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RABBIT'S MILK YIELD AND COMPOSITION AT DIFFERENT WEEKS OF LACTATION PERIOD.

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ABSTRACT: Sixteen non-pregnant doe rabbit's 6 months old (8 New Zealand hite; NZW and 8 Californian; CAL) in the first parity of their first year of production were used in this research. After parturition, the chosen does in both the two breeds were nearly equal in their litter size at birth. One milk sample was collected from each doe during colostrum period (1-2 days post-partium) and biweekly until weaning the kids (35 days). Milk yield from each doe was estimated before feeding individually by the difference in doe weight before and after nursing once a week for a period of 5 weeks.

Milk yield and major milk components except lactose were significantly affected by stage of lactation. The average of milk yield was lower in the first week and reached its peak in the 3 rd week of lactation stage. Both moisture/total solids and calcium/in-organic phosphorus ratios were the same; 2/1 throughout the lactation.

Milk energy was significantly affected by lactation and the high values were during the 5 th week due to high fat content. The concentrations of Na, K, Ca, Mg and P (inorganic) were affected significantly by the lactation stage

Keywords: rabbits, milk yield, milk components, and lactation period.

INTRODUCTION

Knowledge of the composition of rabbits milk is necessary to understand how doe effectively it supplies nutrients to the pups. Some studies since 1960's the last century have measured only gross chemical composition (Davies et al., 1964) or used one or two milk samples from parturition up to only 3 weeks of lactation (Coates et al., 1964). Finally, Elsayiad et al.(1994) reported some notes on rabbit milk composition.

The technical and the physiological difficulties of collecting the milk samples and the very small quantities of milk that can obtain from each doe, especially, in the late lactation stage make such studies more difficult. To improve our knowledge, the effect of lactation stage from colostrum until 5 th week on milk yield, as well as, milk composition in each of New Zealand (NZW) and Californian (CAL) breeds, were the main objective of this study.

MATERIALS AND METHODS

1- Animals, and management:

Eight New Zealand White (NZW) and 8 Californian (CAL) non-pregnant does purebred, with 3670 and 3710 g average body weight, respectively, 6 months old in the first parity of their first year of production were used in this study. The experimental work was carried out in a private Rabbitry farm located in Zagazig city, Sharkiya Province, Egypt during winter conditions January and February of the year 2002 and lasted about 40 days (Suckling period). Averages of maximum and minimum ambient temperatures and relative humidity indoor the rabbitry during the experimental period were 22, 5 C0 and 75,50%, respectively. The day length was 10.30 hr.

The does were kept under the same managerial conditions and housed in individual universal galvanized wire batteries. The batteries cages were provided with feeders, automatic nipple drinkers and external nest boxes for kindling and nursing young. The batteries were located in building naturally ventilated by special windows and provided with electric fans. The does were not transferred to the buck cage for mating during the experimental period. Does were fed ad libitum on lactating commercial pelleted ration (EL- Takamel Factory, 6 October City). Ingredients and chemical analysis are presented in Table 1. Fresh clean water was available at all times.

2- Milk yield and milk samples:

The pups were separated from their mothers on the evening to prevent suckling for a period of 12 hrs before sample collection in the morning. Ninety- sex milk samples were collected manually by gently massaging the mammary gland of the doe and about of 20 ml per doe were obtained.

Samples of colostrum were taken within 48 hrs of parturition and then samples were collected weekly, i.e. at the 7th, 14th, 21st, 28th and 35th days of lactation. The samples were stored at -20 C until analysis.

Milk yield (in grams) was estimated before feeding individually from does by the difference in does weight before and after nursing once a week for a period of 5 weeks.

3- Milk analysis:

Milk samples were thawed and mixed before analysis. The samples were diluted with deionized distilled water at a proportion of 1: 2 to facilitate the analysis. Approximately 10 g of the diluted sample weighed into a weighing silica crucible, kept in an oven at 70 C until dry and then at 105 C for 3 hrs until constant weight to obtain total solids (Ling, 1956).

