RUMINAL FERMINTATION, MILK PRODUCTION, MILK COMPOSITION AND REPRODUCTIVE PERFORMANCE OF FRIESIAN DAIRY COWS SUPPLEMENTED WITH SAFFLOWER OR SUNFLOWER SEEDS

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SUMMARY

A lactation study was conducted to assess productive and reproductive performance of Friesian dairy cows supplemented with raw safflower (R-SAF) or sunflower seeds (R-SUN) and identify its impact on ruminal fermentation, lactational performance, milk fatty acid (FA) profiles and reproductive performance. Fifteen primiparous and multiparous Friesian dairy cows were grouped according to predicted calving date, parity, body weight and previous milk yield for multiparous cows. Cows were randomly assigned equally to one of three treatments: (a) control, (b) R-SAF or (c) R-SUN for 90 days (treatment period, TP). The TP started at approximately 30 ± 5 days prior to their expected calving date and continued until 60 days after calving. Supplemental seeds were added at 3.36% and 3% of dietary DM during prepartum and postpartum periods, respectively. Feed intake was nearly similar among treatments in late gestation or early lactating periods. Digestibility of all nutrients of rations containing R-SAF or R-SUN were significantly ($P<0.05$) increased compared to control. The pH value and NH_3-N concentration were significantly ($P<0.05$) decreased, while total volatile fatty acids (TVFA´s) concentration was increased significantly ($P<0.05$) with R-SAF or R-SUN groups compared to control. Serum total protein, albumin and Urea-N concentrations were increased significantly ($P<0.05$) by supplementation of safflower or sunflower seeds to the lactating cow's ration (R-SAF or R-SUN) compared to control. Globulin concentration was not affected by the fat supplementation. The AST and ALT activities were not affected significantly by the use of R-SAF or R-SUN rations compared to control. Feed conversion as DM, TDN and DCP/kg FCM improved of lactating cows fed R-SAF or R-SUN rations compared to control. Milk yield and its composition of lactating cows fed R-SAF or R-SUN rations were significantly ($P<0.05$) increased compared to control. Palmitic acid (C16:0) concentration in the milk fat was elevated by feeding the R-SAF or R-SUN rations compared to control. The same trend of C16:0 was obtained with C18:0, C18:1 ω 5, 7, 9, C18:2 ω 6, C20:0 and C20:4. Superior the reproductive performance of cows fed rations supplemented with R-SAF or R-SUN compared to non-treated ones. In conclusion, supplementing rations of Friesian dairy cows with R-SAF or R-SUN at 3% of dietary DM can be an effective strategy of fat supplementation to lactating dairy cows with positive effects on lactational performance, milk FA profiles and reproductive performance. In addition, functional quality of milk was enhanced by increased conjugated linoleic acid (CLA) concentration and additional benefit to human health.

***Keywords**: Friesian cows, safflower, sunflower, milk production and reproductive performance.*

INTRODUCTION

The transition period, is defined as starting from the last 3 weeks before birth to 3 weeks after calving in dairy cows. This period is considered one of the most important periods of the production cycle in dairy cows, also considered very dangerous to cow production because of the metabolic changes in the transition from pregnancy to lactation (Amirifard *et al.,* 2016). It is characterized by a reduction in feed intake and a negative energy balance once the lactation starts (Silvestre *et al.,* 2011), and inadequate innate immunity that increases the risk of uterine diseases (Hammon *et al.,* 2006). These changes are generally associated with an

increased risk of metabolic- and production-related diseases (Friggens *et al*., 2004). Therefore, to improve transition success, it has been suggested that we should increase the nutrient intake (Grummer *et al*., 2004) or net energy density of lactation diets to support lactating cows (Eastridge, 2006).

Dietary supplementation with fat, such as oilseeds, may be an appropriate way to meet the nutritional needs of growth, lactation, and postpartum reproduction in dairy cows (Bottger *et al*. 2002), by increasing the energy status of the animal or by other processes independent of energy intake (Mattos *et al*. 2000).

Supplementation with raw safflower seeds (R-SAF) high in either linoleate or oleate increased subsequent conception rates in primiparous beef cows (Lammoglia *et al.*, 1997). However, feed supplements containing fat derived from different sources alter duodenal flow of unsaturated fatty acids (Scholliegeredes *et al*., 2001) and plasma fatty acid composition (Whitney *et al*., 2000), which appears to result in varied metabolic and reproductive responses (De Fries *et al*., 1998). The high oil concentration of R-SAF makes it an attractive energy-dense feed for animals with high energy requirements, such as lactating dairy cattle (Dschaak *et al*., 2011). Alizadeh *et al*. (2010) reported that R-SAF can be included up to 5% of dietary DM alongside cotton seed for early lactating cows without affecting feed intake while maintaining normal ruminal fermentation, peripheral energy supply, and milk production. In addition, the benefits on nutrient utilization, feeding R-SAF enhanced functional quality of milk with increased cis-9, trans-11 conjugated linoleic acid concentrations, which is an additional benefit to human health (Dschaak *et al*., 2010).

Raw sunflower seeds (R-SUN) have several characteristics of a desirable supplement for range beef cows; these include a high lipid concentration, a moderate concentration of protein, and excellent storage and handling characteristics (Mohsen *et al*., 2011). Supplementation of beef cattle with sunflower seeds or feeding diets containing R-SUN has variable effects on body weight and reproduction (Funston *et al.*, 2002). The R-SUN would be a good choice from a consumer's point of view, as it is rich in polyunsaturated fatty acids and a source of linoleic acid (66 % of total fatty acids) which is omega 6 fatty acid (Petit, 2003). The R-SUN including lipid in the diet may increase milk yield, but it has negative effects on the concentration or yield of fat, protein and lactose in milk (Boila *et al*., 1993).

Therefore, the objective of this study was to determine the effect of supplemented rations with 3% of raw safflower (R-SAF) or raw sunflower seeds (R-SUN) during and after transition period on nutrients digestibility, rumen parameters, blood metabolites, productive and reproductive performance of lactating Friesian cows.

MATERIALS AND METHODS

The present study was carried out at El Karada experimental station, Kafr El-Sheikh governorate, which belongs to the Animal Production Research Institute (APRI), Ministry of Agriculture. The chemical analyses were carried out at the Regional Center for Food and Feed (RCFF), Agriculture Research Center, Giza, Egypt.

Experimental animals and diets:

Periparturient, primiparous (n = 6) and multiparous Friesian cows (n = 9) were classified into three groups (5 in each) by predicted calving date, parity (primiparous or multiparous), body weight (500 ± 12.5 kg) and milk production of the previous year for multiparous cows. Cows were randomly assigned to three treatments at approximately 30 ± 5 days prior to their expected calving date.

Cows were housed under sheds in semi-open backyards and fed the experimental dry cow's diets and fed lactating cows diets from calving until 60 days after calving. Three diets were prepared and fed individually as a total mixed ration (TMR). Experimental rations were offered in two equal parts daily at 8 a.m. and 4 p.m. Individual dry matter intake (DMI) was measured daily. Cows were fed to cover the requirement of dry matter (DM) and total digestible nutrients (TDN) according to NRC (2001) and the rations were adjusted biweekly. The first group (control group) was received diet containing no supplementary oilseeds, the 2nd group was received a diet containing raw safflower seeds (R-SAF) and the 3rd group received a diet containing raw sunflower seeds (R-SUN). Supplemental seeds were added at 3.36% and 3% of dietary DM during prepartum and postpartum periods, respectively. Chemical composition and fatty acid profile of safflower and sunflower seeds were shown in Table (1). Ingredients, chemical composition and of major

fatty acids (FAs) profile of total mixed rations for the three treatments during the prepartum and postpartum periods were shown in Table (2). Animals were free for watering all the day round.

Digestibility trial:

Nutrient digestibility of the tested rations was determined by choosing three lactating cows randomly from each group, using acid insoluble ash (AIA) technique according to Van Keulen and Young (1977). Feeds and feces samples were collected for three successive days every month for two months from each animal. Feed and feces samples were analyzed according to A.O.A.C. (2002) procedures.

Table (1): Chemical composition and fatty acid profile of the experimental seeds (on DM basis).

Item	Safflower seeds	Sunflower seeds
Chemical composition (%):		
DM	94.20	95.00
OM	96.50	97.30
CP	19.20	17.40
CF	30.34	28.32
EE	29.35	29.85
NFE	17.61	21.73
Fatty acids profile (%):		
Myristic acid (C14:0)	0.21	7.56
Cis – 10- penta decenoic acid (C15:1ω6)	0.22	0.35
Palmitic acid (C16:0)	7.28	25.86
9- hexa decenoic acid (C16:1 ω7)	0.21	1.24
Stearic acid (C18:0)	2.18	12.2
Oleic acid (C18:1 ω9)	15.25	32.6
Vaccinic acid (C18:1 ω7)	1.43	3.2
Linoleic acid (C18:2 ω6)	67.48	13.62
Arachidic acid (C20:0)	0.34	0.25
Eicosaenoic acid (C20:1 ω11)	0.17	0.25
Eicosatrienoic acid (C20:4 ω3)	0.78	0.63
Eicosapentaenoic acid (C20:5 ω3)	0.80	0.47
Behenic acid (C22:0)	0.71	0.49
Docosenoic acid (C22:1 ω11)	1.41	0.46
Erucic acid (C22:1 ω9)	1.53	0.82

Analysis performed on one composite sample for the study.

