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TOTAL BLOOD PLASMA PROTEIN IN COWS IN DIFFERENT PHASES OF REPRODUCTION CYCLE AND FED SUMMER AND WINTER FEED RATIONS

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Abstract

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The investigation of 3 434 cows during a four years'period (E, F, G, H) fed summer (L) and winter (Z) feed rations has shown that the substantial part of the decrease of the total blood plasma protein (TPP) in late pregnant cows occurred as late as in the last six weeks of pregnancy (cow group IV). The general validity of this phenomenon and its independency on the type of feed rations, on the basal level of proteinemia in the herd and on the animal age was proved. The decrease of TPP level was significant in comparison with TPP in cows in the first phase of lactation (I), in the second phase of lactation (II) and in the 8th month of pregnancy (III) as well. The TPP concentrations in cows I and II did not differ significantly from those in cows II and III.

The average level of TPP in single cow groups has changed in individual feeding periods in the same direction. This illustrates a substantial influence of food contained in the basal rations. The difference between summer and winter TPP concentrations in the groups of the same denotation were found to be significant only infrequently; when summarized for the whole years'period they were significant in the group IV only. The value scatter of TPP was found to be significantly greater during green feeding than during winter feeding.

The research specified the time of TPP decrease in pregnant cows.

Previous works (L e b e d a et al. 1984; L e b e d a and B u š 1985) have shown that the level of proteinemia in cows in eight to ninth and a half month of pregnancy was significantly lower than that in cows in the first and second lactation phases. This observation was made in four subsequent periods of summer and four subsequent periods of winter feeding. This phenomenon was found to be regular and independent of both summer and winter type of feed rations and of seasonal climate influences of individual years as well.

The same decrease of proteinemia level was observed by H e w e t t (1974) in heifers; the greatest decrease was found between the 8th and 10th month of pregnancy. Due to the combined influences of lactation (which also affects the proteinemia) and of pregnancy this author did not manage to differentiate statistically both these influences. H e w e t t (1974) found an increase of proteinemia in the first three months of lactation after which a decrease followed till the 7th month of lactation, this being again changed by a slight elevation of proteinemia till the 13th month of lactation.

In our previous works the proteinemia in cows in the first lactation phase was found to be higher in 5 of 8 investigated feeding periods than that in cows in 2nd lactation phase, the difference being significant in three cases. It appears that the decr. was not so distinct as in the dry period.

In the present work further four summer and four winter feeding periods were studied in order to establish the development of proteinemia in cows in their last three months of pregnancy. For this reason the cows in this period of pregnancy were allocated to two groups: a) those in 8th month and b) those in 9th to 9th and a half month of pregnancy. At the same time possibility of the general validity of previously found phenomena was verified on 3 434 cows.

Table 1

Significance of differences in values of total blood plasma protein of cow groups (I, II, III, IV) in individual summer (L) and winter (Z) feeding periods during four years (period E, F, G, H)

Period	Feeding season	Total blood plasma protein $g.l^{-1}$				Significance of differences $P \leq$ N.S. = not significant											
		I	II	III	IV	I/II		I/III		I/IV		II/III		II/IV		III/IV	
						t-test	F-test	t-test	F-test	t-test	F-test	t-test	F-test	t-test	F-test	t-test	F-test
E	L	74,34± 8,00	74,78± 9,89	75,00±10,79	70,33± 8,57	N.S.	0,05	N.S.	0,01	0,01	N.S.	N.S.	N.S.	0,01	N.S.	0,01	0,05
	Z	79,76±10,33	80,91± 8,99	79,03± 9,31	76,93±10,40	N.S.	N.S.	N.S.	N.S.	0,05	N.S.	N.S.	N.S.	0,001	N.S.	0,05	N.S.
F	L	81,42±15,29	81,93±15,41	79,80±14,10	77,45±14,85	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	0,05	N.S.	N.S.	N.S.
	Z	72,85± 9,56	71,10± 8,87	71,54± 8,94	68,00± 8,35	N.S.	N.S.	N.S.	N.S.	0,001	N.S.	N.S.	N.S.	0,01	N.S.	0,01	N.S.
G	L	73,50± 9,89	72,08± 8,82	72,17± 8,69	68,51± 7,78	N.S.	N.S.	N.S.	N.S.	0,001	0,01	N.S.	N.S.	0,01	N.S.	0,01	N.S.
	Z	74,03± 9,73	73,62± 8,74	71,45± 8,65	68,48± 9,46	N.S.	N.S.	0,05	N.S.	0,001	N.S.	N.S.	N.S.	0,001	N.S.	0,02	N.S.
H	L	81,00±11,48	78,46±10,63	79,81±11,52	75,81±10,44	N.S.	N.S.	N.S.	N.S.	0,01	N.S.	N.S.	N.S.	N.S.	N.S.	0,01	N.S.
	Z	81,05± 9,18	79,83± 9,58	78,69± 8,90	75,45± 8,73	N.S.	N.S.	0,05	N.S.	0,001	N.S.	N.S.	N.S.	0,001	N.S.	0,01	N.S.