Total moisture was calculated as the difference between fresh sample weigh and total solids. Fat content was determined using Gerber method according to British Standards Institution Method (1951). Total protein was estimated by the biuret method (Armstrong and Carr, 1964).

To estimate ash content, the dried samples were ignited in a muffle furnace at 460 C. Lactose was calculated by subtracting the sum of protein, fat and ash from total solids. Milk energy (kcal/100 g milk) was calculated using the following equation (Perrin, 1958):

$$E = 9.11 \times fat + 5.54 \times protein + 3.95 \times lactose$$

Determination of sodium (Na), potassium (K), calcium (Ca), magnesium (Mg) and phosphorus inorganic (P) in milk samples were estimated color metrically using commercial chemical reagent kits after the wet ashing method with nitric and percholoric acids was carried out.

4- Statistical analysis:

Data were subjected to statistical analysis using SAS (1991) according to Snedecor and Cochran (1982). Duncan's New Multiple range test was carried to test the significance of the difference among means within the same column of each item (Duncan, 1955).

RESULTS AND DISCUSSION

1- Milk yield:

Table 2 showed that the averages milk yield were significantly affected due to lactation stage. The highest values were at 3 rd week and then declined afterwards in both two breeds while the lowest values were at 5 th week and then at 1st week. EL-Sayiad et al.(1994) reported similar results.

2. Major milk components:

a- Total solids and moisture

The major component of the milk except lactose significantly fluctuated in concentration with change in milk yield during lactation (Table 2 and Fig.1).The colostrum and the milk of the 5th week contain the lowest of moisture contents. The increase of total solids in colosrum and in the 5th week was due to the increase in proteins, specially, globulin antibodies in early lactation and the increase in fat content at the end of lactation, respectively. Abdel-Fattah(1985)reported a higher value of total solids from 30 to 50 days of lactation (40.5 to 50.4%).It is interesting to observe that total solids/total water ratio was about 1:2 throughout the suckling period. Milk from Californian does contain more solid than that of New Zealand white ones, specially, during the last 3 weeks after parturition (Fig. 1).

b- Fat

The fat content was high at the end of the suckling period than at parturition. The high values of the 5th week may have been due to the low milk yield at this time while the low values in the first and the second weeks were at the peak of milk yield .The present results are in agreement with those reported by Coates et al(1964) ; Lebas (1972) and El-sayiad et al.(1994) in NZW or CL rabbits, while Abdel-Fattah (1985) found higher levels in giza rabbit milk.

c- Protein

The maximum protein values were measured in the colostrum and than declined gradually with increasing lactation stage, reaching a minimum throughout the 4th and 5th weeks. This may be related to its requirement for pups growth .The levels of protein agreed with those reported by Coates et al. (1964); Cowie (1969) and Lebas (1971) and the levels from 2nd day till 30th day in the study of Abdel-Fattah (1985). Milk of the does Californian contained protein more than milk of New Zealand does in the last two weeks of lactation period (Table 2 and Fig.).

d- Lactose

Levels of lactose were nearly constant during lactation (Table 2).This may be because lactose is one of the main constituents concerned in maintaining constancy of the osmotic properties of milk. The results agreed with those reported by Abdel-Fattah (1985) from the second till the 30th day of lactation but the levels at 44 and 51 days were lower than those here at 35 days of lactation. Coates et al. (1964) also reported lactose value about 30% lower than here. EL-Sayiad(1994) reported that lactose concentration was not affected significantly by the lactation stage in both NZW and CAL breeds.

e- Ash

The concentration of ash in the milk was significantly affected by the stage of lactation. The minimum values were in colostrum and the first week followed by a gradually increase to the maximum in the 4th and 5th week (Table 2 and Fig. 1). However, similar levels were obtained by Hafez (1970) and Abdel-Fattah (1985) ranging from 2.0 to 2.5 mg /100g milk and from 1.9 to 2.4 mg / 100 g milk, respectively. The increase in ash content in the 4th to 5th weeks may be due to the increase in Na, K and Ca concentrations. These present about 0.5 of total milk salts in late lactation, which might be due to pregnancy requirements.