Ruminal fluid sampling:

Ruminal fluid was sampled on the last day of experimental period, rumen liquor samples were taken from cows at 0, 3 and 6 h after the morning feeding using a stomach tube attached to an automatic suction machine. The first 100 ml of fluid was discarded to minimize saliva contamination. The second portion was strained through four layers of cheese cloth for each sampling time to get clear liquid. The pH was measured immediately using a mobile pH meter (Orian 680 digital), and 10 ml of the fluid was preserved with 1 ml of 5% sulfuric acid and frozen at - 20 ºC. Ammonia nitrogen (NH_3 - N), was determined using magnesium oxide (MgO), as described by Al-Rabbat *et al*. (1971). Total volatile fatty acids (TVFA'S) concentrations were estimated using steam distillation methods (Warner, 1964).

Blood collection and determination of blood metabolites:

Blood samples were collected biweekly from jugular vein of all cows for each group at zero time before morning feeding. The blood serum was obtained by centrifuging the blood samples soon after collection at 600 *g* for 15 minutes and the obtained clear serum was transferred into a clean dried glass vials, then stored in deep freezer at – 20 °C, for subsequent specific chemical analysis. Total serum protein was estimated according to Biuret-taratrate method described by Henery (1974), while albumin was performed according to Doumas *et al.* (1971). Serum globulin level was obtained by subtracting albumin from total protein. Triglyceride was determined according to Greiling and Gessner (1995). Cholesterol was determined

according to Rolschlau (1974). Blood urea nitrogen was determined according to Fawcett and Scott (1960). Aspartate aminotransferase (AST) and Alanine aminotransferase (ALT) were determined according to Reitman and Frankel (1957).

Table (2): Ingredients, chemical composition and major fatty acids profile of the experimental rations (on DM basis)

Item	Late gestation			Early lactation		
	Control[1]	R-SAF[2]	R-SUN[3]	Control[1]	R-SAF[2]	R-SUN[3]
Ingredients (%):						
Cotton seed meal	18.24	17.95	17.95	13.3	13.09	13.09
Yellow corn	15.36	12.29	12.29	11.2	8.41	8.41
Wheat bran	11.52	11.52	11.52	8.4	8.4	8.40
Safflower seed	-	3.36	-	-	3.00	-
Sunflower seed	-	-	3.36	-	-	3.00
Molasses	1.44	1.44	1.44	1.05	1.05	1.05
Limestone	0.96	0.96	0.96	0.70	0.70	0.70
Salt	0.48	0.48	0.48	0.35	0.35	0.35
Berseem	33.00	34.00	34.00	53.00	53.00	53.00
Rice straw	19.00	18.00	18.00	12.00	12.00	12.00
Calculated chemical composition (%):						
DM	35.03	34.33	34.10	24.68	24.42	24.30
OM	91.45	91.41	91.45	90.77	90.75	90.78
CP	12.05	12.46	12.42	12.14	12.55	12.53
CF	25.78	26.61	26.53	27.96	28.68	28.58
EE	1.71	2.57	2.59	1.55	2.35	2.36
NFE	51.91	49.77	49.91	49.12	47.17	47.31
ADF	25.98	26.75	26.97	28.26	28.70	28.80
NDF	37.99	38.96	39.24	39.29	39.84	39.96
TDN	60.05	60.45	60.71	60.03	60.45	60.75
Major fatty acids profile (%):						
Palmitic acid (C16:0)	12.2	16.08	17.66	12.2	16.17	17.40
Palmitoleic acid (C16:1 ω 9)	0.10	0.46	0.55	0.10	0.46	0.54
Stearic acid (C18:0)	1.30	3.54	4.35	1.30	3.57	4.20
Oleic acid (C18:1 ω 9)	17.35	24.54	25.93	17.35	24.84	25.91
Linoleic acid (C18:2 ω 6)	26.27	42.97	37.04	26.27	42.52	37.92

[1]Control; cows fed the control ration, [2] R-SAF; Raw safflower seeds ration and [3] R-SUN; Raw sunflower seeds ration.

Milk collection and analysis:

Cows were mechanically milked twice daily at 6 a.m. and 5 p.m. Milk yield was recorded individually at each milking time. Individual milk samples from consecutive a.m. and p.m. milking were collected every two weeks postpartum and composited according to milk weight at each milking time (3 mL/kg milk at each milking time). Milk from individual cows was sampled at each milking in pre-labeled plastic vials and was preserved using potassium dichromate. Milk samples were analyzed for fat, protein, lactose, solids not fat (SNF), and total solids (TS) by Milk-O-Scan (model 133B). Another aliquot of the milk samples was frozen at -20°C for fatty acids (FA) determination. Weighted composite milk samples from a.m. and p.m. milking at day 60 postpartum were analyzed for fatty acid (FA) composition using gas-liquid chromatography according to Kramer *et al.* (1997). Fat-corrected milk (FCM; 4%) was calculated according to Gaines (1923) by using the following equation:

FCM in kg (4% fat) = 0.4 (kg milk yield) + 15 (kg fat yield).

Feed conversion:

Feed conversion ratio was determined as the amounts of DM, TDN and DCP required for producing 1 kg 4% FCM.

Reproductive parameters:

Immediately after parturition, the reproductive tract of each cow was rectally palpated once - two times till 21 days postpartum and once - three times after that to assess the uterine involution according to El-Fadaly (1978). All experimental cows were observed twice daily for estrous activity and cows that detected in heat were inseminated 12 h after estrus detection. Cows were examined for pregnancy by rectal palpation after 45 days of insemination. The interval from parturition to each of: uterine involution period (UIP) and uterine simulation period (USP) were recorded. Also, the period from the last calving to first detected estrus (PFE), number of days from the last calving to date of artificial insemination (AI) in association with confirmed pregnancy (days open) and number of services per conception (NSPC) were recorded. In addition, conception rate, % at first AI: (number of cows pregnant after first AI per number of cows bred for the first time post-calving) and pregnancy rate, %: (number of cows pregnant per total number of cows available within a treatment group) were recorded.

Statistical analyses:

The data obtained were statistically analyzed using SAS computer program (SAS, 2005). The following model was used for analyzing data of all traits using analyses of variance: $Y_{ij} = \mu + T_i + e_{ij}$ where: μ = overall mean, T_i = effect of treatments and e_{ij} = random error. Except rumen activity parameters in which the effect of time of sampling and the interaction between effect of treatment and effect of time of samples, were added to the above mentioned model. The differences among means were tested using Duncan's Multiple Range Test (Duncan, 1955).

RESULTS AND DISCUSSION

Feed intake:

Data presented in Table (3) showed somewhat increase in feed intake as DM, TDN and DCP. However, these increasing in feed intake with groups fed safflower or sunflower seeds were not significant. Feed intake as DM, TDN and DCP was nearly similar among experimental rations, either when supplemented with raw safflower (R-SAF) or sunflower (R-SUN) seeds at 3.36% in late gestation or at 3% of DMI in early lactating periods of Friesian cows. The present results of DMI may be due to the lower proportion of supplemented fat seeds, which is consistent with the results of Dschaak *et al.* (2011) who informed that feed intake did not affect by the addition of 3% DM safflower seeds in the diets of Holstein dairy cows. Also, Alizadeh *et al.* (2010) and Dschaak *et al.* (2010) reported no effects on DMI when safflower seeds were supplemented up to 5% DM. Similarly, with Dai *et al.* (2011) reported that sunflower seed oil supplementation did not affect feed intake of Chinese Holstein dairy cows. Contrary to these findings, supplementing whole sunflower seed at a relatively high concentration (15.0% DM) resulted in decreased DMI in lactating dairy cows (Mansoori *et al.,* 2011), whereas an increase in DMI was observed by Beauchemin *et al.* (2009) when feeding crushed sunflower seed at 10.6% of dry matter intake. Also, Mohsen *et al.* (2011) revealed that the amount of concentrate feed intake was nearly the same for the different groups, while the amounts of fresh berseem and berseem hay intake were increased with increasing level of sunflower seeds supplementation.

Table (3): Daily feed intake (on DM basis) of lactating Friesian cows as affected by the treatments

Item	Late gestation				Early lactation			
	Control[1]	R-SAF[2]	R-SUN[3]	±SE	Control[1]	R-SAF[2]	R-SUN[3]	±SE
Intake (kg/d):								
Total DM	9.61	10.03	10.18	0.28	13.67	14.58	15.05	0.90
TDN	5.77	6.07	6.18	0.18	8.22	8.82	9.15	0.57
CP	1.16	1,25	1.26	0.03	1.66	1.83	1.89	0.12

[1]Control; cows fed the control ration, [2] R-SAF; Raw safflower seeds ration and [3] R-SUN; Raw sunflower seeds ration.

