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EFFECT OF ENVIRONMENTAL TEMPERATURE AND RESTRICTED FEEDING ON COMPOSITION RABBIT MILK

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SUMMARY- Thirty-six NZW lactating rabbit does were divided into 6 groups according to environmental temperature and feed intake. The rabbits kept at 5, 15, 23 and 30°C were fed *ad libitum* (5A, 15A, 23A, and 30A) but two groups of does kept at 15 °C were fed restricted rations , being fed the same amount of pellet as the intake of the rabbits kept at 23 or 30 °C (15/23R, 15/30R). Milk samples were collected on days 3, 7, 14, 21, 24 and 27 and the composition of pooled milk samples was subjected to chemical analysis.
The DM content of milk in groups 5A, 15A, 23A, 30A, 15/23R and 15/30R was 30.2, 29.9, 31.3, 28.9, 31.7, and 30.0% the CP content was 14.4, 14.2, 14.6, 14.1, 14.5 and 14.1%, the CF content was 12.2, 11.9, 12.6, 11.9 and 13.2%, and the ash content was 2.25, 2.35, 2.30, 2.30, 2.33 and 2.27% respectively.
The average of Ca, Mg, Zn, Fe, Cu, and Mn content was 2707, 446, 33.6, 2.58, 1.80, and 0.15 ppm and that amino acid content was Gly: 37.3, Ala: 56.6, Val: 59.3, Leu: 89.4, Ile: 35.9, Phe: 32.6, Ser: 60.8, Thr: 41.3, Met: 16.1,Tyr: 25.6, Asp: 40.4, Glu: 126.8, Lys: 76.0, Arg: 48.1, and His:22.8 µmol/g. The effect of temperature and feed restriction was negligible.

Key words: rabbits, milk composition temperature, restricted feeding, lactation stage.

RÉSUMÉ: 36 lapins Nouvelle-Zéland en lactation ont été divisés en 6 groupes selon la température de l'environnement et selon l'alimentation.
Les lapins sont portés á 5, 15, 23 et 30 °C, alimentés ad libitum (5A, 15A, 23A et 30A), mais deux groupes portés a 15 °C à l'alimentation limitée, consommant la même quantité de granulée que les lapins portés à 23 et à 30°C (15/23R, 15/30R).
Les échantillons de lait ont été collectés aux 3^e, 7^e, 14^e, 21^e, 24^e et 27^e jours, la composition des échantillons de lait a été analysée chimiquement.
Le contient de MS de lait des groupes 5A, 15A, 23A et 30A, 15/23R et 15/30R a été 30.2, 29.9, 31.3, 28.9, 31.7 et 30 %, le contient de MP a été 14.4, 14.2, 14.6, 14.1, 14.5 et 14.1 %, le contient de MG a été 12.2, 11.9, 12.6, 11.9 et 13.2 % et le contient de la cendre a été 2.25, 2.35, 2.30, 2.30, 2.33 et et 2.27 % respectivement.
Le moyens de Cn, Mg, Zn, Fe, Cu et Mn a été 2707, 446, 33.6, 2.58, 1.80 et 0,15 ppm et le contient des acides aminées a été Gly: 27.3, Ala: 56.6, Val: 59.3, Leu: 89.4, Ile: 35.9, Phe: 32.6, Ser: 60.8, Thr: 41.3, Met: 16.1, Tyr: 25,6. , Asp: 40.4, Glu: 126.8, Lys: 76.0, Arg: 48.1, et His:22.8 µmol/g.
La restriction de la temperrature et cella de la nurriture n' a pas été une effect szignifiquent.

Mots clés: lapins, composition du lait, température, alimentation limitée, lactation.

Introduction

The composition and changes of doe's milk during lactation was firstly reported by Lebas (1971) Since then more studies have been plublished (Csapó *et al.,* 1985; El Sayiad *et al.,* 1994; Kustos *et al.,* 1996) but most of these studies deal only on the whole with chemical composition of rabbit milk and the effect of lactational periods as well as the effect of the pregnancy status. We did not find data concerning the effect of temperature on composition of rabbit milk, therefore in this study we tested the milk composition of does kept at 5, 15, 23 and 30 °C temperature and two groups of does kept at 15 °C but their feed consumption was restricted to the level of does kept at higher temperature.