Solids- not- fat as a total (protein, lactose and ash) values were not significantly affected by lactation stage. This was a result of the protein content changing in the opposite direction to ash and lactose contents (Fig 1).

f- Energy

Milk energy was significantly affected by lactation stage (Table 2).The high values in the 5th week were due to high fat content. One kg of milk in this week provided about 2330 kcal of which about 66% came from fat, 31% from protein and only 3% from lactose. The high values also observed in the colostrum were due to the high level of proteins. One kg from colostrum provided 2200 kcal of which about 40% came from protein, 56 %from fat and 4% from lactose.

The milk of Californian does contained more energy than the milk of New Zealand does, specially, in the last 3 weeks of lactation. This may be due to that milk of Californian does contained higher protein and fat levels than that of New Zealand does in that period (Fig 1)

3- Minerals in rabbitís milk:

The concentrations of Na, K, Ca, Mg and P(inorganic) were affected ignorantly by the lactation stage.

Sodium and potassium

The values of Na were low in colostrum and increased gradually to reach the maximum in the 5th week. On of the other hand, the concentration of K was high in colostrum, decreased gradually until the 3rd week, and increased in the 4th and the 5th weeks (Table 3 and Fig. 2). Similar findings for Na and K concentrations were reported by, Coates et al. (1964)

Calcium and magnesium

Levels of Ca were varied and showed no clear lactation trend. The Mg values were low in the 4th and 5th weeks, and highest in the colostrum (Table 3).It is interesting to observe that Ca / Mg ratio gradually increased from 11.8 to 13.8 with increasing the lactation period. It may be due to that these divalent electrolytes being responsible with lactose, for the osmotic properties of milk. New Zealand does milk contained Ca more than that of Californian does, specially, in the colostrum and 1st week of lactation period (Table 3 and Fig.)

Inorganic phosphorus

P (inorganic) contents were significantly affected by stage of lactation but no definite trend was observed (Table 3 and Fig 2). New Zealand does, milk contained more P (inorganic), specially, in the first two weeks than did the milk of the Californian does .It is interesting to observe that Ca and P(inorganic) concentrations in milk showed the same trend in that period (Table 3). However, Ca / P ratio was constant (2 / 1) throughout lactation. EL-Sayiad (1994) reported similar findings concerning Ca and P (inorganic) concentrations.

Table1: Ingredients and chemical analysis of the lactating commercial diet fed to does rabbits during the lactation period.

Ingredient and chemical composition	%
The ingredients of the ation:	
Barley	32.0
Wheat bran	21.0
Soya bean meal (44% crude protein)	10.0
Clover hay	22.0
Berseem straw	6.0
Corticated cotton seed meal	3.0
Molasses	3.0
Meat meal (60% crude protein)	1.3
Limestone	1.0
Sodium chloride	0.34
Vitamins and minerals premix*	0.30
DL-Methionine	0.06
2-The chemical composition of the ration** (%Dry matter basis)	
Crude protein	22.52
Crude fiber	16.94
Crude ether extract	2.42
Nitrogen free extract	50.73
Ash	7.39
Digestible energy/ kg ration	2600 k cal

Table 2. Daily milk yield, major milk components (g / 100 g milk) and energy (k cal/100 g milk) at different weeks of lactation period in NZW and CAL breed

