



# Effect of Parity on Fatty Acids of Saudi Camels Milk and Colostrum

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**Abstract** – Fourteen Saudi she-camels were machine milked twice daily and fatty acids of colostrum (1-7 days post partum) and milk (10-150 days post partum) were analyzed. Short chain fatty acids were found in small percentage in colostrums and milk at different parities without insignificant differences and the C4:0 and C6:0 don't appear in the analysis. Colostrums has higher unsaturated fatty acids percentage than that of saturated fatty acids while the opposite was found in milk of camels. Myristic acid (C14:0), palmitic (C16:0), stearic (C18:0) and oleic (C18:1) showed the highest percentage in either colostrums or milk of she-camels. Parity had significant effect on atherogenicity index (AI) which is considered an important factor associated the healthy quality of camel milk. Conjugated linoleic acids (CLA) was recorded the highest percent in the second and third parity in milk and colostrums. Stage of lactation had significant effect on fatty acids profile except the short chain fatty acids. The percentage of unsaturated fatty acids decreased as stage of lactation advanced while the saturated fatty acids increased in older camels. The results indicate that camel milk has an important role in human nutrition in the hot regions and arid countries it contains high percentage of unsaturated fatty acids which is required to reduce the risk of coronary heart disease.

**Keywords** – Camel Milk, Conjugated linoleic acids CLA, Colostrum, Fatty Acid Profile.

## I. INTRODUCTION

Camels are considered the most important livestock in arid and semi-arid regions and play an important role in the life of rural population in these areas and survive under harsh conditions. In Saudi Arabia, there are about 270 thousand heads of Arabian camel (*Camelus dromedaries*) and can produce around 105852 tons of milk and 42460 tons of meat [1]. Saudi Arabia is rated as the fifth highest producer of camel milk in the world.

Camel milk is considered an important source of proteins, energy and vitamins for the people living in the arid and semi-arid lands of the world who consumed significant amounts of camel milk as fresh [2]. Many people prefer camel milk to other types of milks because they believe that it is complete food source for the human body besides its medicinal benefits [3] and [4]. Compared to cow milk, camel milk fat contains less amounts of short-chain fatty acids and saturated fatty acids [5] & [6] and high unsaturated fatty acids [7]. Nowadays, knowledge showed the risk factor for cardiovascular disease from consuming fatty milk, where the fatty acid composition is considered an important factor affecting health [8].

There is a great deal of interest in fatty acids composition in camel milk under different productive systems, different

locations and different feeding regimes, but there is a scare on the effect of parity of lactating camels on the fatty acids. Therefore, the objective of this experiment was to study the changes in the fatty acids profile of colostrums and milk of she-camel during the first three parities.

## II. MATERIALS AND METHODS

### A. Animals and Management

The present study was carried out on fourteen Saudi she camels raised at the experimental Farm, College of Agriculture and Veterinary Medicine, Qassim University. Machine milking was performed for lactating camels twice daily. Animals were grazed for 2-3 hours a day and they were fed *ad libitum* available berseem or 2 kg hay and 3 kg concentrate mixture (16 % CP) besides 2 kg barely. Water was offered to animals at all day times. All animals were healthy.

### B. Milk samples

Milk samples were taken from fourteen lactating she-camels in different parity numbers (1-3) between 0-7 day (colostrum) and 10-150 days post partum. The samples of milk were collected in the morning in polyethylene bottles (350 ml from each lactating camels). Samples were frozen and stored at - 20°C up to analyses.

### C. Milk fatty Acids Analysis

Fatty acids (FAs) composition of milk fat was determined using gas chromatography (apparatus: Chimadzu 2010) as described by [9]. The FAs (g/100 g) were grouped as saturated fatty acid (SFA), unsaturated fatty acid (UFA), monounsaturated fatty acid (MUFA), polyunsaturated fatty acid (PUFA), short chain fatty acid (SCFA), medium chain fatty acid (MCFA) and long chain fatty acid (LCFA).

### D. The index of Atherogenicity (IA)

The IA is an indicator of fatty acids risk on health. The index of atherogenicity (IA) was calculated as reported by [10] and [11] as:

$$IA = aS12 + bS14 + cS16 / dP + eM + fM''$$

where: S12 = C12:0, S14 = C14:0 and S16 = C16:0; P = sum of ω6 and ω3 PUFA; M = oleic acid and M'' = sum of other MUFA. a–f are empirical constants: b = 4 and a, c, d, e and f are equal to 1.