Digestibility coefficients, rumen activity **and blood serum constituents*:***

Data of Table (4) indicated that the digestibility of all nutrients tended to significantly (P<0.05) increased by safflower or sunflower seeds supplementation compared to control except for NFE digestibility with R-SAF diet. Inclusion level of safflower or sunflower seeds (3%) used in the current study, which were rich by Linoleic and Oleic acids (Table 2) improved digestion in rumen. Ivan *et al.* (2004) concluded that the use of Linoleic acid-rich safflower or sunflower-seed supplementation in high-concentrate diets of ruminants reduced rumen protozoa population and increased the rumen microbial synthesis of protein resulting in savings on dietary protein supplements and an increased digestion of feed. In addition, adding fat to diets increases the efficiency of microbial protein synthesis in the rumen, possibly because of the decrease in concentration of protozoa (Oldick and Firkins, 2000). The present results agree with those obtained by Dschaak *et al.* (2010) who reported that total tract digestibilities of DM and OM were increased when cows were fed safflower seeds up to 3.0% of DM compared with those fed the control diet. Also, Mohsen *et al.* (2011) indicated that the digestibility of DM, OM and CP, and the TDN and DCP values were increased by sunflower seeds supplementation at 5%, while EE digestibility was increased significantly (P<0.05) and CF and NFE digestibilities were significantly decreased (P<0.05) with increasing level of sunflower seeds supplementation at 10% of concentrate. Digestibility of CP was decreased and EE digestibility was increased significantly by adding high fat levels in the ration of ruminants that inhibit ruminal fermentation and thus diminish the utilization of dietary fiber (Vafa *et al*., 2009). In addition, Beauchemin *et al.* (2009) indicated that feeding crushed sunflower seed at 10.6% of DM dramatically decreased DM and OM digestibilities. Generally, using low levels of safflower or sunflower seeds in dairy cattle rations tended to increase most of nutrients digestibility.

Results in Table (4) revealed that the pH values and NH_3-N concentrations were decreased significantly (P<0.05), but TVFA´s concentration was increased significantly (P<0.05) with R-SAF or R-SUN groups compared to control post feeding at 3 hr, 6 hr. On the other hand, averages of pH values and NH_3-N concentration appeared to significant decreases, while TVFA´s concentration was increased with treated groups. Decreased pH values with safflower or sunflower seeds supplementation may be association with the increased of fatty acids especially Oleic and Linoleic acids compared to control (Table 2) and for to higher production of VFA´s in the rumen (Table 4). Morsy *et al.* (2015) concluded that pH values were decreased by addition of sunflower seeds oil and whole sunflower seeds related to increased concentrations of TVFA´s in both treatments compared to control goats. Also, Schingoethe *et al.* (1977) indicated that rumen pH was lower in sunflower meal-fed cows compared to the control. Ruminal pH values for all treatments ranged between 6.30 and 6.88, which were within the range considered acceptable for fiber digestion (Ørskov and Ryle, 1990). The incorporation of extra oil seeds in lactating cow's rations may affect rumen fermentation (Polviset *et al*., 2010). Safflower oil caused a log reduction in numbers of protozoa as compared to control (Baaha *et al*., 2007). Similarly, the decrease of NH_3-N concentration of ewes that were fed with supplemental safflower oil was most probably due to the reduction of the protozoal population (Mirzaei *et al*., 2009). The presence results are confirmed by Ivan *et al*. (2003) who found that VFA concentration was increased and Ammonia-N was decreased causing the decrease of pH in the rumen with sunflower seed supplementation. These findings are closely agreeing with those obtained by Mohsen *et al.* (2011) who revealed that value of pH and NH_3-N concentration were decreased significantly (P<0.05), while TVFA´s concentration was increased significantly (P<0.05) with sunflower seeds supplementation for winter and summer rations. In addition, Morsy *et al.* (2015) informed that addition of sunflower seeds oil (SO) decreased ruminal pH, whereas SO and whole sunflower seeds increased TVFA´s concentration compared to the control.

The supplementation of safflower or sunflower seeds to R-SAF or R-SUN rations, respectively increased the serum concentrations of total cholesterol, triglyceride, glucose, total protein, albumin and Urea-N significantly (P<0.05) compared to the control ration, while the globulin, AST and ALT did not alter (Table 4). Obtained results may be related to the chemical composition of the experimental rations (R-SAF and R-SUN) compared to the control (Table 2).

The increase of the serum concentration of triglycerides can be related to the higher digestibility of unsaturated fats than saturated fats (Nik-Khah *et al*., 2001). This finding could also be related to increase to the synthesis of cholesterol and triglycerides in the epithelium of the small intestine and liver cells, and the increase of the absorption of these fats from the small intestine after dietary supplementation of fat (Chichlowski *et al*., 2005). The present results are in agreement with Mirzaei *et al*. (2009) who reported that plasma concentrations of triglycerides and total cholesterol were higher in ewes that consumed the oil-

containing diets than the other groups. Also, Alizadeh *et al.* (2010) indicated that adding safflower seeds linearly increased blood total cholesterol (P<0.01) and low-density lipoproteins (P<0.05) concentrations in early lactating cows.

Table (4): Total tract digestibility, rumen activity and blood serum constituents of lactating Friesian cows as affected by the treatments

Item	Treatment			±SE
	Control[1]	R-SAF[2]	R-SUN[3]	
Digestibility, %:				
DM	63.37^{b}	65.51^{a}	66.48^{a}	0.34
OM	65.95^{b}	67.91^{a}	68.91^{a}	0.32
CP	64.26^{b}	67.23^{a}	67.70^{a}	0.43
CF	67.06^{b}	69.47^{a}	69.71^{a}	0.58
EE	60.45^{b}	69.89^{a}	70.59^{a}	0.59
NFE	65.64^{b}	66.75^{ab}	68.39^{a}	0.55
Rumen activity:				
pH value				
Before morning feeding	7.18	7.23	7.30	0.10
After morning feeding				
3 hr	6.80^{a}	6.55^{b}	6.48^{b}	0.07
6 hr	6.65^{a}	6.35^{b}	6.30^{b}	0.09
Mean	6.88^{a}	6.71^{b}	6.69^{b}	0.06
NH_3-N (mg/100 ml)				
Before morning feeding	10.10	10.63	10.29	0.53
After morning feeding				
3 hr	17.00^{a}	15.50^{b}	15.44^{b}	0.32
6 hr	19.88^{a}	17.98^{b}	17.88^{b}	0.49
Mean	15.66^{a}	14.70^{b}	14.53^{b}	0.29
TVFA´s (meq/100 ml)				
Before morning feeding	8.74	9.46	9.75	0.59
After morning feeding				
3 hr	12.30^{b}	14.72^{a}	14.92^{a}	0.22
6 hr	17.63^{b}	20.60^{a}	21.13^{a}	0.39
Mean	12.89^{b}	14.93^{a}	15.26^{a}	0.18
Blood serum constituents:				
Triglyceride (mg/dl)	33.45^{b}	34.93^{a}	35.02^{a}	0.31
Cholesterol (mg/dl)	92.05^{b}	93.77^{a}	94.00^{a}	0.52
Glucose (mg/dl)	61.47^{b}	63.12^{a}	64.23^{a}	0.51
Total protein (g/dl)	7.46^{b}	7.74^{a}	7.84^{a}	0.08
Albumin (g/dl)	4.02^{b}	4.34^{a}	4.36^{a}	0.08
Globulin (g/dl)	3.44	3.40	3.48	0.05
Urea-N	18.29^{c}	19.78^{b}	22.16^{a}	0.35
AST (u/ml)	62.95	66.91	68.14	3.32
ALT (u/ml)	29.98	31.01	32.03	0.98

a, b and c: Means in the same row with different superscripts differ significantly (P<0.05)
[1]Control; cows fed the control ration, [2] R-SAF; Raw safflower seeds ration and [3] R-SUN; Raw sunflower seeds ration.

Supplementation of safflower or sunflower seeds to the cow's rations significantly (P<0.05) increased serum glucose concentration compared to control one. Increased serum glucose concentration with R-SAF and R-SUN may be due to increase TVFA´s concentration in the rumen of cows (Table 4). Feeding of supplemental fat increases the proportion of propionic acid, one of the major VFA and a precursor for glucose (Howlett *et al*., 2003). Dietary unsaturated fatty acids may modulate the metabolism of dairy cows and hence influence the levels of some blood metabolites like glucose (Adolf *et al*., 2018). Supplementing the diets of dairy cows with conjugated linoleic acids decreased blood non-esterified fatty acid concentration while glucose was increased during the first week of lactation (Odens *et al.*, 2007). The present results are in

accordance with those obtained by Morsy *et al.* (2015) who indicated that addition of sunflower seeds to the goat diets increased serum glucose concentration compared to the control. Similarly, Dafoe *et al.* (2014) reported that safflower seed supplemented diets without vitamin E increased serum glucose concentration of lambs compared to barley-based grain supplement

Serum total protein, albumin and Urea-N concentrations were increased significantly (P<0.05) by supplementation of safflower and sunflower seeds to the lactating cow's ration (R-SAF and R-SUN) compared with control, while globulin concentration was not affected by fat supplementation (Table 4). Increased total protein and Urea-N were associated with increased CP intake (Table 2) and its digestibility (Table 4). Cows fed the seeds-supplemented rations had higher (P < 0.05) concentrations of both urea nitrogen and albumin in serum. A change in nitrogen metabolism, either within the body or within the rumen, was indicated by a difference in serum concentration of urea nitrogen. Lipid released from adipose tissue of ruminants is bound to albumin and transported primarily to liver tissue, where that lipid is utilized (Grummer, 1991). The present results are in agreement with those obtained by Boila *et al*. (1993) who informed that early lactating cows fed the lipid-supplemented sunflower diets had higher (P<0.05) concentrations of plasma urea nitrogen and albumin compared to un-supplemented one.