Lactatin period	Rabbits breed	Daily milk yield (g/doe/day)	Moisture content **	Fat **	Protein **	Lactose NS	Ash **	Energy Kcal/100 g milk
Colostm	NZW	----	66.1	13.9	16.3	1.87	1.87	224
	CAL	----	66.6	13.3	15.6	2.35	2.15	217
	X ±SE	----	66.3±0.8b	13.7±o.6c	15.9±0.7a	2.11±0.1a	2.01±0.2b	221±9ac
First week	NZW	109	68	12.4	14.4	2.00	1.81	201
	CAL	98	69	11.9	15.1	2.03	1.84	200
	X ±SE	103.5±5cd	68.6±o.7ac	12.2±o.5d	14.8±o.6ac	2.00±0.1a	1.83±0.1b	201±9 b
Second week	NZW	157	69	11.5	14.1	1.83	2.12	190
	CAL	158	72	11.5	12.5	1.89	2.26	182
	X ±SE	157.5±4b	70.1±o.7a	11.5±.1cd	13.6±o.6bc	1.86±0.1a	2.2±0.1ab	186±8 b
Third weak	NZW	174	70	13.2	13.5	1.89	1.92	203
	CAL	181	67	14.7	13.3	2.25	2.38	217
	X ±SE	177.5±8a	68.6±o.8ac	13.8±o.5c	13.5±o.6bc	2.07±0.1a	2.2±0.1bc	210±9 b
Forth week	NZW	119	69	14.8 B	11.5 B	2.05	2.52	207
	CAL	105	66	15.2 A	14.8 A	1.64	2.38	227
	X ±SE	112.0±6c	67.6±o.8bc	15.0±o.6b	13.0±o.7b	1.85±0.1a	2.5±0.1ac	217±7 c
Fifth week	NZW	84	68	16.2 B	11.0 B	1.84	2.60	216
	CAL	66	63	17.7 A	14.9 A	1.86	2.33	251
	X ±SE	75.1±6e	65.8±o.9b	16.9±o.6a	13.0±o.7b	1.85±0.1a	2.46±0.2a	233±9 a

a,b,c...Means bearing different subscripts in the same column due to weeks of lactation period, differ significantly($P<0.05$).
** = $P< 0.01$, NS = not significant

Table 3. Some minerals (mg / 100 g milk) in rabbits milk at different weeks of lactation period in NZW and CAL breeds.

Lactation period	abbits breed	Na **	K **	Ca *	Mg **	Ca/Mg ratio	P **	Ca / P ratio
Colostrum	NZW	87	187	507 A	41	12.4	267 A	1.9
	CAL	82	185	478 B	42	11.4	256 B	1.9
	X±SE	84 ± 2 c	186 ±3a	492± 9 a	41±1 a	11.9	260±5 bc	1.90
First week	NZW	103	176	480 A	39	12.3	262 A	1.8
	CAL	101	168	451 B	38	11.9	249 B	1.8
	X+SE	102 ± 2 d	172 + 3b	466± 8 c	38+1 b	12.1	256±4 bc	1.80
Second week	NZW	105	163	494 A	36	13.8	264 A	1.9
	CAL	102	154	490 B	37	13.2	254 B	1.9
	X±SE	103 ± 2 d	159 ± 3c	492± 8 ab	36± 1bc	13.5	259±4 bc	1.90
Third week	NZW	117	151	492 •	36	13.7	263	1.9
	CAL	118	152	490	37	13.2	269	1.8
	X±SE	117 ± 2 c	1 +3d	488± 8 ab	36±1 bc	13.5	266±4 b	1.85
Forth week	NZW	121	172	452	32	14.1	233	1.9
	CAL	126	184	497	38	13.1	259	1.9
	X±SE	123 ± 2 b	178 ± 3 ab	473±9 bc	35±1 c	13.5	245±5 c	1.90
Fifth week	NZW	140	179	504	36	14.0	284	1.8
	CAL	132	185	482	35	13.8	277	1.7
	X+SE	136 ± 2 a	182 ±4 a	492±9 a	35±1 c	13.9	280±5 a	1.75

a,b,c...Means bearing different subscripts in the same column due to weeks of lactation period, differ significantly($P<0.05$). A,B Mean bearing different subscripts in the same column of each week due to breed, differ significantly ($P< 0.05$). * = $P< 0.05$, ** = $P< 0.01$

Conclusion

It is concluded that milk yield of rabbits reached its peak in the third weak of lactation stage. With the advanced of lactation stage, milk fat increased while milk protein decreased due to the requirement of pups growth. Both moisture /total solids and Ca/Pi ratios were almost 2:1 while Ca/Mg ratio was ranged between 12-14:1. The high values of milk energy were in the 5th week due to high fat content and in the colostrum due to high level of protein.

