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EFFECT OF MILKING INTERVAL ON SECRETION RATE AND COMPOSITION OF CAMEL MILK

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ABSTRACT

This study aimed to investigate the effect of milking interval on yield and composition of camel milk to identified appropriate number of daily milking of she-camel. Total of 12 multiparous she-camels (ranged from 3 to 6 parities and 8 to 13 years of age) were used in a short-term experiment done during 1-4 mo postpartum. Camels were daily fed a mixture of berseem hay (3 kg) and concentrate mixture pellets (5 kg) containing 16% CP on DM basis. Milking intervals schedule included 4, 8, 12, 16, 20 and 24 h. Milking order for each replicate was arranged to remove the possible effects between milking intervals. The experiment started (0 h) after complete udder emptying by milking with the help of an i.v injection of oxytocin (10 IU/animal). At each milking, milk yield was recorded and milk samples were individually taken for milk composition and somatic cell count (SCC) Results cleared significantly ($P<0.05$) gradual increase in average milk yield by increasing milking interval. These increases were about 40, 79, 126, 153 and 184% by increasing milking interval from 4 to 8, 12, 16, 20 and 24 hours. However, milk secretion rate during each milking interval showed gradual reduction by increasing milking interval, being significantly ($P<0.05$) the highest (436.5 g/h) for 4 h and the lowest (206.9 g/h) for 24 h milking intervals. When milk secretion rate (g/h) was expressed among milking interval from 4 to either 8, 12, 16 , 20 or 24 hours, results showed no significant differences in secretion rate of milk, ranging from 161.0 g/h between 4-24 h and 183.3 g/h between 4-16 h. The effect of milking interval was significant only on percentage of fat, protein and total solids (TS). Increasing milking interval significantly ($P<0.05$) decrease percentage of fat and increased protein content. The significant ($P<0.05$) decrease in fat content continued by increasing milking interval from 4 to 8 and 12 h and then up to 24 h. However, the significant increase in protein content was found by increasing milking interval from 4 to 24 h. The significant decrease in fat content was associated with significant ($P<0.05$) reduction in TS content, especially by increasing milking interval from 4 to 20 h. On the other hand, lactose and solids not fat contents were not affected significantly by milking interval. SCC in milk of she-camel decreased significantly only by increasing milking interval from 8 to 16 h, showing the minimum count with 16 h milking interval. However, the maximum count was recorded for 8 h milking interval. The present results indicated that increasing milking interval from 4 to 8 h resulted in the highest increase in milk yield of camel. Based on these results it could be suggested two daily milkings of she-camel.
Keywords: Camel, milking interval, milk yield, milk composition, somatic cell count

INTRODUCTION

Milking more than two daily milking (2DM) results in increasing milk yield and milk secretion rate in dairy cows (Hillerton *et al.*, 1990), goats (Knight *et al.*, 1990), ewes (McKusick *et al.*, 2002a) and camels (Alshaikh and Salah, 1994). The increase in cell differentiation appears to be an early response to increasing milking frequency (MF). Increasing MF incremented

the number of secretory cells. Henderson *et al.* (1985) found that the mammary gland milked three daily milkings (DM) was larger than that milked 2 DM, suggesting either growth or reduced regression (involution) of the 3 DM gland. Similarly, Wilde *et al.* (I987) found that the weights of both the whole mammary gland and the mammary parenchyma, and the amount of parenchymal DNA were significantly greater for the 3 DM glands, indicating an increased number of cells compared with that of the 2 DM glands only. Moreover, 3 or 4 DM in early lactation was found to increase mammary cell proliferation of dairy cows (Hale *et al.*, 2003 and Norgaard *et al.*, 2005), indicating relatively more mammary epithelial cells (MEC). Frequent milking may have inhibited MEC death by decreasing the alveolar distension (Wilde *et al.*, 1999).

Peaker and Blatchford (1988) reported that the rate of milk secretion in individual glands of lactating goats was inversely related to the fraction of milk left after milking, irrespective of the actual volume of milk in the gland at the time of milk removal.

Milking for one time caused significant increases in fat and total protein percentages in dairy cows (Carruthers *et al.*, 1991; 1993; Stelwagen *et al.*, 1994; Lacy-Hulbert *et al.*, 1999; O'Brien *et al.*, 2002 and Remond *et al.*, 2004). Nevertheless, Holmes *et al.* (1992) and Remond *et al.* (2002) reported no changes in fat and protein for one milking cows. Also, differences between alveolar and cisternal contents of milk protein and lactose are minimal in dairy cows (Davis *et al.*, 1998 and Ayadi *et al.*, 2004), dairy ewes (McKusick *et al.*, 2002a) and dairy goats (Salama *et al.*, 2005). Protein concentration increased in the cisternal and alveolar milk with extended milking intervals in cows (Ayadi *et al.*, 2004) and ewes (McKusick *et al.*, 2002a).