AST and ALT activities were not affected significantly by the use of R-SAF or R-SUN rations compared to control (Table 4). The values of serum AST and ALT obtained here are within the normal ranges. The AST and ALT activity reflect normal liver function of cows fed the safflower or sunflower seeds supplemented rations. Contrary to these findings Mohsen *et al.* (2011) reported that values of AST and ALT activity were decreased significantly (P<0.05) with sunflower seeds supplementation for winter and summer rations.

Milk production and its composition:

Daily milk and fat corrected milk (FCM) yields of Friesian cows as affected by safflower and sunflower seeds supplementation for 90 days are shown in Table (5). Obtained results of the Table (5) revealed that milk and FCM yields of lactating cows fed R-SAF or R-SUN rations significantly (P<0.05) increased compared to control. These may be attributed to R-SAF or R-SUN rations had greater dietary CP (Table 2). It is apparent that the protein source affected the supply of total available protein and essential amino acids to the small intestine, thus, causing differences in milk yield (Dhiman *et al*., 1999). Also, superior these treatments in digestibility of DM, OM and CP, CF, EE, NFE and rumen TVFA´s concentration led to increased milk yield. Total tract digestibility of DM, OM, NDF, and ADF all showed quadratic responses to increase dietary CP, which ensure a sufficient supply for maximal milk and protein production of dairy cows (Olmos and Broderick, 2006). Safflower and sunflower seeds supplementation improved blood metabolites of glucose, total protein, albumin and Urea-N concentrations compared to control (Table 4), consequently led to increase of milk and FCM yields. These results are agreement with Alizadeh *et al.* (2010) who demonstrated that safflower seeds with fish oil supplementation improved milk yield of Holstein cows. Also, Mohsen *et al.* (2011) reported that total milk yield, price of total milk yield and economic efficiency were increased significantly (P<0.05) with sunflower seeds supplementation for Zaraibi goats. It is of interest that blood serum glucose of the R-SAF and R-SUN groups followed the same trend as their milk yield (Table 5), which may confirm results of Clark et al. (1977) who informed that there is a positive relationship between blood serum glucose and milk yield. Also, serum albumin was higher (P<0.05) in cows that produced more milk and milk protein in response to supplementary lipid (Table 5).

Also, cows fed ration (R-SAF) showed the highest percentages and yield of all milk composition and its yields (kg/d) followed by those fed ration (R-SUN), while those fed control ration had the lowest one. Unsaturated fatty acids (safflower seeds) supplementation may affect the metabolism of dairy cows and enhance the levels milk components like fat, protein, urea nitrogen and lactose (Adolf *et al*., 2018). These results agree with those obtained by Alizadeh *et al.* (2010) who reported that milk fat percentage and yield of Holstein cows increased significantly (P<0.05) with safflower seeds supplementation compared to cows supplemented with fish oil and control. He *et al.* (2005) indicated that increased protein and lactose yields were observed in cows fed safflower seeds diet. In addition, Schroeder *et al.* (2004) found that milk fat concentration was increased by 5.1 % with saturated fat supplementation. Moreover, Junior *et al.* (2010) indicated that the utilization of fat sources in diets changes milk composition of lactating cows.

Feed conversion (Table 5) showed significant differences regarding energy intake, digestible crude protein (TDN & DCP) and DM per kg FCM. Generally, as the safflower or sunflower seeds were included in the ration (R-SAF or R-SUN) the DM, TDN and DCP/kg FCM were reduced (i.e. improved). Such results are in accordance with Hassan *et al.* (2011) who indicated that replacing sunflower cake in goat's diet

showed significantly (P<0.05) improved of feed conversion rate. However, feed efficiency (3.5% FCM yield/DMI) did not differ by adding crushed sunflower seed in lactating dairy cow diets (Beauchemin *et al*., 2009). In contrary, Dschaak *et al.* (2010) reported that efficiency of feed N to milk N was improved in cows fed 1% whole safflower seeds diet, but it tended to decrease when safflower seeds inclusion rate was increased at 3 or 4%.

Table (5): Milk production, milk composition and feed conversion of lactating Friesian cows as affected by the treatments

Item	Treatment			±SE
	Control[1]	R-SAF[2]	R-SUN[3]	
Milk yield (kg/d)	15.19[b]	16.79[a]	17.18[a]	0.31
4% FCM yield (kg/d)	13.14[b]	16.61[a]	16.20[a]	0.29
Milk composition, %:				
Fat	3.10[c]	3.92[a]	3.62[b]	0.03
Protein	3.23[c]	3.53[a]	3.39[b]	0.03
Lactose	4.63[b]	4.79[a]	4.69[ab]	0.04
Total solid	11.65[c]	12.97[a]	12.35[b]	0.10
Milk component yield (kg/d):				
Fat	0.47[c]	0.66[a]	0.62[b]	0.01
Protein	0.49[b]	0.59[a]	0.58[a]	0.01
Lactose	0.70[b]	0.80[a]	0.81[a]	0.02
Total solid	1.77[b]	2.18[a]	2.12[a]	0.04
Feed conversion (Kg/kg):				
DM/ FCM	1.04[a]	0.87[b]	0.93[b]	0.06
TDN/ FCM	0.63[a]	0.54[b]	0.57[b]	0.01
DCP/ FCM	0.13[a]	0.11[b]	0.12[b]	0.002

a, b and c: Means in the same row with different superscripts differ significantly (P<0.05)
[1]Control; cows fed the control ration, [2] R-SAF; Raw safflower seeds ration and [3] R-SUN; Raw sunflower seeds ration.

Fatty acid (FA) Profile in Milk:

Milk FA of lactating cows fed rations supplemented with safflower or sunflower seeds showed that some of fatty acids did not appear in all cows within groups (Table 6). The results showed that short–chain FA (6:0) was decreased with R-SAF or R-SUN rations compared to control. While, the proportion of short- to medium-chain FA (8:0 to 17:0) in milk were not affected by feeding the R-SAF or R-SUN rations compared to control, except for C16:0 as shown in Table (6). Palmitic acid (C16:0) concentration in milk fat was elevated by feeding the R-SAF or R-SUN rations compared to control. The high proportion of C16:0 in milk of the R-SAF and R-SUN groups was associated with increased C16:0 in the R-SAF or R-SUN rations (Table 2). The same trend of C16:0 was obtained with C18:0, C18:1 ω 5, 7, 9, C18:2 ω 6, C20:0 and C20:4 linearly increased with feeding the R-SAF or R-SUN rations compared to control. The obtained results may be related to fatty acids composition of the experimental rations as shown in in Table 2, that R-SAF or R-SUN rations contained higher proportions of these fatty acids than control.

The presence of sufficient amounts of 18-carbon and polyunsaturated fatty acids (PUFA) in the rations of R-SAF or R-SUN have been associated with higher ratios of it in milk fat. The high levels of fat in the R-SAF rations may induce changes in the rumen biohydrogenation (BH) leading to the accumulation of intermediate metabolites of altered ruminal BH (Dschaak *et al.*, 2010). In the present study, inclusion of safflower or sunflower seeds raised levels of C18:1 ω 5, 7, 9, and total 18:2 ω6 FA with linear responses, and other effects were much more pronounced for the R-SAF or R-SUN rations compared to the control ration. Bell *et al.* (2006) reported that addition of safflower oil increased in all 18:1 trans FA isomers in milk with the most pronounced increase in 18:1 trans-11. Typically, unsaturated FA undergoes partial BH in the rumen, resulting in the production of 18:1 trans-10 FA. Because of safflower or sunflower (R-SAF and R-SUN) rations contains 43 and 38 % of linoleic acid, respectively in its lipids compared to 26 % in control (Table 2), and linoleic acid is one of the main substrates for BH (Harfoot and Hazlewood, 1997), an increase in the BH pathway was evidenced with increased total 18:1 FA when R-SAF and R-SUN were supplemented compared to un-supplemented one. Similarly, Dai *et al.* (2011) indicated that supplementing

sunflower oil as a source of linoleic acid was more effective in enhancing contents of total volatile acids and conjugated linoleic acids (CLA) in milk fat than oleic acid.