Materials and Methods

During four seasons of green foods available (L) and four seasons of winter feed rations (Z) of the 1980 - 1984 period (E, F, G, H) the concentration of total plasma protein (TPP) in venous blood was investigated in 3 434 cows; 1 441 of them were examined in summer and 1 993 in winter periods. Samples of blood taken from v. jugularis were collected between 9 and 11 a. m. and were treated with heparin. The TPP concentration was determined using Bio-test Lachema, the error of measurement being $\pm$ 4.27 %.

The animals examined came mostly from the South-Moravian region. In individual farms the sets of 20 cows without clinical symptoms of illness were usually examined. Each set of animals consisted usually of four groups each having 5 cows: I - cows in the first lactation phase, from two weeks to two - three months at the most after calving; II - cows in the second lactation phase, four - six months after calving; III - cows in the eight months of pregnancy, IV - cows in the ninth to ninth and a half month of pregnancy. The cows in the last two groups were usually in dry period.

The results were statistically evaluated using the t-test and F-test: the significance of differences between a) single groups in the same feeding period, b) values in the groups of the same denotation during the summer period and during the next winter period, c) all years with the same type of feeding rations (green of winter feed). The same method was used in whole animal populations. In addition, the value differences among populations and among groups were evaluated.

Results

The results have unequivocally shown (Table 1) that the lowest concentration of total plasma protein (TPP) occurred in cows 9 - 9.5 months pregnant (group IV) in all studied summer and winter feeding periods and during the whole four years' period as well. This decrease of TPP was significant with regard to the values found in cows 8 months pregnant (group III) in 7 out of 8 estimated feeding periods. The same frequency of significance was in relation to both lactating groups of cows (I, II). The TPP values between these lactating groups did not differ significantly and the same situation was observed in values of cows III and II. The TPP values in the group III differed significantly from those in the group I in two feeding periods only.

The TPP value scatter in individual cow groups differed significantly in the same feeding period in 3 out of 48 cases only.

Table 2 shows that the decrease of average TPP values in the cow group IV was caused first of all by a higher frequency of lowered values in the interval 50 - 65 $g.l^{-1}$. During the whole four-year period the frequency of these reduced values in this range was in the group IV higher by 8.85 - 10.35 % and by 7.26 - 10.38 % in summer and winter periods, resp. in comparison with other groups of cows. During four feeding periods the decrease of average TPP values in the group IV was also supported by a lower frequency of normal values.

The distribution curves of TPP values in the whole populations studied during four years has a Gaussian character in both seasons (Fig. 1). All summarized winter and summer values did not differ significantly, the scatter of them being greater in summer.

The TPP concentrations of groups with green feeding periods differed from those of subsequent winter feeding periods in 50 % only and in the first two years (Fig. 2 - 5). When summarized for all four seasons the summer and winter TPP concentrations differed significantly only in the group IV (Fig. 6), the scatter value being greater in all groups with green feeding.

The conditions of particular summer and winter feeding periods had a considerable influence on TPP concentrations (Fig. 7). The highest average summer values were found in the F period, the lowest ones in the G period; the highest winter values were observed in the E period, the lowest ones in the F period. The dynamics of TPP development was found to be conformable in all groups. It shows that the seasonal influences had the same effect on tendency of changes in TPP in all groups. Greater deviations of TPP concentrations have been found among individual green feeding periods (all neighbouring periods differed significantly) than among winter feeding periods (the differences between F and G period were not significant).