Material and method

The experimental conditions and establishment of groups (treatments) was descreibed by Szendrõ *et al.,* (1998).

Obtaining milk samples

Milk samples were obtained after 3, 7, 14, 24 and 27 days of kingling by oxitocyn injection with help of milking machine from the first pair of chest teat. The milk samples of one group were mixed and stored at - 25 °C till the chemical analysis.

Chemical analysis

High performance liquid chromatographic determination of protein amino acids by precolumn derivatization with o-phthaldialdehyde.

Preparation of milk:

- Drying of 5 cm^3 milk with lyophilization
- Grease extraction by petroleum ether
- Protein hydrolisis (about 200 mg degreased milk samples by 6 m HCl at 110 °C for 24 hours)
- Drying storage in deep freeser
- Before measuring solving of samples in 2 cm^3 0.01 m HCl
- Precolumn derivatization with o-phthaldialdehyde os samples (injection after 2.5 minutes)

Apparatus:

HPLC produces by Jasco
Column: 150*4 mm Hypersil ods (3 μm)

Chromatographic conditions:

Flow rate: 1 cm^3/minute
Column temperature: 35 °C

Quantitative analysis:

- International standrad was used (2-amino butiric acid)
- Gradient elution: A- Tetrahydrofuran:Methanol: 0.05 m Sodium acetate (pH 5.9), 1:90:90
  B- Methanol
- Gradient program: From 0 % B to 78 % B for 22 minutes (Linear gradient)

Lactose was obtained by extraction from raw material of protein, fat and ash. The energy was defined by formula of Pekkin (1958) : E = 4.184 x (9.11 fat + 5,54 x protein + 3,95 x lactose).
Due to the mixed samples, in each group we had only a single value per each testing day. In tables the averages of the six experimental groups are published from different stage of lactation, that is the tables contain the average result of the six sample - drawing days per experimental group.

Results and discussion

The main components

The rabbit milk contained in average the following amount of components in course of drz matter crude protein, crude fat, ash and energy content: 303, 143, 123, 23, 14,3 g. per milk kg and 8,15 MJ/kg milk. These data agree with most of the earlier published data (Lebas, 1971; El-Sayied *et al.,* 1994; Szendrõ *et al.,* 1996) but in some cases they are differed from data of Csapó *et al.,* (1985) which, were elaborated on Angora rabbit.
We have noticed that in the third day of lactation the value of dry matter was on the average (303 g/kg milk) but the value of crude fat (130 g/kg milk) was higher than the average. These values later on, at day of the 30th of lactation after a short low-values period - significantly increased (250 and 130 g/kg milk) (Table 1). The protein content remained unchanged betwen days of 3 and 21 (but little changes could be observed) then, increased to 147 and 160 g/kg. In ash content a growing tendency was observed. The lactose content had accidental changes and attained its maximum value (26,5 g/kg milk) at the 27th day of lactation. The energy - agreeing with the other component of calculation attained values above the average (8,40 and 9,41 MJ/kg milk) during period of 3-27 days of lactation.

These changes are agreed with changes observed by most of other authors (Lebas, 1971; Csapó *et al.,* 1985; El-Sayiad *et al.,* 1994) but Kustos *et al.,* (1996) observed a much bigger change in milk fat between the 3rd and 24th days of lactation.
The environmental temperature does not exert unanimous and significant influence on composition of rabbit milk. (Table 2). The dry matter, - crude fat, - lactose and energy content was the lowest in milk of does kept at 30 °C, but the deviation from levels of other groups only in lactose content was significant. One out of the two restricting fed groups, group 15/30 R, had definitely low lactose content. This low level probably connected with the low feed consumption of group 30 A.