In dairy ewes, cisternal and alveolar somatic cell count (SCC) was similar for milking intervals of 4, 8 and 12 h, however, at longer milking intervals cisternal SCC was lower than alveolar SCC (McKusick *et al.*, 2002a). Little information exists in literature on milk yield and the fractional composition of milk in camels as affected by milking interval. Therefore, the current study aimed to investigate the effect of milking interval on yield and composition of camel milk to identified appropriate number of daily milking of she-camel.

MATERIALS AND METHODS

The current study was carried out at the camel studies and production development center (CSPDC), Marsa Matrouh Animal Production Research Station, Animal Production Research Institute, Agricultural Research center, Ministry of Agriculture in co-operation with Animal Production Department, Faculty of Agriculture, Mansoura University.

Animals and management conditions:

Total of 12 multiparous she-camels (ranged from 3 to 6 parities and 8 to 13 years of age) were used in a short-term experiment done during 1-4 mo postpartum. All experimental camels were chosen from the flock of CSPDC with symmetrical and healthy udders, on the basis of similar stage of lactation and milk yield. Mammary glands of the experimental camels were

checked for the absence of intramammary infections by milk sample bacteriology and all camels were milked according to treatment order (Table 1) in 6 replicates. Camels were housed in a barn separate from the main flock to avoid conditioned stimulation of milk letdown between planned milkings as a consequence of milking operation. Camels were daily fed a mixture of berseem hay (3 kg) and concentrate mixture pellets (5 kg) containing 16% CP on DM basis.

Experimental procedures:

Milking interval schedule during each replicate was applied successively (total length 84 h) without any period of washing-out between milking intervals. Milking order for each replicate was arranged to remove the possible effects between milking intervals (Table 1). The experiment started (0 h) after complete udder emptying by milking with the help of an i.v injection of oxytocin (10 IU/animal to remove residual milk. Thereafter, 1 of the 6 milking interval treatment was applied for each replicate and the same udder emptying procedure using oxytocin was repeated for each replicate.

Table (1): Experimental schedule for each studied group applied at 19 day to 69 day of lactation in dromedary dairy camels.

Replicate number	Treatment order[1]						Treatment period
	1	2	3	4	5	6	
1	24h	20h	16h	12h	8h	4h	84 h
2	20h	16h	12h	8h	4h	24h	84 h
3	16h	12h	8h	4h	24h	20h	84 h
4	12h	8h	4h	24h	20h	16h	84 h
5	8h	4h	24h	20h	16h	12h	84 h
6	4h	24h	20h	16h	12h	8h	84 h

[1] **Treatment included milking at intervals of 4, 8, 12, 16, 20, 24h.**

Sampling and analyses:

At each milking, milk yield was recorded and milk samples were individually taken. For milk composition analysis a samples of approximately 100 ml for each were collected and preserved at -20^{o}C. Unhomogenized milk samples were analyzed for main milk component by milko-scan, while somatic cell count (SCC) was determined using an automatic cell counter.
0.11in 60 min.

Statistical analyses:

The obtained data were statistically analyzed according to Snedecor and Cochran (1982) using the general linear model procedures of SAS (1987). The significant differences among treatment groups were tested using Duncan's Multiple Range Test (Duncan, 1955).

RESULTS AND DISCUSSION

Effect of milking interval on milk yield:

Effect of short-term milking interval on milk yield of she-camel shown in Fig, (1) cleared significantly ($P<0.05$) gradual increase in average milk yield by increasing milking interval. These increases were about 40, 79, 126, 153 and 184% by increasing milking interval from 4 to 8, 12, 16, 20 and 24 hours. It is of interest to note that these increases were the highest (40%) by increasing milking interval from 4 to 8 h, being moderate (28 and 26%) between 8 and 12 h and between 12 and 16 h, respectively. While the lowest

increase was observed between 16 and 20 as well as between 20 and 24 h, being 12% for each, respectively.