Substantially greater variability of food rations based on green foods had a clear impact upon the scatter difference in TPP concentrations. That was significant among all three subsequent neighbouring periods in populations and in groups I, III and IV, in group II between two periods only. The long lasting stability of winter feed rations was reflected also in the lack of statistical significance of TPP scatter in all subsequent neigh-

Table 2

PERIOD	POPULATION GROUP	PERCENTACE OF NORMAL, LOW AND HIGH TPP VALUES (IN $g.l^{-1}$)													
		< 50		50 - 65		65 - 85		85 - 100		100 - 110		110 - 120		> 120	
		L	Z	L	Z	L	Z	L	Z	L	Z	L	Z	L	Z
E	P	0	0	20,74	8,78	65,66	62,21	13,32	26,53	0,28	2,29	0	0,19	0	0
	I	0	0	15.38	8,33	72,53	61,91	12,09	25,00	0	4,76	0	0	0	0
	II	0	0	18,54	4,17	64,04	64,01	17,42	28,03	0	3,79	0	0	0	0
	III	0	0	19,57	7,63	61,41	61,07	17,93	31, 30	1,09	0	0	0	0	0
	IV	0	0	29,35	14,82	64,67	61,85	5,98	21,85	0	0,74	0	0,74	0	0
F	P	2,51	2,20	12,31	24, 10	50,63	66,80	22,74	6,90	9,30	0	2,01	0	0,50	0
	I	2,11	2,31	9,47	18,08	52,63	68,85	21, 05	10, 77	10,53	0	4,21	0	0	0
	II	1,98	2,54	11,88	22,03	45,05	69,07	28,22	6,36	9,90	0	1,98	0	0,99	0
	III	3,00	0,79	10,00	24,02	54,00	67, 32	24,00	7, 87	7,00	0	1,00	0	1,00	0
	IV	2,94	3,20	17,65	32,40	50,98	62, 00	17, 65	2,40	9,80	0	0,98	0	0	0
G	P	0	0,43	25,93	25,27	45,74	64,09	7,80	10,00	0,27	0,21	0,26	0	0	0
	I	0	-0	21, 50	20,35	65,00	64,60	16,00	14,16	1,00	0,89	0	0	0	0
	II	0	0	24, 16	18,97	66,29	68,97	9,55	12,07	0	0	0	0	0	0
	III	0	0,83	22,28	24,38	70,65	66,94	5,98	7,85	0	0	1,09	0	0	0
	IV	0	0,87	35,57	37,39	61,34	55,65	3,09	6,09	0	0	0	0	0	0
H	P	0,33	0	10, 13	7,64	62,79	67, 36	22,76	22,82	3,32	2, 18	0,33	0	0,33	0
	I	1,54	0	6,92	4,84	53, 85	61,69	34,61	30,24	3,08	3,23	0	0	0	0
	II	0	0	9,26	5,51	66,66	66,53	19,14	24,58	4,94	3,38	0	0	0	0
	III	0	0	9,26	6,92	61, 11	68,08	24,69	24,23	3,70	0,77	0	0	1,24	0
	IV	0	0	14,87	12,88	68,24	72, 72	14, 19	12,88	1,35	1,52	1,35	0	0	0
E H	P	0,76	0,65	17,56	16,18	60,93	65, 10	16,45	16,81	3,40	1,20	0,69	0,05	0,21	0
	I	0,86	0,61	13,96	12,78	61,54	64,30	18,80	20,08	3,70	2, 23	1, 14	0	0	0
	II	0,56	0,62	15,97	12,40	59,86	67,05	18,89	18,08	3,89	1,86	0,56	0	0,27	0
	III	0,82	0,39	15,34	15,52	61,64	65,82	18,08	18,07	3,03	0,20	0,55	0	0,55	0
	IV	0,82	0,99	24,79	22,78	60,68	63, 31	10, 14	11, 14	3,01	0,59	0,55	0,20	0	0

bouring winter feeding periods in the group I, II and III. In the group IV and in the whole populations the scatter of differences was significant between period E and F only (Fig. 2 - 6).