Milk Na concentration increased while milk Mg concentration decreased gradually, from colostrum to 5th week of lactation stage. Milk of NZW does contained more Ca and P(inorganic), especially in the first two weeks of lactation period, than did the milk of the CAL. Milk from CAL does contained more total solids (fat and protein) and consequently milk energy than that of NZW ones ,especially, during the last 2 weeks after parturition.

When comparing milk composition between milk from cows and milk from rabbits, it is interesting to observe that milk total solids in rabbits milk was 33% i.e. equal to 3 times of that in milk cows (11%). Rabbitís milk fat was 15% i.e. 5 times of the fat percentage in cowís milk. Similarly, the percentage of rabbitís milk protein ranged between 13-16%, which equal to 4 times of the percentage of protein in milk cows. However, the opposite was true in lactose concentration, since the % of lactose in rabbitís milk was half that percentage in milk cows.

Composition of rabbitís milk declared how effectively of the low quantity of milk supplies the nutrients to the pups and satisfies, the large number of litter, which sometimes, reached to 15 kids.

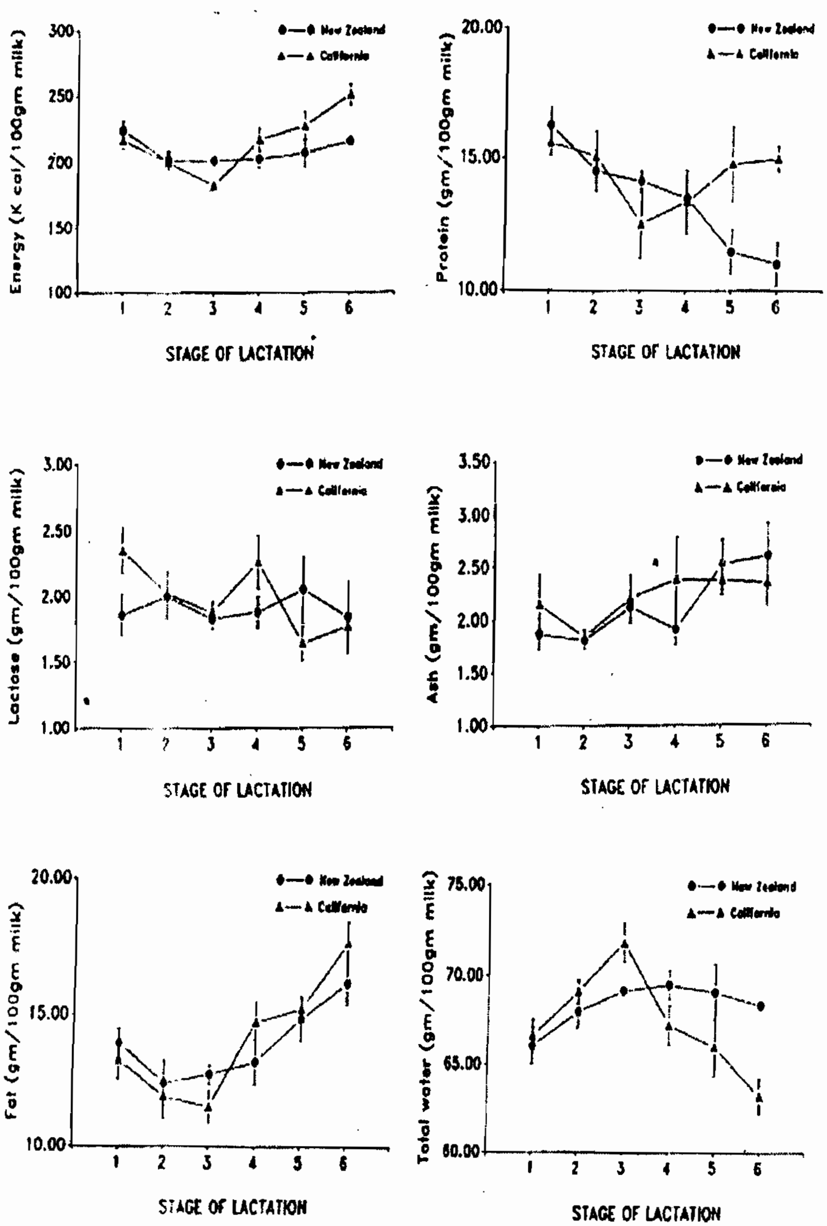

Fig. (1): Rabbit's major components as affected by lactation stage (weeks) in each of NZW and CAL breeds.

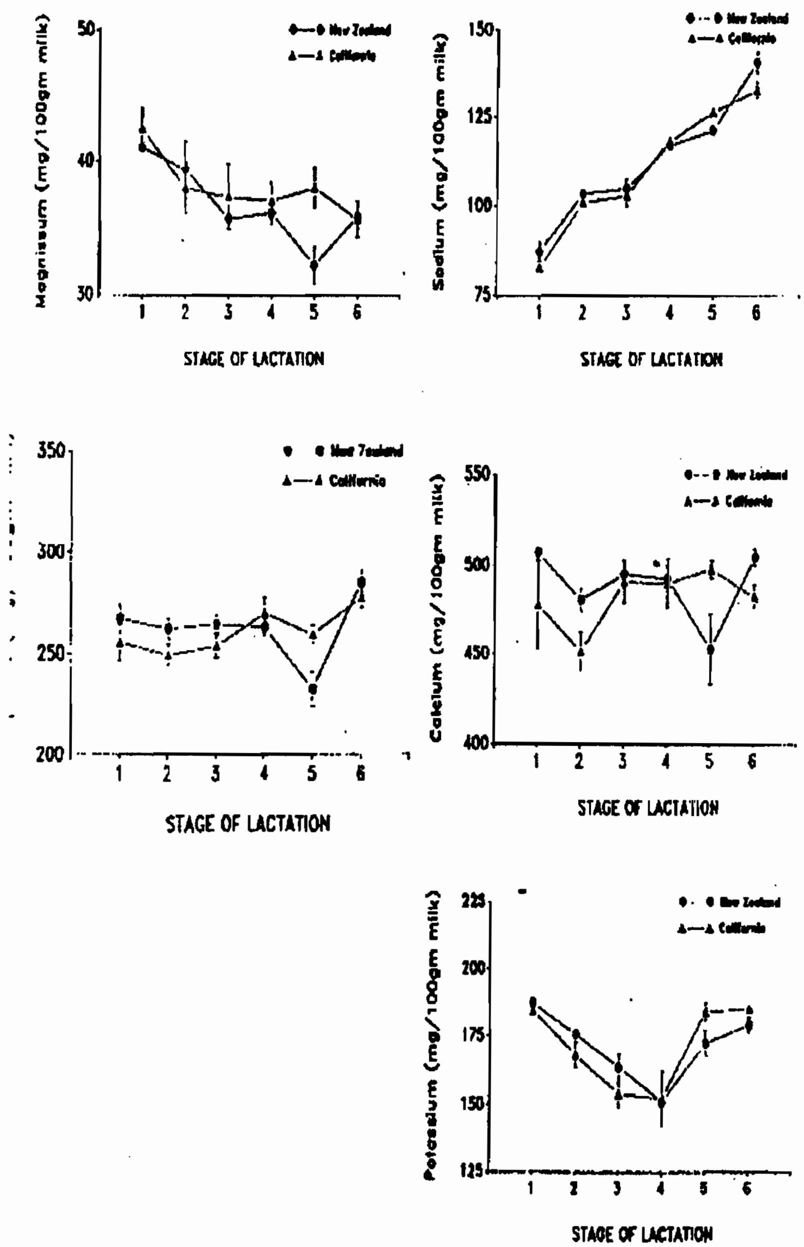

Fig. (2): Rabbet's milk mineral concention as affected by laction stage (weeks) in each of NZW and CAL breeds.