Iso fatty acids were not included in the last equation. Thus, the final calculation of the IA of the she camel milk and colostrum was as follows:

$$IA = \frac{C12:0 + (4 * C14:0) + C16:0}{C10:1 + C14:1 + C16:1 + C17:1 + C18:1 + C18:2 + C18:3}$$



### E. Statistical Analysis

Data were analyzed using proc GLM according to [12]. The model included parity as fixed effect, was as follows:

$$Y_{ij} = \mu + P_i + e_{ij} \text{ where:}$$

$Y_{ij}$  = an observation taken on the  $j^{\text{th}}$  sample

$\mu$  = overall mean

$P_i$  = a fixed effect of the  $i^{\text{th}}$  parity ( $i=1$  to 3)

$e_{ij}$  = Random error assumed to be independent by and normally distributed with mean = 0 and variance =  $\sigma^2$

Duncan multiple range test was conducted to determine differences among means, using 5% significant level.

## III. RESULTS AND DISCUSSION

### A. Fatty Acids Concentration in Colostrums

The mean fatty acids of colostrum of lactating camels among different parities is presented in Table 1. It is clear to note that C4:0 or C6:0 don't appear in the analysis of colostrums. Short chain fatty acids (C8:0) constituted a very small amount and averaged 0.080 in the first parity, 0.082 in the second parity and 0.096 in the third parity without any significant difference. It is worthy to note that the highest values were recorded for C18:1, C16:0, C18:0, C16:1, C14:0 and C17:1. Reference [13] found that colostrum had low amount of short chain fatty acids (C4-C8) and added that colostrums showed high amount of C18:1 and C16:1. Authors [14] stated that amount of C18:1 and C16:0 recorded the highest value in colostrums.

Parity had highly significant effect on the concentration of C12:0, C13:0, C14:0, C14:1 and C15:0 and significant effect on C16:0 ( $P<0.03$ ). Colostrums has higher unsaturated fatty acids amount than that of saturated fatty acids (50.12, 50.36 & 49.99 vs. 48.98, 49.54 & 49.58 for 1st, 2nd and 3rd parity, respectively).

CLA in colostrums increased as parity of camel increased with insignificant difference. It considered the best nutritional option for newborns for the beneficial properties of CLA [15]. The ratio unsaturated / saturated was 1.024, 1.017, 1.011 in the first three parities, respectively. The present results are higher than that of [13].

Regarding the highest atherogenicity index (AI), the third parity had the highest index in the colostrum of camels ( $P<0.04$ ) while the difference between the value of index in the first and second parity was low and insignificant.

### B. Fatty Acids Concentration in Camel Milk

The results in Table 2 showed that camel milk constituted a very small amount of short chain fatty acids (C8:0) in all parity numbers studied. [16] Stated that short chain fatty acids amounted to 1.12 % in camel milk. Reference [17] reported that short chain fatty acid accounted as 0.1% and added that these fatty acids did not observed in colostrum. Reference [5] reported that short chain fatty acids in camel

milk ranged between 0.49 and 3.91 %. [17] explained disappear short chain or its low percentage to their rapid metabolize by camel tissue before excreting in the milk.

Saturated fatty acids averaged 54.318, 58.898 and 57.621 (g/100 g) in camel milk at the first three parities, Palmitic acid (C16:0) had the highest value in she-camel milk ( $P = 0.008$ ) and its value increased as parity number increased. The Stearic acid (C18:0) and myristic acid (C14:0) had the second high values and the camel in the second parity gave significantly higher mean than that milked at the first or third parity. The present results are in agreement with results of [18], [13] and [14], who illustrated that C14:0, C16:0 and C18:0 are considered the major components of total fatty acids. The increase of those saturated fatty acids can attributed to activity and fermentation in rumen. [19] On Najdi ewes, pointed out that Palmitic, stearic and palmitic acids had the highest percentages of milk total fatty acids.