Discussion

Our research has confirmed the general validity of proteinemia decrease in late pregnant cows which was already reported earlier (L e b e d a and B u š 1985; L e b e d a et al. 1984). It has been proved that the substantial phase of the decreases occurs as late as in the ninth to ninth and a half month of pregnancy. These findings are fundamentally in accordance with the results obtained in pregnant heifers (H e w e t t 1974). It can thus be assumed that the decrease in TPP in late pregnant cattle is independent of age. The TPP decrease assessed from several years' average values becomes evident already at the second phase of lactation in both types of feeding. During winter feeding it is, however, more distinct and the significance is reached earlier.

The TPP decrease in cows in 9th - 9.5th month of pregnancy is associated in both types of feeding first of all with a lower frequency of moderatery elevated values within the range of 85 - 100 $g.l^{-1}$ and with a higher frequency of lowered values within the range of 50 - 65 $g.l^{-1}$.

The decrease of proteinemia in this group of cows appears to be independent of different total level of proteinemia in individual summer and winter feeding periods. That suggests that this phenomenon is bound to a late stage of pregnancy.

Already in our previous paper we have advanced a hypothesis of endogenous origin of this lower proteinemia in pregnant cows (L e b e d a et al. 1984). A change in blood plasma protein synthesis in liver of high pregnant cows shows to be the most probable cause. This opinion is based on the fact that these cows have usually the highest concentration of urine ammonia (L e b e d a 1984) in both feeding periods which can be manifestation of protein starvation or of impairment of liver function (V á r a d y et al. 1970). Liver damage seems to be more probable since starvation during summer feeding is out of question. The results of the last four year investigation (concentration of urine ammonia, blood and urine urea, triglycerides, non-esterified fatty acids and glycaemia) are still to be evaluated; at present, it is therefore impossible to confirm or disprove this hypothesis.

It has, however, been demonstrated that the TPP concentration is significantly affected by the food balance in individual years in both types of feeding. In fact, the level of proteinemia differed significantly in particular years. Here, the quantity and quality of foods in basal rations seem to be the decisive factor because the four year dynamics of TPP concentration appears nearly identical in all four groups.

Significantly higher scatter of the TPP values in green feeding when compared with the winter feeding has been observed, which is in accordance with greater variability of summer feed rations. The total decrease of proteinemia is, however, more marked in winter period when the feed rations short in nutrients are more frequent.

The TPP decrease in cows in the last six weeks of pregnancy can be metabolically critical for new-born calf vitality if the background of low proteinemia in the herd is also present.

Celková bílkovina krevní plazmy krav v různých fázích reprodukčního cyklu krmených letními a zimními krmnými dávkami

Vyšetření 3 434 krav ve 4 následujících ročních periodách (E, F, G, H) letních (L) a zimních (Z) krmných dávek ukázalo, že podstatná část poklesu celkové bílkoviny krevní plazmy (TPP) u vysokobřezích krav nastává až v posledních 6 týdnech březosti (skupina IV). Byla prokázána obecná platnost tohoto jevu a jeho nezávislost na typu krmných dávek, na základní úrovni proteinémie ve stádě a na stáří zvířat. Pokles TPP byl signifikantní vzhledem k úrovni TPP u krav v 1. fázi laktace (I), v 2. fázi laktace (II) a rovněž v 8. měsíci březosti (III). Koncentrace TPP u krav I a II a u krav II a III se signifikantně nelišily.