REFERENCES

Abdel-Fattah, F. A. I. (1985). Studies on some factors affecting reproductive performance, milk production and preweaning growth in rabbits. M .Sc. Thesis, Faculty of Agriculture, Cairo University.

Annino, S. and W. Giese (1975). Clinical Chemistry: Principles and Procedures, 4 th Ed., Little Brown Company, Boston, USA, PP: 319.

Armstrong, W. D. and C. W. Carr (1964). Estimation of serum total proteins, 3 th Ed., Physiological Chemistry Lab. Directions. Burges Published Co., Minneapolis, Minnesota, USA.

Association of Official Analytical Chemists (A.O.A.C.) (1990). Official Methods of Analysis. 5 th Ed., Washington, DC,USA.

British Standards Institution Methods (1951). Gerber methods for determination of fat in milk products. Publication No 696 Part 2.

Coates, M. E. ; M. E. Gregory and S. Y. Thompson (1864). The composition of rabbitís milk. British J. of Nutrition, 18: 583-586.

Cowie, A. I. (1969). Variations in the milk yield and composition of milk during lactation in the rabbits and the galactopoieretic effect of prolactin. J.of Endocrinology, 44: 437-450.

Davies, J. S. ; E. M. Widdowson and R. A. McCance (1964). The inake of milk and the retention of its constituents while the new born rabbit doubles its weight. J. of Nutition, 18: 385-392.

Duncan, D. B. (1955). Multiple range and multiple F-test. Biometrics ,11: 1- 42 .

EL- Sayiad, Gh. A. ; A. A. M. Habeeb and A. M. EL-Maghawry (1994). A note on the effects of breed, stage of lactation and pregnancy status on milk composition of rabbits. Animal Production, 58: 153 -157.

Food and Agriculture Organization (FAO)(1986). Rabbit Husbandry, Health and Production (Edit. By Lebas, Coudert, Rouvier and Rochambeau), FAO of the Unitd Nations ,Roma, Animal Production Series No 21, Chapter 3, PP: 58- 59.

Hafez, E. S. E. (1970). Reproduction and breeding techniques for laboratory animals. Lee and Febieger. Philadelphia, USA.

Lebas, F. (1971). Chemical composition of rabbit milk; Evolution of the milk due to lactation stage. Annales de Zootechnie, 20 : 158- 191.

Lebas, F. (1972). Effect of simultaneity of lactation and gestation on the performance of rabbitís milk. Annales de Zootechnie , 21 : 129 -131.

Ling, E. R. (1956) A text book of dairy chemistry vol. 11, Chapman and Hall, Ltd., London.

Perrin, D. R. (1958). The colorific value of milk of different species. J of Dairy Research, 25 : 215.

SAS (1991). Statistical analysis system, SAS Users Guide; Statistics SAS Institute Inc., Editors Cary" NC.

Snedecor, G. W. And W. G. Chochran (1982). Statistical Methods, 7 th ed., Iowa University Press , Ames-Iowa, USA.