The unsaturated fatty acid in milk varied by parity ( $P<0.04$ ), oleic acid (C18:1) were present in higher concentration followed by Palmitoleic acid (C16:1). These two acids were higher in milk of camels in first parity and decline in the second parity and increased at the third parity. [13] and [20] reported that the C18:1 and C16:1 represented the major unsaturated fatty acids of camel milk. Our results are higher than that of [7] who found that unsaturated fatty acid averaged 33.81 %. The authors [5] pointed out the importance of camel milk in nutrition of human because increasing supply of these unsaturated fatty acids is required to reduce the risk of coronary heart disease.

Results of [21] reported that the high percentage of C18:0 and C18:1 is reflected changes in the energy balance of the camels during lactation. Negative energy balance was found in the first months of lactation, therefore animals used non-esterified fatty acids stored in adipose tissues which were very rich in C18:0 and C18:1 fatty acids.

Linoleic acid (C18:2 c-9) which called conjugated linoleic acids (CLA) averaged 1.85, 2.21 and 2.06 in milk of lactating camels at the three parities, respectively. Reference [15] reported that the CLA is the most important source in human diets which comes from camels' milk. Reference [22] pointed out the importance of CLA in medical effect. The present results are in the range of results of both [10] on milk of camel from four regions of Kazakhstan and [5] on camel milk collected from different locations in Jordan and our results are high than that of [15].

Results in Table 2 showed that parity had highly significant effect on the ratio of unsaturated to saturated fatty acids in milk of camel and equal 0.82, 0.67 and 0.72 for 1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> parity, respectively. These high ratios support the previous explanation of importance of unsaturated fatty acids in human nutrition. Reference [11]

Table 1. Fatty acid composition (g/100g) of she-camel colostrum.

Fatty acids		Parity			SEM	P-value
Common name	Lipid no.	1	2	3		
Caprylic acid	(C8:0)	0.080	0.082	0.096	0.003	0.086
Capric acid	(C10:0)	0.115	0.127	0.113	0.002	0.061
Undecylic acid	(C11:0)	0.013	0.016	0.012	0.0007	0.072
Lauric acid	(C12:0)	0.653 <sup>b</sup>	0.825 <sup>a</sup>	0.803 <sup>a</sup>	0.022	<0.0001
Tridecylic acid	(C13:0)	0.148 <sup>b</sup>	0.181 <sup>a</sup>	0.198 <sup>a</sup>	0.006	0.003
Myristic acid	(C14:0)	9.913 <sup>c</sup>	10.918 <sup>b</sup>	11.986 <sup>a</sup>	0.261	0.001
Pentadecylic acid	(C15:0)	0.277 <sup>b</sup>	0.533 <sup>a</sup>	0.570 <sup>a</sup>	0.036	<0.0001
Palmitic acid	(C16:0)	23.120 <sup>a</sup>	21.576 <sup>b</sup>	21.256 <sup>b</sup>	0.322	0.031
Stearic acid	(C18:0)	13.961	14.611	13.820	0.296	0.525
Arachidic acid	(C20:0)	0.697	0.674	0.726	0.049	0.927
Meristoleic acid	(C14:1)	1.765 <sup>b</sup>	2.615 <sup>a</sup>	2.748 <sup>a</sup>	0.130	0.0001
Pentadecenoic acid	(C15:1)	0.468	0.287	0.539	0.098	0.584
Palmitoleic acid	(C16:1)	10.175	10.247	10.252	0.266	0.992
Heptadecenoic acid	(C17:1)	3.395	3.425	3.245	0.076	0.656
Oleic acid	(C18:1)	27.290	26.856	25.451	0.337	0.084
Elaidic acid	(C18:1t)	4.133	3.768	4.375	0.124	0.129
Eicosenoic acid	(C20:1)	1.349	1.257	0.991	0.084	0.257
Lenoleic acid	(C18:2c-9)	1.392	1.715	2.203	0.156	0.132
Linolelaidic acid	(C18:2t-11)	0.113	0.131	0.127	0.005	0.295
Linolenic acid	(C18:3)	0.045	0.058	0.058	0.003	0.237
Saturated fatty acids		48.981	49.547	49.581	0.398	0.814
Short		0.080	0.082	0.096	0.003	0.086
Medium		10.844 <sup>c</sup>	12.069 <sup>b</sup>	13.113 <sup>a</sup>	0.278	0.0006
Long		38.057	37.395	36.372	0.445	0.371
Unsaturated fatty acids		50.128	50.364	49.992	0.388	0.934
Mono		48.577	48.458	47.603	0.435	0.681
Poly		1.550	1.905	2.389	0.154	0.106
Unsaturated / saturated		1.024	1.017	1.011	0.015	0.953
AI*		1.440 <sup>b</sup>	1.471 <sup>b</sup>	1.599 <sup>a</sup>	0.026	0.043

\*IA = atherogenicity index

<sup>a,b,c</sup> Means within row with different superscript letters are significantly different.

revealed that the high ratio of unsaturated / saturated in milk had an effect in lowering blood cholesterol level in human.