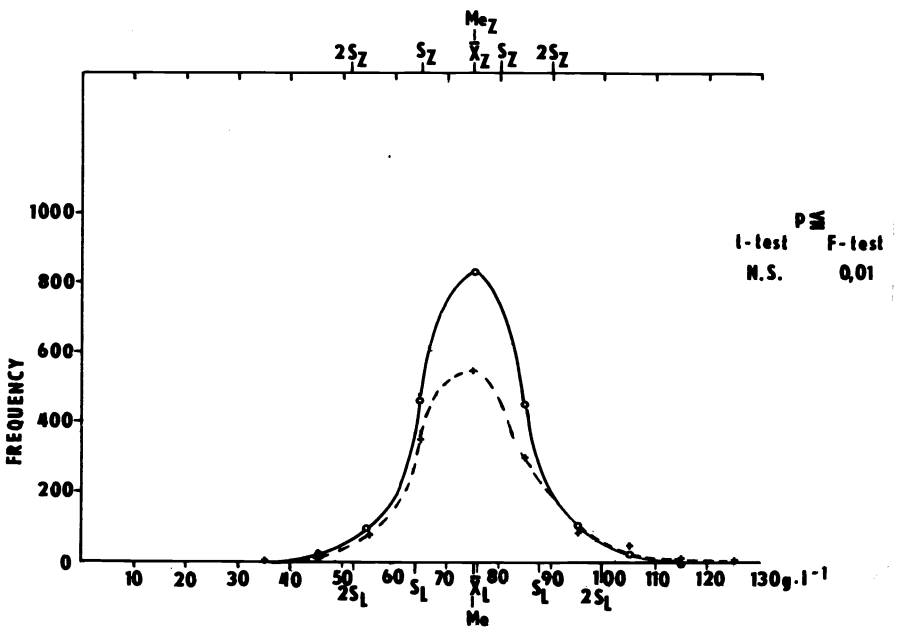
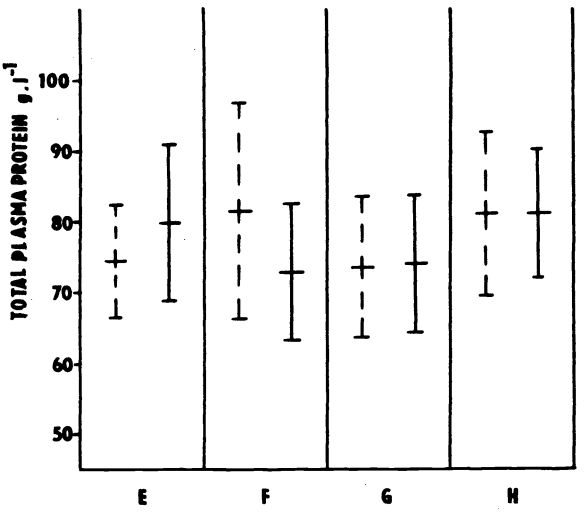


Fig. 1

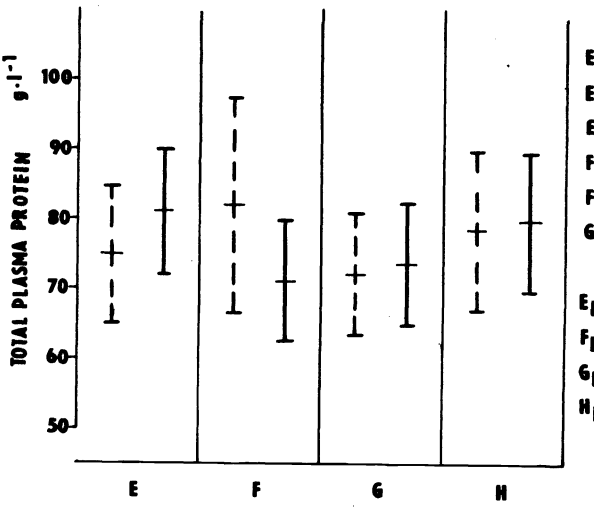


P ≤

	t - TEST L	t - TEST Z	F - TEST L	F - TEST Z
E/F	0,001	0,001	0,01	N.S.
E/G	N.S.	0,001	N.S.	N.S.
E/H	0,001	N.S.	0,01	N.S.
F/G	0,001	N.S.	0,01	N.S.
F/H	N.S.	0,001	0,01	N.S.
G/H	0,001	0,001	N.S.	N.S.

E_L/E_Z	0,001	0,01
F_L/F_Z	0,001	0,01
G_L/G_Z	N.S.	N.S.
H_L/H_Z	N.S.	0,05

Fig. 2.