Table (6): Fatty acids composition (%) in the milk of lactating Friesian cows as affected by the treatments

Fatty acid*			Treatment			
			Control[1]	R-SAF[2]	R-SUN[3]	±SE
C6:0		Caproic acid	0.78[a]	0.71[b]	0.63[c]	0.012
C8:0		Caprlyic acid	0.78	0.70	0.69	0.067
C10:0		Capric acid	1.62	1.65	1.48	0.193
C11:0		Undecanoic acid	0.14[b]	0.21[a]	0.11[c]	0.010
C12:0		Lauric acid	2.10	1.95	2.10	0.180
C14:0		Myristic acid	7.52	7.29	7.23	0.677
C14:1	ω5	Tetradecenoic acid	0.57	0.59	0.65	0.070
C15:0		Pentadecanoic acid	0.33	0.40	0.48	0.113
C16:0		Palmitic acid	23.60[b]	25.26[a]	25.89[a]	0.590
C16:1	ω7		1.05[a]	0.87[b]	0.90[ab]	0.053
C16:1	ω9	Palmitioleic acid	0.38	---	---	
C17:0		Heptadecanoic acid	1.73	1.50	1.45	0.087
C16:2	ω4		---	0.15	---	
C16:3	ω4	Hexadecatrienoic acid	0.33[a]	0.35[a]	0.30[b]	0.010
C18:0		Stearic acid	11.88[b]	14.33[a]	13.15[a]	0.450
C18:1	ω9	Oleic acid	23.73[b]	27.01[a]	26.43[a]	0.773
C18:1	ω7	Vaccinic acid	2.83[b]	3.63[a]	3.09[a]	0.073
C18:1	ω5	Octadecosaenoic acid	0.80[b]	0.91[a]	0.98[a]	0.033
C18:2	ω5		0.28[b]	0.31[ab]	0.35[a]	0.010
C18:2	ω6	Linoleic acid	2.57[c]	7.25[a]	4.51[b]	0.667
C18:2	ω4		0.17	0.17	0.16	0.010
C18:3	ω6	Gamma linolenic	0.13	0.13	0.14	0.002
C18:3	ω4		0.14	0.14	---	0.001
C18:3	ω3	Linolenic acid	0.35[b]	0.60[a]	0.33[b]	0.040
C18:4	ω3	Alpha octadecatetraenoic acid	0.54	0.50	0.57	0.040
C20:0		Arachidic acid	0.24[b]	0.37[a]	0.34[a]	0.020
C20:1	ω11	Eicosaenoic acid	0.14	---	---	
C20:1	ω9	Gadolic acid	0.24[b]	0.36[a]	0.23[b]	0.010
C20:2	ω6		---	0.15	---	
C20:3	ω3	Eicosatrienoic acid	2.95[a]	0.13[b]	0.20[b]	0.730
C20:4	ω6	Arachidonic acid	0.13[b]	1.08[a]	1.22[a]	0.250
C20:4	ω3	Eicosatrienoic acid	2.29[a]	0.20[b]	1.97[a]	0.457
C20:5	ω3 EPA	Eicosapentaenoic acid	2.25[a]	0.49[b]	1.90[a]	0.350
C22:0		Behenic acid	0.14[c]	0.26[b]	0.28[a]	0.002
C22:1	ω11	Docosenoic acid	6.73[a]	---	1.71[b]	0.580
C22:1	ω9	Erucic acid	0.35	---	0.42	0.010
Unidentified			0.19[ab]	0.35[a]	0.11[b]	0.067

a, b and c: Means in the same row with different superscripts differ significantly (P<0.05)
*Fatty acid composition was expressed as g/100 g of fatty acid methyl esters.
[1]*control; cows fed the control ration,* [2] *R-SAF; Raw safflower seeds ration and* [3] *R-SUN; Raw sunflower seeds* ration.

Reproductive performance:

Reproductive performance of experimental lactating cows fed safflower and sunflower seeds are shown in Table (7). The interval from calving to the uterine involution and uterine simulation were significantly (P<0.05) shortest for cows supplemented with safflower seeds (R-SAF) followed by cows supplemented with sunflower seeds (R-SUN), while cows of control were longest ones. Similarly, days open and the

interval between calving to first artificial insemination (AI) were significantly shorter for cows treated with R-SAF or R-SUN. However, the interval between calving to the first detected estrus was 37.00, 52.25 and 44.00 days for control, R-SAF and R-SUN groups, respectively (Table 7 and Figure 1). This interval was significantly longer for cows treated with R-SAF than for control cows. No significant differences were detected, either between R-SAF and R-SUN or between R-SUN and control groups. Conception rate following the first postpartum AI was 0%, 75% and 50% in control, R-SAF and R-SUN groups, respectively (Table 7). Likewise, the final pregnancy rate was 50%, 100%, and 75% in control, R-SAF and R-SUN groups, respectively. These results are in agreement with other studies that have reported decreased the interval from calving to the uterine involution and uterine simulation. Also, improved conception rates and delayed resumption of cyclicity when fatty acids were added to the ration (Sklan *et al.* 1989; 1991, Ferguson. 1990, Scott *et al.* 1995, El-Banna *et al.*, 2005).

Cows fed safflower (R-SAF) or sunflower (R-SUN) seeds (3% dietary fat) had a tendency to have a greater percentage of linoleic acid than cows fed control ration (Table 2). Linoleic acid can be desaturated and elongated to form arachidonic acid (C20:4), that is a precursor for prostaglandins ($PGF_2\alpha$), which is responsible for uterine involution after parturition. The greater the postpartum prostaglandin concentration resulted to the faster of the uterus involution (Funston and Filley, 2002). Some authors reported that $PGF_2\alpha$ administration on 20 – 33 days posparum resulted in cleaning of the uterine environment (Pankowski *et al.*, 1995; Kasimanickam *et al.*, 2005). Also, $PGF_2\alpha$ treatment induced luteolysis causing a decrease in the P_4 levels and subsequent up-regulation of the immune function making the uterus able to clear infections (Lewis, 1997). These findings support our results related to cows supplemented with R-SAF or R-SUN arrived faster to the uterine involution and uterine simulation than un-supplemented one (Table 7).

Cows of the control group showed the first postpartum detected estrus earlier than the other treated groups (R-SAF or R-SUN). However, there no significant differences either between control and R-SUN groups, or between R-SAF and R-SUN groups (Figure 1). The results obtained may be related to the higher concentrations of cholesterol and glucose of treated cows treated groups compared to control (Table 4). El-Banna *et al.* (2005) reported that there were negative correlation coefficients between the interval from calving to the first detected estrus with plasma glucose and cholesterol concentration.

Feeding R-SAF or R-SUN ration considerably affected reproductive performance, especially days to first AI, days open, number of services per conception and Pregnancy rate (Table 7). The improved reproductive performance of cows on the R-SAF or R-SUN ration compared with control cows can be explained by the higher concentration of circulating lipids during part of the period of insemination and the enhanced feed energy intake. Dietary fats positively affect reproductive function by supplying energy and by actions on reproductive processes that are not related to energy. Increased availability of fatty acid precursors enhanced steroid and eicosanoid secretion, which can alter ovarian and uterine function and affect pregnancy rates. Also, at the cell, fatty acids may have a direct effect on the transcription of genes that encode proteins that are essential to reproductive events (Mattos *et al.*, 2000). Also, El-Banna *et al.* (2005) showed that fat

Table (7): Reproductive performance of lactating Friesian cows as affected by the treatments

Item	Treatment			±SE
	Control[1]	R-SAF[2]	R-SUN[3]	
UIP*	26.75^{a}	18.25^{c}	22.00^{b}	1.05
USP**	34.75^{a}	25.50^{c}	30.00^{b}	1.33
PFE***	37.00^{b}	52.25^{a}	44.00^{ab}	3.52
Days to first AI	88.75^{a}	73.00^{b}	69.00^{b}	3.27
Days open	121.25^{a}	77.50^{b}	85.25^{b}	10.24
NSPC****	2.50^{a}	1.25^{b}	1.75^{ab}	0.35
Conception rate, % at first AI	0%^{b}	75%^{a}	50%^{ab}	22.05
Pregnancy rate, %	50%^{b}	100%^{a}	75%^{ab}	22.05

a, b and c: Means in the same row with different superscripts differ significantly (P<0.05).

[1]Control; cows fed the control ration, [2] R-SAF; Raw safflower seeds ration and [3] R-SUN; Raw sunflower seeds ration. *UIP*: uterine involution period, USP**: uterine simulation period, PFE***: the period from the last calving to first detected estrus and NSPC****: number of services per conception.*

supplemented diet increases the diameter of dominant follicles postpartum and resulted in higher peak estradiol levels. In addition, increased concentrations of serum lipids could influence production and (or) metabolism of important reproductive hormones (Filley *et al.,* 2000) resulting in improvement of reproductive function.