The means atherogenicity index (IA) were high in this study (1.898, 2.437 and 2.184 in milk of camels in the first three parities, respectively and the differences were highly significant. The present results were higher than that of [11] and lower than that of [10].

### C. Effect of Stage of Lactation on Colostrum and Milk of she-camel

Regarding the effect of stage of lactation on fatty acids, Table 3 showed that short chain did not appear clear trend throughout months of lactation and the changes were small and not significant. Medium chain saturated fatty acids and long chain saturated fatty acid significantly increased as lactation period advanced and reached their peak at the fifth month of lactation. Also, lactation period showed significantly effect on the percentages of unsaturated fatty acids during different stages of lactations. Monounsaturated fatty acids percentage decreased as lactation months advanced while the opposite was found in the case of poly unsaturated fatty acids. In general, saturated fatty acids decreased from 50.161 in colostrums to 45.585 in the first month of lactation, and reached the lowest value in the fifth month (39.030). Results of [23] illustrated that the content of short chain fatty acids in cow's milk was unaffected by

lactation period. The variation in fatty acids concentrations could be due to differences in the stage of lactation [13].

## IV. CONCLUSION

The results of the present study indicated that camel milk could be considered as a good nutritive quality in the arid and semi-arid lands because of its high unsaturated fatty acids percentage and atherogenicity index which lead to decrease the incidence of lipid-related cardiovascular diseases. Milk of camel had high ratio of unsaturated / saturated which had a medical effect. Conjugated linoleic acids (CLA) is high in the present results which considered the most important source in human diets for its healthy effect. In addition, the highest oleic acid concentration in colostrum indicated the calf needs to suckle colostrum or milk that containing high oleic concentration because he can't able to produce it. Therefore it is well known that the best nutritional option for new-borns is their mother's milk because milk consumed by calves is related to get healthy calves with fast growth and reduce mortality to increase income of breeder conjugated linoleic acids (CLA).

Table 2. Fatty acid composition (g/100g) of she-camel milk.