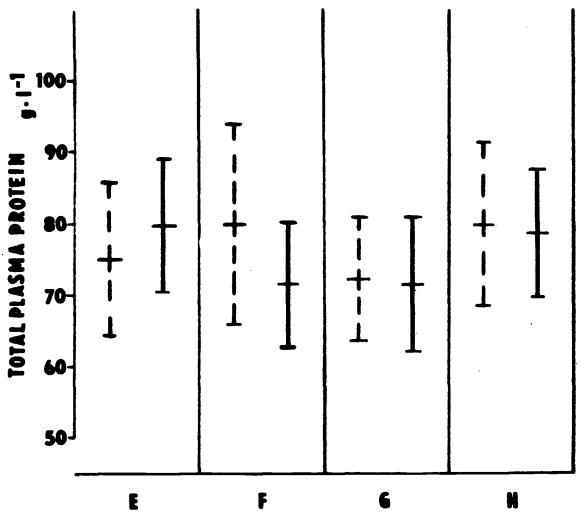


P ≤

	t - TEST L	t - TEST Z	F - TEST L	F - TEST Z
E/F	0,001	0,001	0,01	N.S.
E/G	N.S.	0,001	0,01	N.S.
E/H	0.02	N.S.	N.S.	N.S.
F/G	0,001	N.S.	0,01	N.S.
F/H	N.S.	0,001	0,01	N.S.
G/H	0,001	0,001	0,05	N.S.

E_L/E_Z	0,001	N.S.
F_L/F_Z	0,001	0,01
G_L/G_Z	N.S.	N.S.
H_L/H_Z	N.S.	N.S.

Fig. 3.

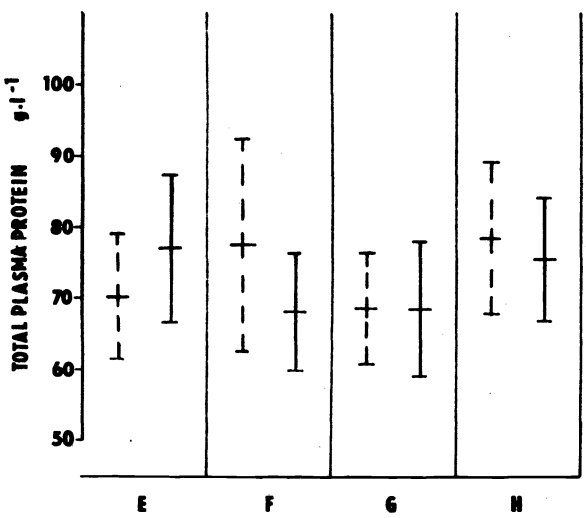


PS

	TEST L	TEST Z	L	Z
E/F	0,01	0,001	0,01	N.S.
E/G	N.S.	0,001	0,05	N.S.
E/H	0,01	N.S.	N.S.	N.S.
F/G	0,001	N.S.	0,01	N.S.
F/H	N.S.	0,001	0,05	N.S.
G/H	0,001	0,001	0,01	N.S.

E_L/E_Z	0,001	N.S.
F_L/F_Z	0,001	0,001
G_L/G_Z	N.S.	N.S.
H_L/H_Z	N.S.	0,01

Fig. 4.

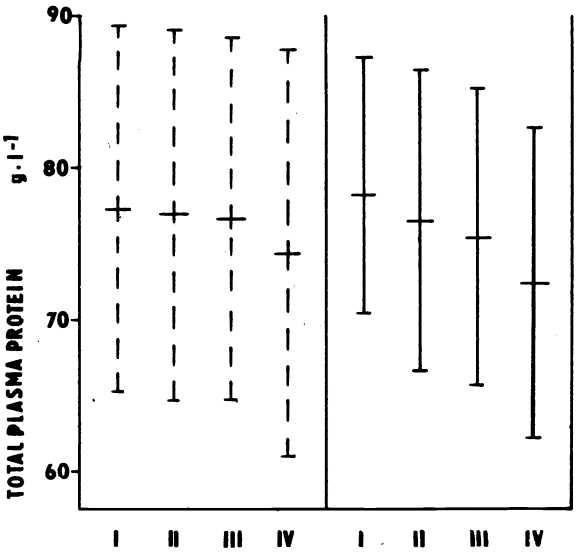


PS

	t-TEST L	t-TEST Z	F-TEST L	F-TEST Z
E/F	0,001	0,001	0,01	0,01
E/G	N.S.	0,001	N.S.	N.S.
E/H	0,001	N.S.	0,05	0,05
F/G	0,001	N.S.	0,01	N.S.
F/H	N.S.	0,001	0,01	N.S.
G/H	0,001	0,001	0,01	N.S.

E_L/E_Z	0,001	0,05
F_L/F	0,001	0,01
G_L/G	N.S.	0,05
H_L/H	N.S.	0,05

Fig. 5.