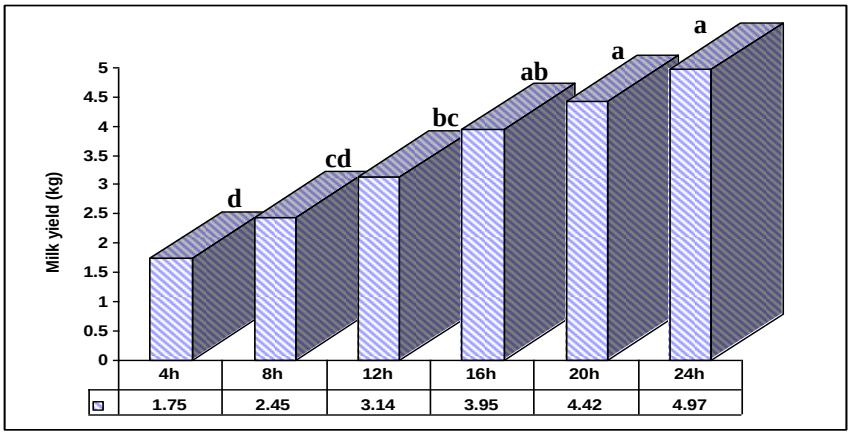

Fig. (1): Short-term effects of milking interval on milk yield of she-camels.

Similar trend was recorded by Castillo *et al*. (2008) on dairy sheep, who found that milk volume was affected (*P*<0.001) by milking interval (4, 8, 12, 16, 20 and 24) and accumulated linearly (*P*< 0.05) up to 24 h in two breeds of ewes. The present linear pattern of milk accumulation according to milking interval obtained in camel was early reported in dairy ewe breeds (McKusick *et al*., 2002) and dairy goats (Salama *et al*., 2004).

The present results indicated that increasing milking interval from 4 to 8 h resulted in the highest increase in milk yield of camel. Based on these results it could be suggested two daily milkings of she-camel. In agreement with the present results, Castillo *et al*. (2008) found that the milk accumulation rate in two breeds of ewes reached the greatest value with the 8-h milking interval and the lowest at the 20- to 24-h interval, indicating a secretion rate saturation effect with time, as reported in dairy ewes (McKusick *et al*., 2002), goats (Salama, *et al*., 2003), and cows (Knight *et al*., 1994 and Ayadi *et al*., 2003).

Effect of milking interval on milk secretion rate:

Also, milking interval affected significantly (P<0.05) milk secretion rate (g/h) of she-camel. Milk secretion rate during each milking interval showed gradual reduction by increasing milking interval, being significantly (P<0.05) the highest (436.5 g/h) for 4 h and the lowest (206.9 g/h) for 24 h milking intervals (Fig. 2).

When milk secretion rate (g/h) was expressed among milking interval from 4 to 8, 12, 16 20 or 24 hours, results illustrated in Fig. (3) showed no significant differences in secretion rate of milk, ranging from 161.0 g/h between 4-24 h and 183.3 g/h between 4-16 h.

Such trend indicated that the fastest period of milk secretion within camel udder was during the 1st four hours after udder empting and increasing milking interval more than 4 h did not affect milk secretion rate.

The reduction of milk accumulation rate, after reaching the maximum value, was more marked after 4 h milking interval from the 8- to 20-h milking interval), suggesting that she-camel did not tolerate extended milking intervals more than 8 h. In our study, milk secretion rate reached the greatest values between 4- to 16-h milking interval 183.3 g/h.

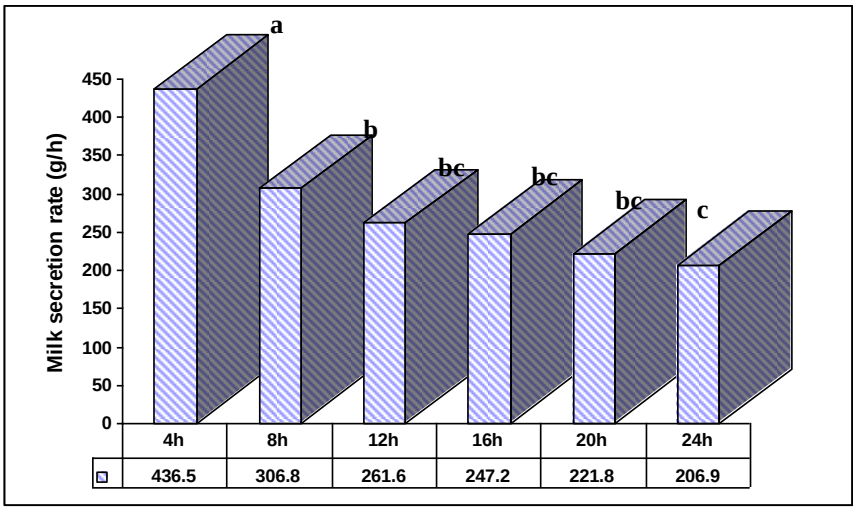

Fig. (2): Short-term effects of milking interval on milk secretion rate of she-camels.