إنتاج و تركيب اللبن فى الأرانب خلال الأسابيع المختلفة لفترة الرضاعة

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تمت هذه التجربة فى مزرعة أرانب خاصة بمدينة الزقازيق أثناء فصل الشتاء (يناير وفبراير ٢٠٠٢) حيث استخدم فى هذا البحث ١٦ أنثى أرنب منهم ٨ من النوع النيوزيلندى الأبيض و ٨من النوع الكاليفورنيا بعد أول ولادة لهم وأثناء فترة الرضاعة للموسم الأول من أول نة إنتاجية. تم تقدير كمية اللبن اليومية المنتجة من كل أم عن طريق وزن الخلفة قبل وبعد الرضاعة بعد أن تم حجز الخلفة عن أمهاتهم لمدة ١٢ اعة (من الساعة ٨ مساءا إلى الساعة ٨ صباحا) وذلك يوم واحد من كل أبوع. تم أيضا اخذ حوالى ٢٠ ملي لبن كعينة من كل أم أثناء فترة الرسوب (خلال ٤٨ ساعة من الولادة) ثم عينة واحدة أسبوعيا خلال فترة الرضاعة أى فى الأيام ٧ و ١٤ و ٢١ و ٢٨ و ٣٥ من الولادة يمثلان خمة أابيع لفترة الحليب أى ٩٦ عينة (١٦ أم ولكل أم ٦ عينات).

تم تقدير مكونات اللبن الرئيية من الرطوبة والمادة الصلبة ونسبة الدهن والبروتين وسكر اللاكتوز والرماد وكذلك كمية الطاقة الناتجة من اللبن. كما تم تقدير تركيز عناصر الصوديوم والبوتاسيوم والكالسيوم والماغنسيوم والفوسفور غير العضوى فى عينات اللبن المختلفة.

وأهم نتائج هذا البحث هو:

متوسط إنتاج اللبن اليومى فى الأرانب يختلف حسب أسابيع فترة الحليب حيث يزداد كلما زادت فترة الرضاعة حتى يصل أقصى إنتاج له خلال الأسبوع الثالث ثم يقل بعد ذلك تدريجيا حتى يصل إلى أقل ما يمكن خلال الأسبوع الخامس.

تركيز المادة الصلبة أعلى ما يمكن فى لبن الرسوب ثم يقل تدريجيا وبعد ذلك يزداد فى الأسبوع الخامس.

اللبن الناتج من الكاليفورنيا يحتوى مادة صلبة ونسبة بروتين أعلى من اللبن الناتج من النيوزيلندى خاصة أثناء الأابيع الثلاثة الأولى بعد الولادة.

تركيز كل مكونات اللبن الرئيسية ماعدا سكر اللاكتوز تتأثر باختلاف أسابيع فترة الحليب حيث تزداد نسبة الدهن ونسبة الرماد فى اللبن مع تقدم فترة الحليب على عك نبة البروتين التى تقل مع تقدم فترة الحليب حيث يكون أعلى ما يمكن فى لبن السرسوب.

متوسط كمية الطاقة الناتجة من اللبن تكون أعلى ما يمكن فى الأسبوع الخامس لزيادة نسبة الدهن وكذلك فى الأسبوع الأول لزيادة نسبة البروتين خلال هذا الأسبوع.

تركيز الصوديوم فى اللبن يزداد مع تقدم موسم الحليب على عكس تركيز الماغنسيوم أما تركيز كل من البوتاسيوم والكالسيوم والفوسفور غير العضوى ليس لهم اتجاه محدد مع اختلاف اسابيع الرضاعة.

لبن النيوزيلندى يحتوى على كالسيوم بتركيز أعلى من ذلك الناتج من الكاليفورنيا خاصة أثناء فترة السرسوب والأسبوع الأول من الرضاعة.

لبن النيوزيلندى يحتوى على فوسفور غير العضوى بتركيز أعلى من ذلك الناتج من الأرانب الكاليفورنيا خاصة فى أول أسبوعين من الرضاعة.

غالبا نسبة المادة الصلبة الى الماء فى اللبن هى٢ : ١ للكلة بسذك لذكو سيوم إلى الفوسفور غير العضوى هى أيضا ٢ : ١ أما نسبة تركيز الكالسيوم إلى تركيز الماغنسيوم هى تتراوح بين ١٤٠١٢ : ١.