average values of 48,20 mg for adult cows and 43,43 mg for calves of the same breed. An increase with age is further substantiated by the work of Kennedy, Anderson, Bechdel & Shingley (1939) who worked on dairy cattle and indicated that blood sugar increased with age.

The decrease of N.P.N. from 45,7 mg/100 ml in the blood of calves to 21,01 mg in that of cows, as reported by Kennedy *et al.* (1939), is not in agreement with the increase of this constituent with age as revealed by the present experiment. Anderson *et al.* (1930), however, could not demonstrate a significant difference between the blood N.P.N. values of young and adult cattle.

In the present experiment the difference between the age-groups for the creatinine content of the blood was not consistent. Statistically significant differences were found between young and old cows within each breed, the young cows having higher levels of creatinine in the blood. Within each breed, however, the cows exhibited significantly higher values than the calves. The decrease in creatinine with age supports the findings of Anderson *et al.* (1930). Hammersma (1937), on the other hand, did not find any variation in creatinine values between cattle of different ages.

No statistically significant difference between age-groups for the albumin fraction of the serum could be found, but the globulin fraction of serum showed a difference. The higher values found in calves are, however, not in agreement with the increase in the serum proteins with age reported by Cärlstrom (1962a), Cahilly, Kelly, Brooks, Davis & Graham (1960) and Larson & Touchberry (1959), working on the serum of dairy cattle. They found a statistically significant positive correlation between age and serum proteins. These results confirm the significantly higher values found in this experiment for old Afrikaner cows in comparison with those of young cows.

According to Fletcher, Shrode & Kunkel (1956) who worked on the blood of growing Brahman cattle, the serum alkaline phosphatase activity decreased with an increase in age. The same results were reported by Kunkel, Stokes, Anthony & Futrell (1953), who worked on Brahman and European beef breeds. This tendency is confirmed by the results of the present experiment. It was found that calves of both breeds exhibit significantly higher serum alkaline phsophatase activities than their dams. These results were, however, not in agreement with the results obtained for adult cattle. In the adult cattle, the old cows of both the Afrikaner and Friesian breeds showed significantly higher pohsphatase actitivies than the young cows of the same breed.

Of the minerals in blood, phosphorus has received the most attention from research workers. The decrease in phosphorus values of the blood with age found in this investigation is confirmed by Sikes (1962) who worked on the blood of Guernsey, Jersey and Holstein-Friesland cattle and who found a significant negative correlation between the age of the animals and inorganic phosphorus in serum. Cärlstrom (1962b) reported that inorganic phosphorus in the blood of normal calving cows decreased with age. A decrease of phosphorus level with age in blood was reported by Green & McCaskell (1928) who reported higher inorganic phosphorus values in the blood of younger animals, Palmer, Cunningham & Ekles (1930) who worked on three dairy breeds and reported a decrease of from 7,26 mg in calves to 5,87 mg in cows, Johnson (1939) on dairy cattle, Mullick & Pal (1943), Payne, Clark, Kingman & Stansbury (1946) on a large Hereford herd, Gonzaga & Vergara (1956) and van Landingham, Henderson & Bowling (1938) who found higher inorganic phosphorus values in the blood of calves than in cows.

In the present study the calcium content of the blood serum of the experimental animals did not vary greatly between ages. Only in the Friesian breed did adult cattle exhibit significantly higher values than the calves. Gonzaga & Vergara (1956), however, reported higher calcium values in calves than in cows. This is substantiated by the work of Mullick & Pal (1943) working in India on the blood of Hariana and Dhanni cattle. They found calcium values of 6,5meq/1 serum for growing cattle in comparison with 5,6meq/1 for adult cattle. Although McSherry & Gringer (1954) reported calcium values of 5,08meq/1 for calves and 4,meq/1 for adult Friesian cattle, they could not demonstrate a statistically significant difference. Cärlstrom (1962a), working on dairy cows, concluded that the calcium in the serum did not vary with age. This is also in agreement with the work of Anderson *et al.* (1930) who reported little or no variations in the calcium content of the blood of cattle in different age-groups.

Only limited references could be found in the literature to the relationship between age and the sodium as well as the potassium content of the serum. In this experiment the sodium and potassium contents of the serum of the Friesian calves were significantly higher than that of the adult cows. The Afrikaner breed showed no statistically significant variations between age-groups. Wise, Caldwell, Parrish & Hughes (1947 a,b) who worked on Ayrshire, Holstein and Jersey cattle reported an increase of sodium from 150,4 meq/1 in serum of calves to 167 meq/1 in serum of adult cattle. The potassium showed little variation. McSherry & Gringer (1954) could not find a significant difference in the sodium and potassium content of serum of calves and cows.

The rate and nature of body increase varies with

age and it is evident therefore, that animals of different ages will also vary as far as the composition of their blood is concerned. This was substantiated by the results of the present work.

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