Fatty acids		Parity			SEM	P-value
Common name	Lipid no.	1	2	3		
Caprylic acid	(C8:0)	0.101	0.171	0.109	0.014	0.09
Capric acid	(C10:0)	0.141	0.190	0.185	0.013	0.24
Undecylic acid	(C11:0)	0.022 <sup>a</sup>	0.024 <sup>a</sup>	0.015 <sup>b</sup>	0.001	0.04
Lauric acid	(C12:0)	0.914	1.024	0.844	0.036	0.13
Tridecylic acid	(C13:0)	0.188	0.220	0.209	0.008	0.32
Myristic acid	(C14:0)	12.362 <sup>b</sup>	13.712 <sup>a</sup>	12.095 <sup>b</sup>	0.249	0.005
Pentadecylic acid	(C15:0)	0.669 <sup>a</sup>	0.579 <sup>a</sup>	0.404 <sup>b</sup>	0.037	0.004
Palmitic acid	(C16:0)	25.886 <sup>b</sup>	27.929 <sup>a</sup>	29.137 <sup>a</sup>	0.482	0.008
Stearic acid	(C18:0)	13.156 <sup>b</sup>	14.458 <sup>a</sup>	13.903 <sup>ab</sup>	0.210	0.01
Arachidic acid	(C20:0)	0.878 <sup>a</sup>	0.599 <sup>b</sup>	0.718 <sup>b</sup>	0.039	0.001
Meristoleic acid	(C14:1)	2.089	2.463	2.119	0.140	0.51
Pentadecenoic acid	(C15:1)	0.135 <sup>b</sup>	0.587 <sup>ab</sup>	1.084 <sup>a</sup>	0.130	0.01
Palmitoleic acid	(C16:1)	10.281 <sup>a</sup>	8.780 <sup>b</sup>	8.982 <sup>b</sup>	0.220	0.0007
Heptadecenoic acid	(C17:1)	3.689 <sup>a</sup>	3.628 <sup>ab</sup>	3.273 <sup>b</sup>	0.080	0.07
Oleic acid	(C18:1)	22.274 <sup>a</sup>	17.219 <sup>c</sup>	19.458 <sup>b</sup>	0.613	<0.0001
Elaidic acid	(C18:1t)	2.356 <sup>b</sup>	3.858 <sup>a</sup>	3.923 <sup>a</sup>	0.257	0.004
Eicosenoic acid	(C20:1)	1.759 <sup>a</sup>	0.901 <sup>c</sup>	1.185 <sup>b</sup>	0.109	<0.0001
Lenoleic acid	(C18:2c-9)	1.856	2.210	2.064	0.174	0.72
Linolelaidic acid	(C18:2t-11)	0.134 <sup>a</sup>	0.105 <sup>b</sup>	0.110 <sup>b</sup>	0.004	0.0001
Linolenic acid	(C18:3)	0.037 <sup>b</sup>	0.059 <sup>a</sup>	0.065 <sup>a</sup>	0.004	0.001
Saturated fatty acids		54.318 <sup>b</sup>	58.898 <sup>a</sup>	57.621 <sup>a</sup>	0.707	0.005
Short		0.101	0.170	0.109	0.014	0.094
Medium		13.627 <sup>b</sup>	15.160 <sup>a</sup>	13.349 <sup>b</sup>	0.286	0.006
Long		40.589 <sup>b</sup>	43.566 <sup>a</sup>	44.162 <sup>a</sup>	0.617	0.022
Unsaturated fatty acids		44.613 <sup>a</sup>	39.812 <sup>b</sup>	41.724 <sup>b</sup>	0.716	0.004
Mono		42.584 <sup>a</sup>	37.434 <sup>c</sup>	39.485 <sup>b</sup>	0.694	0.0004
Poly		2.028	2.375	2.240	0.172	0.726
Unsaturated / saturated		0.823 <sup>a</sup>	0.676 <sup>b</sup>	0.726 <sup>b</sup>	0.022	0.005
AI*		1.898 <sup>c</sup>	2.437 <sup>a</sup>	2.184 <sup>b</sup>	0.070	<0.0001

\*IA = atherogenicity index

<sup>a,b,c</sup> Means within row with different superscript letters are significantly different.

Table 3. Least square means of fatty acids in colostrum and milk as affected by stage of lactation of lactating she-camel.

Stage of lactation	Saturated fatty acids SFA				Unsaturated fatty acid USFA		
	Short	Medium	Long	Total	Mono	Poly	Total
Colostrums	0.085	12.009 <sup>b</sup>	37.274 <sup>b</sup>	49.368 <sup>c</sup>	48.213 <sup>a</sup>	1.948 <sup>ab</sup>	50.161 <sup>a</sup>
First month	0.111	12.944 <sup>ab</sup>	40.319 <sup>b</sup>	53.374 <sup>b</sup>	44.511 <sup>b</sup>	1.074 <sup>b</sup>	45.585 <sup>ab</sup>
Second month	0.127	13.315 <sup>ab</sup>	42.659 <sup>ab</sup>	56.101 <sup>ab</sup>	41.424 <sup>bc</sup>	1.286 <sup>b</sup>	42.710 <sup>b</sup>
Third month	0.116	14.501 <sup>a</sup>	42.610 <sup>ab</sup>	57.227 <sup>a</sup>	39.237 <sup>c</sup>	2.923 <sup>a</sup>	42.160 <sup>b</sup>
Fourth month	0.131	14.708 <sup>a</sup>	43.291 <sup>a</sup>	58.130 <sup>a</sup>	37.995 <sup>c</sup>	2.766 <sup>a</sup>	40.761 <sup>b</sup>
Fifth month	0.150	14.760 <sup>a</sup>	44.981 <sup>a</sup>	59.891 <sup>a</sup>	36.005 <sup>c</sup>	3.025 <sup>a</sup>	39.030 <sup>c</sup>
SEM	0.018	0.221	0.522	0.564	0.854	0.119	0.845
P-value	0.071	0.045	0.023	0.001	0.008	0.042	0.009

<sup>a,b,c</sup> Means within column with different superscript letters are significantly different.

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