In the present study, safflower and sunflower seeds supplementation were stopped at 60 days after birth, which affected the uterus to produce less $PGF_2\alpha$ and helped small embryos reach the uterus and inhibited natural luteolysis by reducing the level of $PGF_2\alpha$ and increasing the concentration of progesterone, consequently increasing the pregnancy rate (Mattos *et al* 2002). Similarly, Ambrose *et al.* (2006) found that reduce $PGF_2\alpha$ synthesis in the endometrium, delay luteolysis, and improve pregnancy rates in lactating dairy cows.

First detected estrus

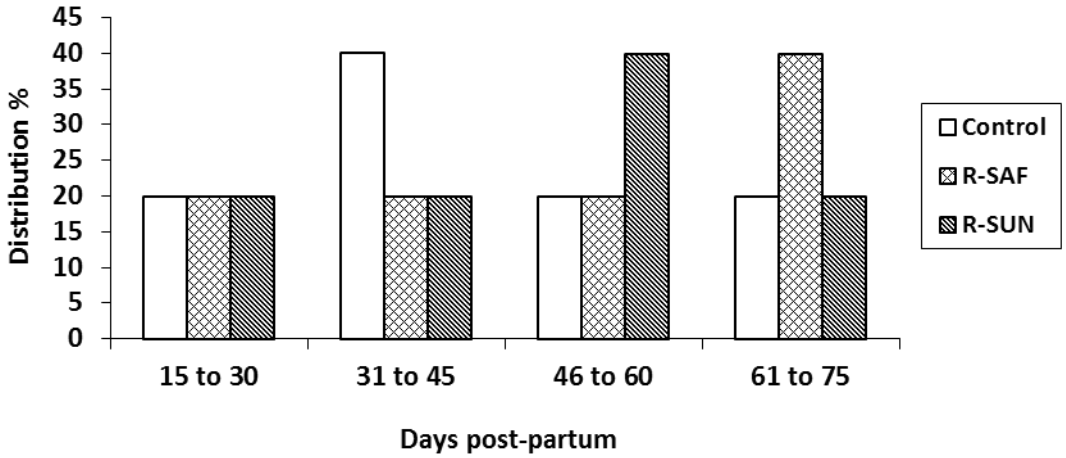

Figure (1): Frequency distribution of lactating Friesian cows at first detected estrus

CONCLUSION

Supplementing safflower or sunflower seeds with rate of 3% of DM in lactation rations led to positive effects on ruminal fermentation, lactational performance, milk fat yield and reproductive performance. Moreover, this supplementation can be an effective strategy on lactating dairy cows with positive effects on lactational performance and milk FA profiles. In addition, the enhanced functional quality of milk with increased conjugated linoleic acid (CLA) concentration and additional benefit to human health were found.

REFERENCES

A.O.A.C. (2002). Official Methods of Analysis Association of Official Analytical Chemists, Washington, DC.

Adolf, A. A.; B. Chaouki; B. Nathalie; G. Nicolas and Eveline M. Ibeagha-Awemu (2018). Treatment and post-treatment effects of dietary supplementation with safflower oil and linseed oil on milk components and blood metabolites of Canadian Holstein cows. Journal of Applied Animal Research, 46 (1): 898–906.

Alizadeh, A. R.; G. R. Ghorbani; M. Alikhani; H. R. Rahmani and A. Nikkhah (2010). Safflower seeds in corn silage and alfalfa hay based early lactation diets: A practice within an optimum forage choice. Anim. Feed Sci. Technol., 155:18–24.

Al-Rabbat, M.F.; Bald win and W.C. Weir (1971). In vitro nitrogen-treacer technique for some kinetic measures of rumen ammonia. J. Dairy Sci., 54:150.

Ambrose, D. J.; J. P. Kastelic; R. Corbett; P. A. Pitney; H. V. Petit; J. A. Small and P. Zalkovic (2006). Lower pregnancy losses in lactating dairy cows fed a diet enriched in α-Linolenic acid. J. Dairy Sci., 89 (8): 3066-3074.

Amirifard, R.; M. Khorvash; M. Masiholla Forouzmand; H. Rahmani; A.Riasi; M. Malekkhahi; M. Yari and M. Hosseini-Ghaffari (2016). Performance and plasma concentration of metabolites in transition dairy cows supplemented with vitamin E and fat. J. Integ. Agric., 15(5): 1076–1084.

Baaha, J.; M. Ivanb; A.N. Hristov; K.M. Koenig; L.M. Roded and T.A. McAllister (2007). Effects of potential dietary antiprotozoal supplements on rumen fermentation and digestibility in heifers. Anim. Feed Sci. and Technol., 137: 126-137.

Beauchemin, K. A.; S. M. McGinn; C. Benchaar and L. Holtshausen (2009). Crushed sunflower, flax, or canola seeds in lactating dairy cow diets: Effects on methane production, rumen fermentation, and milk production. J. Dairy Sci., 92: 2118–2127.

Bell, J.A.; J.M. Griinari and J.J. Kennelly (2006). Effect of safflower oil, monensin, and vitamin E on concentration of conjugated linoleic acid in bovine milk fat. J. Dairy Sci., 89: 733–748.

Boila, R. J.; B. M. Mabon and J. R. Ingalls (1993). Response of dairy cows to barley grain, tallow or whole sunflower seed as supplemental energy in early lactation. Can. J. Anim. Sci., 73: 327-342.

Bottger, J. D.; B. W. Hess; B. M. Alexander; D. L. Hixon; L. F. Woodard; R. N. Funston; D. M. Hallford and G. E. Moss (2002). Effects of supplementation with high linoleic or oleic cracked safflower seeds on postpartum reproduction and calf performance of primiparous beef heifers. J. Anim. Sci., 80: 2023-2030.

Chichlowski, M. W.; J. W. Schroeder; C. S. Park; W. L. Keller and D. E. Schimek (2005) Altering the fatty acids in milk fat by including canola seed in dairy cattle diets. J. Dairy Sci., 88: 3084-3094.

Clark, J.H.; H.R. Spires; R.G. Derring and M.R. Bennink (1977). Milk production, protein utilization and glucose synthesis in lactating cows infused postruminally with sodium caseinate and glucose. J. Nutr., 107: 631–644.

Dafoe, J. M.; R. W. Kott ; B. F. Sowell; J. G. Berardinelli; K. C. Davis and P. G. Hatfield (2014). Effects of supplemental safflower and vitamin E during late gestation on lamb growth, serum metabolites, and thermogenesis. J. Anim. Sci., 86: 3194–3202.

Dai, X.J.; C. Wang and Q. Zhu (2011). Milk performance of dairy cows supplemented with rapeseed oil, peanut oil and sunflower seed oil. Czech J. Anim. Sci., 56(4): 181–191.

De Fries, C. A.; D. A. Neuendorff and R. D. Randel (1998). Fat supplementation influences postpartum reproductive performance in Brahman cows. J. Anim. Sci., 76: 864–870.

Dhiman, T. R; E. D. Helmink; D. J. Mcmahon; R. L Fife. and M. W. Pariza (1999). Conjugated linoleic acid content of milk and cheese from cows fed extruded oilseeds. J. Dairy Sci., 82: 412–419.

Doumas, B.; W. Wabson and H. Biggs (1971). Albumin standareds and measurement of serum with bromocresol green. Clin. Chem. Acta, 31: 87.

Dschaak, C. M.; C. T. Noviandi; J.-S. Eun; V. Fellner; A. J. Young; D. R. ZoBell and C. E. Israelsen (2011). Ruminal fermentation, milk fatty acid profiles, and productive performance of Holstein dairy cows fed 2 different safflower seeds. J. Dairy Sci., 94: 5138–5150.

Dschaak, C. M.; J.S.Eun; A. J. Young and J. W. Bergman (2010). Nutritive merits of whole Nutrasaff safflower seed when fed to Holstein dairy cows during midlactation. Anim. Feed Sci. Technol., 156: 26-36.

Duncan, D.B. (1955). Multiple Ranges and Multple F-Test. Biometics, 11: 1-42.

Eastridge, M. L. (2006). Major advances in applied dairy cattle nutrition. J. Dairy Sci., 89: 1311-1323.

El-Banna, M.K.; F.M. Abo-Donia and S.A. Ibrahim (2005). Post-partum productive and reproductive responses of lactating Friesian crossbred cows to Fat- supplemented diet. Proc. 2nd Conf. Anim. Res. Inst., Sakha 27-29 Sep.: 409- 423. https://www.researchgate.net/publication/320407940.

El-Fadaly, M. A. (1978). Some studies on the puerperium in buffaloes. M. D. Vet. Thesis, Cairo Univ., Egypt.

Fawcett, J.K. and J.E. Scott (1960). Determination of serum urea. J. Clin. Path., 13: 156.

Ferguson, J.D.; D. Sklan; W.V. Chalupa and D.S. Kronfeld (1990). Effects of hard fats on in vitro and in vivo rumen fermentation, milk production, and reproduction in dairy cows. J. Dairy Sci., 73: 2864.

Filley, S. J.; H. A. Turner and F. Stormshak (2000). Plasma fatty acids, prostaglandin F2α metabolite, and reproductive response in postpartum heifers fed rumen bypass fat. J. Anim. Sci., 78:139-144.