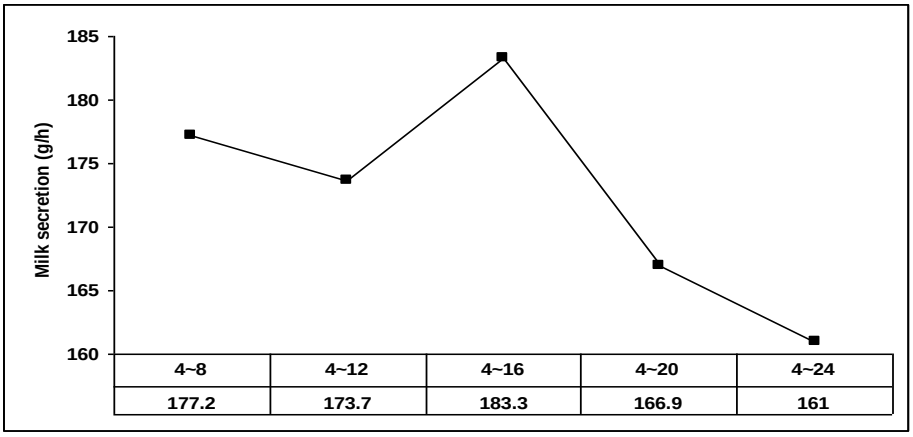

Fig. (3): Milk secretion rate by increasing milking interval from 4 to 8, 12, 16, 20 and 24 h.

According to Castillo *et al*. (2008), milk secretion rate reached the greatest values in the 4- to 8-h milking interval for Manchega ewes (51 ml/h) and Lacaune ewes (112 ml/h) and decreased as time after milking increased. The lowest milk secretion was obtained in the 16- to 20-h milking interval.

The observed reduction of milk secretion rate in this study by increasing milking interval more than 4 h might be due to changes in tight junction permeability (Stelwagen *et al*., 1995) and increments of intra-alveolar

pressure (Davis *et al*., 1999) or to the increase in the concentration of the putative feedback inhibitor of lactation in the mammary gland (Wilde *et al*., 1995) recently identified as serotonin (Hernandez *et al*., 2008).

As expected, lower milk secretion rates were observed for the 20- to 24-h milking interval, whereas a dramatic decrease in milk secretion rate after 20 h. This finding for long milking intervals has been previously reported and could be attributed to tight junction permeability, which may did not allow the flow of interstitial fluid into milk. This reduction in milk secretion after 20 h milking interval agreed with the increase of milk secretion rate reported in dairy goats after inducing the disruption of mammary tight junction with ethylene glycol-tetra acetic acid (Stelwagen *et al*., 1995). Therefore, tight junction of camel mammary gland may tolerate increasing milking interval up to 24 h.

Effect of milking interval on milk composition:

Effect of short-term milking interval on milk composition of she-camel is shown in Table (2). The effect of milking interval was significant only on percentage of fat, protein and total solids (TS). Increasing milking interval significantly (P<0.05) decrease percentage of fat and increased protein content. The significant (P<0.05) decrease in fat content continued by increasing milking interval from 4 to 8 and 12 h and then up to 24 h.

Table (2): Short-term effects of milking interval on milk composition of she-camels.

Item	Milking interval (h)						SEM
	4	8	12	16	20	24	
Milk content (%):							
Fat	5.72^{a}	4.26^{b}	3.64^{cd}	3.99^{bc}	3.58^{cd}	3.04^{d}	0.204
Protein	1.81^{b}	2.01^{ab}	1.62^{b}	1.91^{ab}	1.77^{b}	2.21^{a}	0.124
Lactose	3.05	3.63	3.30	3.94	3.51	3.62	0.272
TS	11.6^{a}	9.90^{ab}	8.56^{b}	9.84^{ab}	8.86^{b}	8.87^{b}	0.506
SNF	5.88	5.64	4.92	5.85	5.28	5.83	0.386
Somatic cell count (x 10^3/ml)							
SCC	324.8^{ab}	339.25^{a}	191.75^{ab}	121.58^{b}	155.33 ^{ab}	310.42^{ab}	66.22

a, b ….d: Means within the same row with different superscripts are significantly different at P<0.05).