Minerals

In the experment the following average mineral content was measured : Ca:2707, Mg:446, Zn:33.6, Fe: 2,57, Cu: 1,80, Mn: 0,15 ppm.
Depending on the stages of lactation the amount of minerals differently changed (Table 3). The Ca rised till the 21th day then a little bit decreased. During this period the amount of Zn increased continuously as high as 2,5 fold of the original level. The Zn evenly decreased to half of the original level, the Fe decreased to 14th day, then remained unchanged, the amount of Mn suddenly decreased, but between 14th and 27 th day did not change.
The changes in chemical components during lactation are the nearest to data of Csapó *et al.,* (1985) but apart from some litte deviations they are not in contradiction with data of Lebas (1971) and Kustos *et al.,* (1996). On the other hands El-Sayiad *et al.,* (1994) noted different tendencies.
Effects of temperature and temperature-connected feeding was in this experiment not revealed (Table 4). The highest and lowest values often appared in the nearest temperature-zones, so the effect of temperature culd not reveal even as tendencies.

Amino acids

Regarding to the amino acid content of rabbit milk the following values were measured: Gly: 37.3, Ala: 56.6, Val: 59.3, Leu: 89.4,Ile: 35.9, Phe: 32.6, Ser: 60.8, Thr: 41.3, Met: 16.1,Tyr: 25.6, Asp: 40.4, Glu: 126.8, Lys: 76.0, Arg: 48.1, and His:22.8 µmol/g.
Nearly each amino acid showed a decreasing then an increasing tendency. The lowest value was measured at the 14th day of lactation. At the third day a relative high value was abtained, and that was surpased the amino acid content of milk sample obtained at the 27th day of lactation (Table 5). Exception were the Val. and Met.
The amount of valine practically was unchanged during the whole lactation, the amount of methionine continously increased. Data of Csapó *et al.,* (1985) are inconsistent with these findings, they values at the seventh or eleventh day of lactation were the highest.
The highest values of most amino acids were noticed at optimal temperature that is in group 15A (Table 6). Similar results were obtained in the two restricted fed groups, kept at 15 °C temperature (15/23R and 15/30 R). Above and below 15 °C the amino acid content decreased and the lowest value was measured at 5 °C temperature.
We did not find data regarding to rabbit, our data therefore was compared with the change in composition of cow and sheep milk. Most of the authors (Belo, 1990, Habeeb *et al.,* 1991; Flamenbaum *et al.,* 1995; Muroya *et al.,* 1997) state that with rising temperature the amont and ratio of milk components have decreasing tendency. These statements and our findings justify that values below the average measured at 30 °C are not accidental.

Conclusions

On base of our results and findings in other studies we can conclude that after parturition, then at the and of lactation the values of dry matter crude fat, lactose, and energy are higher than the average of the whole lactation, but in case of high milk production these values are lower than the average. The protein content at beginning is permanent, but increases as the drying of mothers is progressed. The ash content increases during the whole lactation. Amount of minerals differently changes. The Ca has the highest value and it increased till the 21st day, the value of Mg increased during the whole experiment, but the Zn and Cu showed decreasing tendency.
With increasing temperature the amount of the most important milk-components hardly change. Only at 30 °C can be seen a little decreasing in amount of dry matter crude fat and energy content, but the amount of lactose significantly decreased. Most of the amino acids attained the lowest level at the 14th day of lactation, but the amont of Met. increased during the whole lactation.

Table 1

Effect of stage of lactation on chemical composition of rabbit milk

Composition *(g/kg milk)*	Days after parturition					
	3	*7*	*14*	*21*	*24*	*27*
Dry matter	303	286	298	296	284	350
C. protein	135	141	140	133	147	160
C. fat	130	122	124	117	106	138
Ash	18.8	20.3	23.4	23.6	26.6	25.5
Lactose	19.2	2.7	10.6	22.4	4.4	26.5
Energy (MJ/kg milk)	8.40	7.52	8.15	7.91	7.52	9.41

Table 2

Effect of temperature and restricted feeding on the chemical composition of rabbit milk

Composition *(g/kg milk)*	Groups[x]					
	5A	*15A*	*23A*	*30A*	*15/23R*	*15/30R*
Dry matter	302	299	313	289	317	300
C. protein	144	142	140	144	141	145
C. fat	122	119	126	117	119	132
Ash	22.5	23.5	13.0	23.0	23.3	22.7
Lactose	13.5	14.5	24.0	5.0	33.7	0.3
Energy (MJ/kg milk)	8.21	8.07	8.44	7.88	8.36	8.40

[x] 5A, 15A, 23A, 30A = rabbits kept at 5, 15, 23 and 30°C were fed ad libitum
[x] 15/23R, 15/30R = does kept at 15°C were fed the same amount of pellet as the intake of the rabbits kept at 23 and 30°C.