Friggens, N. C.; K. L Ingvartsen. and G. C. Emmans (2004). Prediction of body lipid change in pregnancy and lactation. J. Dairy Sci., 87: 988–1000.

Funston, R. and S. Filley (2002). Effects of fat supplementation on reproduction in beef cattle. Proceedings, The Applied Reproductive Strategies in Beef Cattle Workshop, September 5-6, 2002, Manhattan, Kansas.

Funston, R. N.; T. W. Geary; R. P. Ansotegui; R. J. Lipsey and J. A. Patterson (2002). Supplementation with whole sunflower seeds before artificial insemination in beef heifers. Prof. Anim. Sci., 18: 254-257.

Gaines, W. L. (1923). Relation between percentage of fat content and yield of milk. 1. Correction of milk yield for fat content. Agric. Hand book 379, USDA. Washington, D.C.

Greiling, H. and A. M. Gessner (1995). Lehrbuch der Klinischen Chemie und Pathobiochemie. 3 Aufl. Stuttgart; Schattauer.

Grummer, R. R. (1991). Effect of feed on the composition of milk fat. J. Dairy Sci., 74: 3244-3257.

Grummer, R. R.; D. G. Mashek and A. Hayirli (2004). Dry matter intake and energy balance in the transition period. The Veterinary Clinics of North America. Food Anim. Prac., 20: 447–470.

Hammon, D. S.; I. M. Evjen; T. R. Dhiman; J. P. Goff and J. L. Walters (2006). Neutrophil function and energy status in Holstein cows with uterine health disorders. Vet. Immunol. Immunopathol., 113: 21–29.

Harfoot, C.G. and G.P. Hazlewood (1997). Lipid metabolism in the rumen. In: Hobson, P.N., Stewart, C.S. (Eds.), Rumen Microbial Ecosystem, 2nd ed. Blackie Academic & Professional, New York, NY, USA, pp. 382–426.

Hassan, H.E.; K.M. Elamin; A.A. Tameem Eldar and O.H. Arabi (2011). Effect of feeding different levels of decorticated sunflower cake (Abad Alshames) (Helianthus nnuus L.) on performance of Sudan desert goats. Online J.Anim. and Feed Res., 1(5): 235-238.

He, M. L.; P. S. Mir; K. A. Beauchemin; M. Ivan and. Z. Mir (2005). Effects of dietary sunflower seeds on lactation performance and conjugated linoleic acid content of milk. Can. J. Anim. Sci., 75-83.

Henery, E. J. (1974). Calorimetric determination of total lipids. Clin. Chem. Principples and Technics. Harper Row NY, pp. 181.

Howlett, C. M.; E. S. Vanzant; L. H.Anderson; W. R. Burris; B. G. Fieser and R. F. Bapst (2003). Effect of supplemental nutrient source on heifer growth and reproductive performance, and on utilization of corn silage-based diets by beef steers. J. Anim. Sci., 81: 2367–2378.

Ivan, M.; T. Entz; P. S. Mir; Z. Mir and T.A. Mcallister (2003). Effects of sunflower seed supplementation and different dietary protein concentrations on the ciliate protozoa population dynamics in the rumen of sheep. Can. J. Anim. Sci., 83: 809-817.

Ivan, M.; P. S. Mir; Z. Mir; T. Entz; M. L. He and T. A. McAllister (2004). Effects of dietary sunflower seeds on rumen protozoa and growth of lambs. British J. Nutr., 92: 303-310.

Junior, J. E. F.; F. P. Renno; M. V. Santos; J. R. Gandra; M. M. Filho and B. C. Venturelli (2010). Productive performance and composition of milk protein fraction in dairy cows supplemented with fat sources. Revista Brasileira de Zootecnia, 39, 845-852.

Kasimanickam, R.; T.F. Duffield; R.A. Foster; C.J. Gartley; K.E. Leslie; J.S. Walton and W.H. Johnson (2005). The effect of single administration of cephapirin or cloprostenol on the reproductive performance of dairy cows with subclinical endometritis. Theriogenol., 63: 818.

Kennelly, J.J. (1996). The fatty acid composition of milk fat as influenced by feeding oilseeds. Anim. Feed Sci. Technol., 60: 137-152.

Kramer, J.K.G.; V. Fellner; M.E.R. Dugan; F.D. Sauer; M.M. Mossoba and M.P. Yurawecz (1997). Evaluating acid and base catalysts in the methylation of milk and rumen fatty acids with special emphasis on conjugated dienes and total trans fatty acids. Lipids, 32: 1219-1228.

Lake, S. L.; T. R. Weston; E. J. Scholljegerdes; C. M. Murrieta; B. M. Alexander; D. C. Rule; G. E. Moss and B. W. Hess (2014). Effects of postpartum dietary fat and body condition score at parturition on plasma, adipose tissue, and milk fatty acid composition of lactating beef cows. J. Anim. Sci., 85: 717–730.

Lammoglia, M. A.; R. A. Bellows; E. E. Grings; J. W. Bergman; R. E. Short and M. D. MacNeil (1997). Effects of dietary fat composition and content, breed, and calf sex on birth weight, dystocia, calf vigor, and postpartum reproduction of first calf beef heifers. Proc. West. Sect. Am. Soc. Anim. Sci., 48: 81-83.

Lewis, J.S. (1997). Health problems of the postpartum cow, uterine health and disorders. J. Dairy. Sci., 80: 984.

Mansoori, H.; A. Aghazadeh and K. Nazeradl (2011). Sunflower oil seed (raw-or heat-treated) in lactating dairy cow's diets: Effects on milk fatty acids profile and milk production. J. Anim. Vet. Adv., 10: 470–479.

Mattos, R.; R. S. Charles and W. T. William (2000). Effects of dietary fatty acids on reproduction in ruminants. J. Reprod. and Fert., 1359-6004.

Mattos, R.; C.R. Staples; J. Williams; A. Amorocho; M.A. McGuire and W.W.Thatcher (2002). Uterine, ovarian, and productive responses of lactating dairy cows to increasing dietary concentrations of Menhaden fish meal. J. Dairy Sci. 85: 755-764.

Mirzaei, F.; M. Rezaeian; A. Towhidi; A. Nik-khah and H. Sereshti (2009). Effects of Fish Oil, Safflower Oil and Monensin Supplementation on Performance, Rumen Fermentation Parameters and Plasma Metabolites in Chall Sheep. Int. J. Vet. Res., 3(2): 113-128.

Mohsen, M.K.; M.I. Bassiouni; H.M.A. Gaafar; M.H. El-Shafiey and A.A. El Sanafawy, Heba (2011). Effect of whole sunflower seeds supplementation in performance of Zaraibe goats. Slovak J. Anim. Sci., 44(4): 154-161.

Morsy, T.A.; S.M. Kholif; A.E. Kholif; O.H. Matloup; A.Z.M. Salem and A. Abu Elella (2015). Influence of sunflower whole seeds or oil on ruminal fermentation, milk production, composition, and fatty acids profile in lactating goats. Asian Australas. J. Anim. Sci., 28(8): 1116 -1122.

Nik-Khah, A.; H. Sadeghi-Panah; A. ZareShahneh and P. Jamei (2001). Effect of dietary fat level and source on feed lot performance carcass characteristics and digestibility of kordian yearling bulls. Iranian, J. Agric. Sci., 32: 637-648.

NRC (2001). Nutrient Requirements of Dairy Cattle. 7th Rev. Ed. National Research Council. National Academy of Science, Washington, DC.

Odens LJ; R. Burgos; M. Innocenti; M.J. VanBaale; L.H. Baumgard (2007). Effects of varying doses of supplemental conjugated linoleic acid on production and energetic variables during the transition period1. J Dairy Sci., 90: 293–305.

Oldick, B.S. and J.L. Firkins (2000). Effects of degree of fat saturation on fiber digestion and microbial protein synthesis when diets are fed twelve times daily. J. Anim. Sci., 78: 2412-2420.

Olmos, J. J. Colmenero and G. A. Broderick (2006). Effect of Dietary Crude Protein Concentration on Milk Production and Nitrogen Utilization in Lactating Dairy Cows. J. Dairy Sci., 89: 1704–1712.

Ørskov, ER and R. Ryle (1990). Energy Nutrition in Ruminants. Elsevier Science Publishers, New York.

Pankowski, J.W.; D.M. Galton; H.N. Erb; C.L. Guard and Y.T. Grőhn (1995). Use of prostaglandin F2α as a postpartum reproductive management tool for lactating dairy cows. J. Dairy Sci., 78: 1477.

Pariza, M.W.; Y. Park and M.E. Cook (2001). The biologically active isomers of conjugated linoleic acid. Prog. Lipid Res., 40: 283–298.

Petit, H. V. (2003). Digestion, milk production, milk composition, and blood composition of dairy cows fed formaldehyde treated flaxseed or sunflower seed. J. Dairy Sci., 86: 2637-2646.