The observed reduction in fat content was almost attributed to increasing milk yield as affected by milking interval. This indicated a negative correlation between milk yield and milk fat percentage of she-camel, as it well known in other animals. The present results indicated pronounced decrease in fat and increase in protein contents by increasing milking interval.

However, the significant increase in protein content was found by increasing milking interval from 4 to 24 h. The significant decrease in fat content was associated with significant (P<0.05) reduction in TS content, especially by increasing milking interval from 4 to 20 h. On the other hand, lactose and solids not fat contents were not affected significantly by milking interval (Table 2).

In accordance with the present results, milk fat content was the most markedly affected component by increasing milking interval of dairy ewes (Castillo *et al*., 2008). They found that fat content decreased (*P*<0.05) with longer milking intervals. Similar observations were previously observed by

McKusick *et al*. (2002) in a short-term experiment done in dairy ewes. Changes in fat content according to milking interval are related to the regulatory mechanisms for secretion of large and high-viscosity milk fat globules relative to the components in the aqueous phase of milk (Davis *et al*., 1999). The recorded significant increase in milk protein content with increasing milking interval between 20 and 24 h was a consequence of the decrease observed in milk protein content for the last 8- to 20-h milking interval, which agreed with the increase in milk protein content in dairy ewes for the 24-h milking interval reported by McKusick *et al*. (2002) and contrasted that reported by Castillo *et al*. (2008). Casein does not move through leaky mammary tight junction and increased slightly as milk secretion progressed by effect of a concentration process. On the other hand, the recorded insignificant effect of milking interval on lactose content disagreed with the results of several authors, who found that lactose content dramatically changed and was lowest ($P<0.05$) at the 24-h milking interval in Manchega ewes (Castillo *et al*., 2008), Awassi and Merino ewes (Nudda *et al*., 2002), in which a decrease in lactose content was observed in animals exposed to once-daily milking for a short period.

Effect of milking interval on somatic cell count (SCC):

Effect of short-term milking interval on SCC in milk of she-camel was significant only by increasing milking interval from 8 to 16 h, showing the minimum count with 16 h milking interval. However, the maximum count was recorded for 8 h milking interval (Fig. 4).

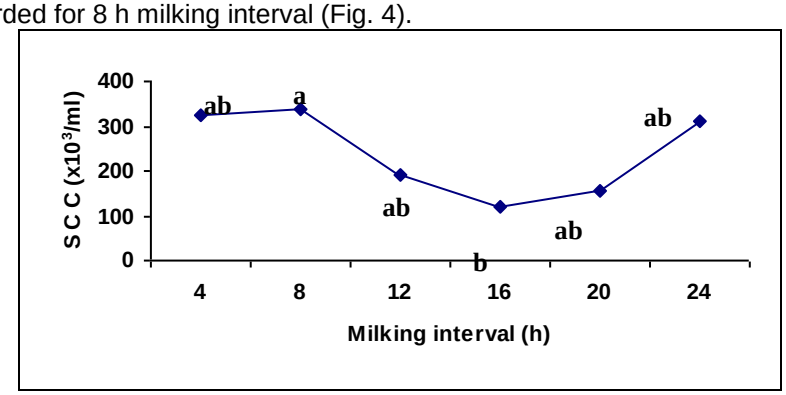

Fig. (4): Somatic cell count obtained in milk of she-camel at 4, 8, 12, 16, 20, and 24 h after the last milking.

The observed reduction in fat content was almost attributed to increasing milk yield as affected by milking interval. This indicated a negative correlation between milk yield and milk fat percentage of she-camel, as it well known in other animals.

The present results indicated pronounced decrease in fat and increase in protein contents by increasing milking interval.

It of interest to note that the marked reduction in milk SCC at milking intervals from 8-20, showing a very low level of SCC may indicate that camel udders were healthy and were not affected negatively by different milking intervals in a short period. Similar findings were reported by Castillo et al. (2008) on dairy ewes. Nevertheless, the highest milk SCC values observed at

8-h milking interval at 8 to 12 h, probably due to a concentration effect as reported by several authors on dairy ewes (McKusick et al., 2002 and Castillo et al., 2008), dairy goats (Salama et al., 2003), where milk obtained at short milking intervals had slightly greater SCC values.

Conclusion

Camels were able to tolerate extended milking intervals during short-term experiment, maintaining linear increases of milk production up to 24 h of udder filling with no negative effects on udder health. However, milk secretion rate and milk composition varied in extended milking intervals, especially in the case of milk fat and milk protein. Based on the foregoing results, the current study can suggest two daily milking of she-camel.

