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Effect of Restaurant Fat on Milk Yield and Composition of Dairy Cows Limit-Fed Concentrate Diet with Free Access to Forage

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***Abstract*—**Ten lactating multiparous Holstein cows were used in a cross-over design with two dietary treatments and 28-d periods (with 14 d as an adaptation) to study the effect of restaurant fat on milk production and composition. Each cow was offered 14.7 kg DM /d of the basal concentrate diet based on barley and corn (crude protein = 17.7%, neutral detergent fiber = 23.5%, and acid detergent fiber = 5.8% of dry matter) with free access to alfalfa. Dietary treatments were arranged as supplying each cow with 0 (CONTROL) or 150 g/day (RF) of restaurant fat. Supplemental RF did not significantly ($P > 0.25$) affect milk yield, composition, and composition yields, except for milk fat contents. Milk fat contents were depressed ($P < 0.05$) with supplemental RF. Our results indicate that RF could depress milk fat without affecting milk yield and that the depression in milk fat in response to RF precedes the depression in milk yield.

***Keywords*—**Dairy Cows, Restaurant Fat, Lipids.

I. INTRODUCTION

LIPIDS (fats and oils) are usually added to animal feed because they are excellent sources of energy due to high caloric value. Thus, fat inclusion is the easiest way to increase dietary contents of metabolizable energy [4] and serves as a source of essential fatty acids [6]. Fat supplements are usually added to ration for dairy cows in early lactation, where consumed energy is insufficient to meet all needs for milk energy [7]. Additionally, fat minimizes the dustiness generated during mixing and handling of feed and, subsequently, minimizes irritation to the respiratory tract when consumed by animals.

Fats, from different sources, have been widely added to diets for both dairy and beef cattle. The effect of restaurant fat (RF) inclusion on milk yield of dairy cows has been inconsistent. For example, RF improved [2, 5] or had no effects [3, 7] on milk yield of dairy cows.

In literature, RF has been given many names including: used frying fats, waste restaurant grease, frying oil from deep fryers, recycled restaurant grease, and spent restaurant-cooking oil. In this study, RF is referred to as spent-cooking oil from restaurants and cafeterias. Disposal of RF in developing countries has been problematic as most of waste-cooking oil is aimlessly disposed into the environment and sewage. Thus, using RF as a supplemental energy will have both environmental and economical advantages. In this regard, results from studies on nursing ewe [1] and dairy cows [2, 5] are promising and encouraging.

In literature, most of previous work on dairy cows included RF at levels of ≥ 700 g/cow/d [5, 7]. Supplying RF for dairy cows at moderate levels has not been widely investigated. The objective of this study was to investigate the effects of supplemental RF at moderate levels (150 g/cow/d) on milk yield and composition of dairy cows.

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II. MATERIALS AND METHODS

This study was conducted at the Agriculture Center for Research and Production at Jordan University of Science and Technology (JUST).

A. Animals, Design, and Dietary Treatments

Ten Holstein multiparous cows individually housed in tie-stall barn were used in a cross-over design to study the effect of supplemental restaurant fat on milk production and composition. Cows were fed individually a fixed amount (14.7 kg DM/d) of concentrate diet twice a day (two equal proportions at 0800 and 1800 h). The concentrate diet contained barley, corn, soybean meal, and vitamin/mineral premix (Table I). Cow had free access to alfalfa after consuming their assigned amount of concentrate. Cows had free access to clean water throughout the study. Cows were milked twice a day at the time of offering the concentrate diet.

The study consisted of two 28-d periods (with 14 d as an adaptation). In the first period, cows were randomly assigned to one of two dietary treatments (five cows per treatment per period). In the second period, cows were switched to the other treatments so that, each cow received consecutively the two treatments during the course of the study. Dietary treatments were 0 (CONTROL) or 150 g/cow/day (RF) of supplemental restaurant fat. Restaurant fat was mixed with the concentrate diet at each time of feeding (Table I). Restaurant fat was obtained from JUST's cafeteria and composed of waste soybean oil used for frying vegetables.

B. Analytical Methods

Samples of the concentrate diet were collected upon mixing at the beginning, middle, and end of the study, composited, and saved (−20°C) for later analysis of dry matter (DM; 105°C in a forced-air oven for 24 h), organic matter (OM, weight loss upon ashing at 550°C for 8 hours), crude protein (CP, Kjeldahl procedure), neutral detergent fiber (NDF, with heat stable α-amylase and Na sulfite), and acid detergent fiber (ADF, ANKOM^{2000} fiber analyzer, ANKOM Technology Corp., Fairport, NY). Values for NDF and ADF were not corrected for ash contents. Ingredient and chemical composition of the concentrate diet is listed Table I.