Table 3

Effect of stage of lactation on content of some minerals in rabbit milk

Minerals *ppm*	Days after parturition					
	3	*7*	*14*	*21*	*24*	*27*
Ca	2115	2451	2857	3056	2923	2838
Mg	282	371	337	460	519	706
Zn	47.8	39.4	33.2	29.0	28.2	23.9
Fe	3.70	2.80	2.26	2.21	2.28	2.25
Cn	2.54	2.66	1.74	1.25	1.18	1.40
Mn	0.33	0.05	0.12	0.12	0.13	0.14

Table 4

Effect of temperature and restricted feeding on content of some minerals in rabbit milk

Minerals *ppm*	Groups					
	5A	*15A*	*23A*	*30A*	*15/23R*	*15/30R*
Ca	2340	2922	2683	2612	2636	3047
Mg	451	440	432	440	467	446
Zn	31.4	34.4	33.4	32.4	36.4	33.6
Fe	2.58	2.32	2.80	2.51	2.75	2.53
Cu	1.72	1.62	1.48	2.00	2.12	1.85
Mn	0.11	0.13	0.18	0.11	0.17	0.20

Table 5

Effect of stage of lactation on the amino acids content in rabbit milk

Amino acids	Days after parturition					
µmol/g	*3*	*7*	*14*	*21*	*24*	*27*
Gly	40.7	33.8	33.0	36.9	33.5	46.0
Ala	65.5	54.5	48.0	57.4	49.9	64.1
Val	63.5	62.3	37.4	67.2	57.3	67.9
Leu	99.2	85.5	79.4	89.5	78.3	104.2
Ile	38.2	32.9	32.6	37.8	34.1	39.8
Phe	35.7	28.6	28.4	34.6	30.2	38.1
Ser	67.7	60.2	51.3	62.1	53.1	70.6
Thr	46.6	37.5	29.8	45.3	39.4	49.5
Met	10.7	17.2	12.8	12.9	16.6	26.4
Tyr	26.6	24.5	22.7	26.7	23.3	29.9
Asp	47.9	35.9	31.9	43.6	38.2	44.7
Glu	147.0	104.2	98.3	141.6	120.5	149.1
Lys	79.2	71.8	62.8	77.8	70.6	93.5
Arg	55.4	47.3	41.6	47.6	41.5	55.4
His	24.3	21.6	19.5	23.3	21.2	27.0

Table 6

Effect of temperature and restricted feeding on the amino acid content in rabbit milk

Amino acids	Groups					
µmol/g	*5A*	*15A*	*23A*	*30A*	*15/23R*	*15/23R*
Gly	29.7	41.8	32.5	32.7	41.1	46.2
Ala	44.7	64.6	50.6	53.0	65.6	60.9
Val	46.0	71.4	59.1	48.8	66.4	64.0
Leu	71.7	101.6	82.6	82.6	98.9	98.7
Ile	28.4	41.2	35.1	34.9	36.4	39.2
Phe	26.0	38.3	31.7	29.0	34.1	36.4
Ser	47.5	70.4	56.6	54.4	67.7	68.5
Thr	32.4	47.8	41.0	40.6	40.2	46.1
Met	19.6	15.2	14.7	13.9	15.3	17.8
Tyr	20.3	28.7	24.1	24.0	28.1	28.4
Asp	32.7	46.1	38.4	40.6	41.5	42.8
Glu	100.6	146.1	124.9	124.9	123.7	140.4
Lys	58.3	80.0	67.5	73.8	88.1	88.0
Arg	37.0	56.3	44.1	45.1	52.6	53.5
His	18.0	26.3	21.3	20.7	24.5	26.0

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