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تأثير فترات الحليب علي معدل إفراز و تركيب لبن النوق

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**** معهد بحوث الإنتاج الحيواني – مركز البحوث الزراعية – وزارة الزراعة**

أجري هذا البحث لدراسة تأثير فترات الحليب على إنتاج وتركيب لبن النوق لتحديد العدد المناسب لمرات الحليب اليومي للنوق . واستخدم في هذه الدراسة عدد(١٢) ناقة متعددة مواسم الولادات (تتراوح من ٣-٦مواسم) وذات أعمار من ٨-١٣ سنة وفي مرحلة حليب من ١-٤ شهور بعد الولادة.

كانت النوق تغذى يوميا على دريس برسيم بواقع ٣ كجم بالإضافة إلى مخلوط علف مركز يحتوي على ١٦ % بروتين خام بواقع ٥ كجم لكل ناقة على أساس المادة الجافة . استخدم نظام لفترات الحليب تضمن عدد ٦ مرات (٤-٨-١٢-١٦-٢٠-٢٤ ساعة) ونظمت عمليات الحليب لكل مكررة لتلافي التأثيرات المحتملة بين فترات الحليب. حددت بداية التجربة بعد اكتمال تفريغ الضرع عن طريق المساعدة بحقن ١٠ وحدة دولية من هرمون الأوكسيتوسين لكل ناقة عند كل حلبة وتم تسجيل إنتاج اللبن وأخذ عينات لبن من كل ناقة لتقدير تركيب اللبن وعدد الخلايا الجسدية .

وكان من أهم النتائج المتحصل عليها أنه ازداد متوسط إنتاج اللبن معنويا زيادة تدريجية مع زيادة فترات الحليب وكانت هذه الزيادة(٤٠-٧٩-١٢٦-١٥٣-١٨٤%) مع زيادة فترات الحليب من (٤-٨-١٢-١٦-٢٠-٢٤ساعة) . كما أن معدل إفراز اللبن خلال فترات الحليب أوضح انخفاضاً تدريجياً مع زيادة فترات الحليب على مستوى معنوية ٥% وبلغ أعلى معدل له (٤٣٦,٥جرام /ساعة)عند فترة حليب ٤ ساعة وأقل معدل (٢٠٦,٩ جرام /ساعة) عند فترة حليب ٢٤ ساعة حيث تم حساب معدل إفراز اللبن بين فترات الحليب ٤-٨-١٢-١٦-٢٠-٢٤ ساعة . وأوضحت النتائج عدم وجود اختلافات معنوية في معدل إفراز اللبن والذي بلغ ١٦١جرام /ساعة بين ٤-٢٤ ساعة و ١٨٣,٣ جرام /ساعة بين ٤-١٦ ساعة. كان تأثير فترات الحليب معنوياً فقط على نسبة الدهن والبروتين والمواد الصلبة الكلية بزيادة فترات الحليب حيث حدث انخفاضاً في نسبة الدهن وزيادة في نسبة البروتين عند مستوى معنوية ٥%. إستمر الانخفاض في نسبة الدهن عند مستوى معنوية ٥% بزيادة فترات الحليب من ٤الى ٨-١٢ وحتى ٢٤ ساعة . كما أن زيادة البروتين كانت واضحة مع زيادة فترات الحليب من ٤-٢٤ ساعة. كان الانخفاض المعنوي في نسبة الدهن مرتبطاً بانخفاض في نسبة المواد الصلبة الكلية عند مستوى معنوية ٥% وخصوصا بزيادة فترات الحليب من ٤-٢٠ ساعة. بينما لم تتأثر نسبة اللاكتوز والمواد الصلبة اللادهنية معنويا بفترات الحليب. انخفض عدد الخلايا الجسدية في لبن النوق معنويا فقط بزيادة فترات الحليب من ٨-١٦ ساعة حيث أوضحت النتائج أن أقل عدد للخلايا الجسدية في اللبن كان عند فترة حليب ١٦ ساعة كما أوضحت النتائج أن أعلى عدد للخلايا الجسدية في اللبن سجل عند فترة حليب ٨ ساعات.

النتائج الحالية أظهرت أنه بزيادة فترة الحليب من ٤-٨ ساعة أدت إلى الحصول على أعلى إنتاج في الجمال. ومن هذه الدراسة يمكن التوصية بحلب النوق مرتين يوميا.