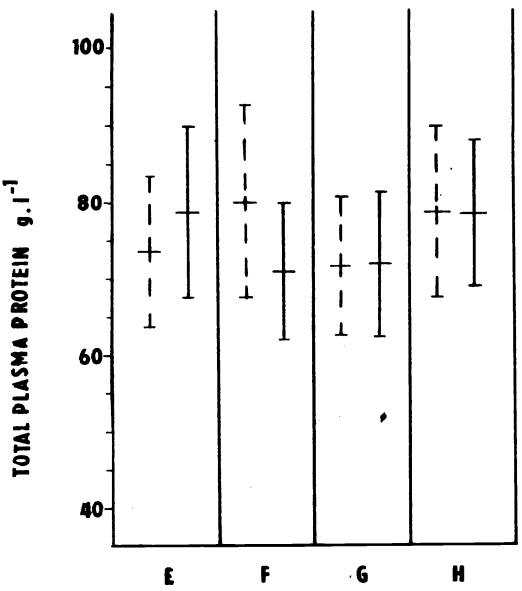


PM

	t-test L	t-test Z	F-test L	F-test Z
I/II	N.S.	N.S.	N.S.	N.S.
I/III	N.S.	0,02	N.S.	N.S.
I/IV	0,001	0,001	0,05	N.S.
II/III	N.S.	N.S.	N.S.	N.S.
II/IV	0,001	0,001	N.S.	N.S.
III/IV	0,02	0,001	0,05	N.S.

I_L/I_Z	N.S.	0,01
II_L/II_Z	N.S.	0,01
III_L/III_Z	N.S.	0,01
IV_L/IV_Z	0,01	0,01

Fig. 6.



PM

	t-test L	t-test Z	F-test L	F-test Z
E/F	0,001	0,001	0,01	0,05
E/G	0,001	0,001	N.S.	N.S.
E/H	0,001	N.S.	0,01	N.S.
F/G	0,001	N.S.	0,01	N.S.
F/H	N.S.	0,001	0,01	N.S.
G/H	0,00	0,001	0,01	N.S.

E_L/E_Z	0,001	N.S.
F_L/F_Z	0,001	0,01
G_L/G_Z	N.S.	N.S.
H_L/H_Z	N.S.	0,01

Fig. 7.

Průměrná úroveň TPP ve skupinách krav se měnila v jednotlivých krmných obdobích v tomtéž směru. To svědčí o podstatném vlivu krmiv tvořících základní krmné dávky. Rozdíly mezi letními a zimními koncentracemi TPP u stejnojmenných skupin krav byly signifikantní jen ojediněle; při sumarizaci hodnot za celé čtyřleté období byly signifikantní jen u skupiny IV. Rozptyly hodnot TPP byly signifikantně větší při zeleném než při zimním krmení.

Výzkum časově upřesnil dobu poklesu TPP u březích krav, potvrdil a doplnil výsledky získané v předchozím čtyřletém období.

Общая белковина кровяной плазмы коров на разных этапах репродуктивности, откармливаемых летними и зимними кормовыми рационами

Исследованием 3 434 коров в 4 последующих годичных периодах (E, F, G, H) летних (Л) и зимних (З) кормовых рационов было установлено, что существенная часть понижения общей белковины кровяной плазмы (TPP) коров на высокой стадии стельности наступает лишь в последние 6 недель стельности (группа IV). Была установлена общая действенность данного явления и его независимость от типа кормовых рационов, от основного уровня протеинемии в стаде и от возраста животных. Понижение TPP было значимым по отношению к уровню TPP на первой фазе лактации (I) , на второй фазе лактации (П), а также на восьмом месяце стельности (Ш). Концетрация TPP у коров I и П и у коровиШ явно не отличалаць.

Средний уровень TPP в группах коров проходил изменениями в отдельных кормовых периодах в том же направлении. Это свидетельствует о существенном влиянии кормов, образующих основной кормовой рацион. Разница между летними и зимними концентрациями TPP у одноименных групп коров была значимой только в отдельных случаях; при обобщении величин за четырехлетний период наблюдалась значимая разница лишь у группы IV. Рассеивания величин TPP были существенно больше при зеленем чем при зимнем кормовом рационе.

Исследование уточнило время понижения TPP у стельных коров, подтвердило и дополнило результаты, полученные в предыдущий четырехлетний период.

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