TABLE I
INGREDIENT AND CHEMICAL COMPOSITION OF THE CONCENTRATE DIET

Item	% of DM
Ingredient	
Barley	55.0
Ground corn	20.5
Soybean meal	18.1
Vitamin/mineral premix[1]	6.4
Nutrient[3]	
Dry matter	89.1
Organic matter	97.3
Crude protein	17.7
Neutral detergent fiber	23.5
Acid detergent fiber	5.8

[1]Contained salt, limestone, and vitamin premix.

For each cow, individual milk yields were recorded daily throughout the study. Data from the first 14 d of each period were considered as an adaptation and were not used for data analysis. At the end of each period, 125-mL milk sample was collected and immediately analyzed for composition. Milk samples were analyzed for total solids (50°C in a forced-air oven to each a constant weight), ash (weight loss upon ashing at 550°C for 8 hours), crude protein (Kjeldahl procedure), and fat (Gerber method).

C. Statistical Analysis

All data were analyzed statistically using the Mixed procedure of SAS System for Windows Release 8.1 (SAS Inst. Inc., Cary, NC). Data were analyzed according to the cross-over design. The model was $Y_{ijk} = \mu + S_i + C_{ij} + P_k + T_h + E_{ijk}$, where Y_{ijk} = response during the kth period of the jth cow in the ith sequence group (i = 1, 2; j = 1 to 10; k = 1, 2), μ = population mean, S_i = sequence effect, C_{ij} = the effect of the jth cow on the ith sequence, P_k = period effect, T_h = treatment effect (h = 1, 2), and E = residual error. Treatment means were computed using the LSMEANS option and separated using preplanned pair-wise comparisons of least squares means using t-tests.

III. RESULTS AND DISCUSSION

Milk yield, composition, and composition yield are presented in Table II. Supplemental RF did not significantly (P > 0.25) affect milk yield, composition, and composition yields, except for milk fat contents. Compared to non-supplemented group, RF depressed (P < 0.05) milk fat content by 18% (from 3.88 to 3.17%). Similarly, supplemental RF tended (P = 0.13) to decrease fat yield by 22% (from 680 to 531 g/d).

TABLE II
MILK YIELD, COMPOSITION, AND COMPOSITION YIELD OF DAIRY COWS SUPPLEMENTED WITH OR WITH NO FAT

	Dietary Treatment[1]			
Item	**CONTROL**	**RF**	**SEM**	***P*-value**
n	10	10		
DMI, kg/d	14.70	14.70	-	-
Milk, kg/d	17.35	17.16	1.83	0.83
Milk Composition, %				
Total solids	12.62	12.07	0.35	0.28
Protein	3.48	3.46	0.12	0.94
Fat	3.88	3.17	0.21	0.02
Ash	0.80	0.82	0.02	0.35
Composition Yield, g/d[2]				
Total solids	2,197	2,049	228	0.33
Protein	600	586	60	0.72
Fat	680	531	76	0.13
Ash	137	140	15	0.60

[1]CONTROL and RF = 0 or 150 g/cow/d of supplemental restaurant fat, respectively.
[2]Calculated as, composition yield = composition percentage*milk yield.

The effect of RF supplementation on milk yield and, specifically, on milk fat contents has been controversial. For example, when Jenkins and Jenny [7] included RF in diets for dairy cows at 5% (calculated as 1025 g/cow/d of RF) it did not affect milk yield, but it depressed milk fat content by 19% (from 3.5 to 2.83%). However, RF at 3.5 or 7% (calculated as 773 and 1477g/cow/d of RF, respectively) improved milk yield from 28.6 to 33.9 and 31.9 kg/d, respectively; but milk fat content was depressed by 12% (from 3.45 to 3.04%) only with 7 but not 3.5% RF [5]. Our cows were supplemented with 150 g/cow/d of RF. Our report indicates that RF could depress milk fat content and yield even at very modest levels (150 g/d corresponding to 1.0% of concentrate DM) and the depression in milk fat in response to RF precedes the depression in milk yield.

Additionally, this report demonstrated that RF could depress milk fat without affecting milk yield when NE_L was in excess of lactation requirements in the basal diet. For instance, when our concentrate diet was evaluated [8] based on the observed production level (average 17 kg/d of milk) and DMI (14.7 kg/d), energy intake of our cows exceeded the requirements with excluding the nutrients coming from alfalfa. For example, NE_L-allowable milk was 23 kg/d with excess of 4.3 Mcal/d. We did not observe improvement in milk yield in response to supplemental RF perhaps due to the fact that the performance of our cows was not limited by energy supply. Beside it is not economically favorable, it is concluded that supplying extra energy above the requirements in the form of RF could depress milk fat without affecting milk yield.

IV. Conclusion and Recommendations

Supplying extra energy above the requirements in the form of RF for dairy cows producing moderate amount of milk (< 20 kg/d) is not recommended. Such extra energy could depress milk fat contents without apparent depression in milk yield. Thus, it is economically beneficial to supply energy based on production levels of dairy cows.

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