Polviset, W.; C. Wachirapakorn; A. Alhaidary; H. E. Mohamed; A. C. Beynen and C. Yuangklang (2010). Rumen fermentation and nutrient digestibility in beef steers fed rations containing either cotton seed or sunflower seed. Research J. Biological Sci., 5: 204-208.

Reitman, S. and S. Frankel (1957). A colorimetric method for the determination of serum glutamic oxalacetic and glutamic pyruvic transaminases. American J. Clini. Path., 28(1): 56-63.

Ritzenthaler, K.L.; M.K. McGuire; R. Falen; T.D. Shultz; N. Dasgupta and M.A. McGuire (2001). Estimation of conjugated linoleic acid intake by written dietary assessment methodologies underestimates actual intake evaluated by food duplicate methodology. J. Nutr., 131: 1548–1554.

Rolschlau, P. (1974). Klin. Biochem., 12: 226.

Sarrazin, P.; A.F. Mustafa; P.Y. Chouinard; G.S.V. Raghavan and S.A. Sotocinal (2004). Performance of dairy cows fed roasted sunflower seed. Sci. Food Agric., 84:1179-1185.

SAS (2005). SAS User's Guide: Statistics, SAS Institue, Cary, NC.

Schingoethe, D.J.; J.A. Rook and F. Ludens (1977). Evaluation of sunflower meal as a protein supplement for lactating cows. J. Dairy Sci., 60: 591.

Scholliegeredes, E. J.; B. W. Hess; B. W. Hightower; G. E. Moss; D. L. Hixon and D. C. Rule (2001). Biohydrogenation, flow and disappearance of fatty acids in beef cattle fed supplemental highlinoleate or high-oleate safflower seeds. In: Proc. West. Sect. Am. Soc. Anim. Sci., 52: 59-62.

Schroeder, G. F.; G. A. Gagliostro; F. Bargo; J. E. Delahoy and L. D. Muller (2004). Effects of fat supplementation on milk production and composition by dairy cows on pasture: a review. Livestock Prod. Sci., 86: 1-18.

Scott, T.A.; R.D. Shaver; L. Zepeda; B. Yandell and T.R. Smith (1995). Effect of rumen-inert fat on lactation, reproduction, and health of high producing Holstein herds. J. Dairy Sci., 78: 2435.

Silvestre, F. T.; T. S. M. Carvalho; N. Francisco; J. E. P. Santos; C. R. Staples; T. C. Jenkins and W. W. Thatcher (2011). Effects of differential supplementation of fatty acids during the peripartum and breeding periods of Holstein cows: I. Uterine and metabolic responses, reproduction, and lactation. J. Dairy Sci., 94: 189-204.

Sklan, D., E. Bogin; Y. Avidar and S. Gur-Arie (1989). Feeding calcium soap of fatty acids to lactating cows: effect on production, body condition and blood lipids. J. Dairy Res., 56: 675.

Sklan, D.; Moallem U. and Y. Folman (1991). Effect of feeding Calcium soap of fatty acids on production and reproductive responses in high producing lactating cows. J. Dairy Sci., 74: 510.

Vafa, T. S.; A. A. Naserian and A. R. Heravimoussavi (2009). Effect of different levels of fish oil and canola oil on in vitro and in vivo nutrient digestibility. Res. J. Biol. Sci., 4: 1221-1226.

Van Keulen, J. and B.A. Young (1977). Evaluation of acid insoluble ash as a natural marker in ruminant digestibility studies. J. Anim. Sci., 44: 282-287.

Warner, A.C.I. (1964). Production of volatile fatty acids in the rumen: methods of measurement. Nutr. Abstr. Rev., 34: 339–352.

Whigham, L.D.; M.E. Cook and R.L. Atkinson (2000). Conjugated linoleic acid: implications for human health. Pharmacol. Res., 42: 503–510.

Whitney, M. B.; B. W. Hess; L. A. Burgwald-Balstad; J. L. Sayer; C. M. Tsopito; C. T. Talbott and D. M. Hallford (2000). Effects of supplemental soybean oil level on in vitro digestion and performance of prepubertal beef heifers. J. Anim. Sci., 78: 504–514.

تخمرات الكرش، انتاج اللبن، تركيب اللبن والأداء التناسلى للأبقار الفريزيان الحلابة التى تغذت على بذور القرطم أو دوار الشمس

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تم إجراء هذه الدراسة على الأبقار الحلابة لتقييم الأداء الإنتاجي والتناسلي على الأبقار الفريزيان الحلابة المضاف لعلائقها بذور خام من القرطم أو دوار الشمس ومعرفة تأثيرها على تخمرات الكرش وأداؤها الإنتاجي من اللبن والأحماض الدهنية المكونة لدهن اللبن وكذلك الأداء التناسلي. تم تقسيم 15 بقرة وحيدة ومتعددة المواسم طبقاً لميعاد الولادة المتوقع وترتيب الموسم ووزن الجسم وإنتاج اللبن في الموسم السابق للأبقار المتعددة المواسم. تم تقسيم الأبقار عشوائياً لثلاثة مجاميع هي: (أ) وهي المجموعة الضابطة والتي تغذت أبقارها على عليقة لا تحتوي على بذور القرطم أو دوار الشمس ، (ب) وهي التي تغذت أبقارها على عليقة تحتوي على بذور القرطم و(جـ) وهي التي تغذت أبقارها على عليقة تحتوي علي بذور دوار الشمس وذلك لمدة 90 يوم وهي فترة التجربة. بدأت التجربة قبل ميعاد الولادة التالي تقريباً بـ 30 ±5 يوم وأستمرت حتى 60 يوم بعد الولادة. تم الإمداد بالبذور بمعدل 3,36 % و3% من المادة الجافة للعليقة أثناء فترات قبل وبعد الولادة على التوالي. أظهرت النتائج المتحصل عليها : أن كمية المادة الجافة المأكولة متشابهة تقريباً بين المعاملات سواء في مرحلة الحمل المتأخر او مرحلة بداية الحليب. ارتفعت معاملات الهضم للمادة الجافة والمادة العضوية والبروتين الخام والألياف الخام ومستخلص الإثيروالكربوهيدرات الذائبة في الأبقار الحلابة المغذاة على علائق تحتوي على بذور القرطم أو دوار الشمس مقارنة بعليقة المجموعة الضابطة. إنخفضت معنوياً قيم الأس الهيدروجيني وتركيزات أمونيا سائل الكرش في حين إرتفعت معنوياً تركيزات الأحماض الدهنية الطيارة في المجموعات المعاملة ببذور القرطم أو دوار الشمس مقارنة بالمجموعة الضابطة. إرتفعت معنوياً تركيزات البروتين الكلي والألبيومين واليوريا في سيرم دم الأبقار الحلابة المعاملة ببذور القرطم أو دوار الشمس مقارنة بالمجموعة الضابطة. لم تتأثر تركيزات الجلوبيولين في سيرم دم الأبقار بإضافة البذورالدهنية. لم يتغير نشاط إنزيم اسبارات أمينو ترانسفيريز وإنزيم ألانين أمينو ترانسفيريز في مجاميع علائق بذور القرطم أودوار الشمس مقارنة بعليقة المجموعة الضابطة. تحسنت قيم معامل التحويل للمادة الجافة ومجموع المركبات الغذائية المهضومة والبروتين المهضوم المنسوب إلى إنتاج اللبن مصحح الدهن في الأبقار الحلابة المغذاة على علائق تحتوي على بذور القرطم أو دوار الشمس مقارنة بالأبقار الحلابة المغذاة على العليقة الضابطة. إرتفع معنوياً كلاً من إنتاج اللبن ومكوناته للأبقار الحلابة المغذاة على علائق تحتوي على بذور القرطم أو دوار الشمس مقارنة بعليقة المجموعة الضابطة. إرتفع تركيز الحمض الدهني البالمتيك في دهن اللبن معنوياً بالتغذية على علائق تحتوي على بذور القرطم أو دوار الشمس مقارنة بعليقة المجموعة الضابطة. أخذت بعض الأحماض الدهنية مثل الأوليك واللينوليك والأراشيدونيك نفس اتجاه حمض البالمتيك حيث زادت زيادة خطيه مع التغذية على علائق تحتوي على بذور القرطم أو دوار الشمس مقارنة بالمجموعة الضابطة. تفوقت مجموعة الأبقار المغذاة على عليقة تحتوي على بذور القرطم أو دوار الشمس في أداؤها التناسلي بمقارنتها بأبقار المجموعة الضابطة. يمكن التوصية بان إحتواء علائق الأبقار الحلابة على البذور الخام من القرطم او دوار الشمس بنسبة 3% من المادة الجافة الماكولة يمكن أن يكون لهذه الإضافة الدهنية تأثير إستراتيجي على أداء الأبقار الحلابة أثناء موسم الحليب متزامنة مع تأثيرات إيجابية على إنتاج اللبن وتركيزات الأحماض الدهنية باللبن وكذلك أداؤها التناسلي. بالإضافة إلى تحسين الجودة الوظيفية للبن بزيادة تركيز حمض اللينوليك المرتبط و كذلك الفائدة الإضافية العائدة على صحة الإنسان.