

# Short Communication: Influence of Dietary Tallow and Fish Oil on Milk Fat Composition<sup>1</sup>

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## ABSTRACT

Four midlactation Holstein cows in a 4 × 4 Latin square design were fed one of four diets that contained 3% added fat (dry matter basis) as 100:0, 67:33, 50:50, or 33:67 tallow:fish oil. Feed intake and yield and composition of milk were not affected by treatment. The proportion of fatty acids 18:0 and *cis*-18:1 decreased and *trans*-18:1, conjugated linoleic acid, 18:3, 20:4, and 20:5 increased in milk fat with increasing fish oil. The efficiency of transferring dietary 20:5 and 22:6 to milk fat was < 7%.

**(Key words:** fish oil, tallow, fat, dairy cow)

**Abbreviation key:** CLA = conjugated linoleic acid.

Compared with cows fed no supplemental fat, fish oil supplementation usually does not affect milk yield of low producing cows but has consistently reduced milk fat percentage (1, 4, 7). Fish oil could replace other fat sources in the diet, but most studies on fish oil used control diets with no added fat. The objective of this experiment was to compare the effects of fish oil with dietary tallow, a commonly used fat, on production and milk fat composition of dairy cows.

Four multiparous Holstein cows at 138 DIM (± 11 DIM) were used in a 4 × 4 Latin square with 28-d periods. Four total mixed diets were formulated to contain 30% corn silage, 29% alfalfa silage, 7.4% alfalfa hay, 30.6% corn grain and soybean meal-based concentrate, and 3% fat supplement (DM basis). The supplemental fat was: 100% tallow, 67:33 tallow: fish oil, 50:50 tallow:fish oil, and 33:67 tallow:fish oil. The fish oil was light, cold-pressed, feed grade Menhaden oil (Zapata Protein Inc., Reedville, VA). Diets (DM basis) contained 15% CP, 31% NDF, 21% ADF, and 5.6, 5.3, 5.3, and 5.1% fatty acids, respectively. Milk yield and DMI was

measured daily (last 7 d of each period) and milk (a.m. and p.m.) was sampled on d 22, 23, and 24 of each period, composited, and analyzed for fatty acids (8). The GLC system used to quantify milk fatty acids did not separate 20:1 n-9 completely from the several conjugated dienes found in milk fat (5). Thus, conjugated linoleic acid (CLA) is reported as total conjugated dienes plus 20:1 n-9 (if present). Isomers of *trans*-18:1 also were not separated. Rumen fluid was collected at 1000 h on d 24 of each period via stomach tube and analyzed for VFA (9). Data were analyzed with a model that included effects for cow, period, and diet; the residual was used as the error term. The general linear model procedure of SAS (6) was used for calculations. Treatment effect was partitioned into linear, quadratic, and cubic components.

Treatment did not affect DMI, milk yield, or gross milk composition (Table 1). Intakes of individual fatty acids reflected the fatty acid composition of the diets. Total fatty acid intake decreased linearly ( $P < 0.05$ ) as dietary fish oil increased because the diets were balanced for crude fat and not fatty acids. Tallow contained 91% fatty acids and the fish oil contained 82% fatty acids. The molar proportions of ruminal VFA averaged 0.62 (SE = 0.02), 0.21 (SE = 0.02), and 0.13 (SE = 0.01) for acetate, propionate, and butyrate and were not affected by treatment (data not shown). Mean acetate to propionate ratio was 3.1:1 and not affected by treatment.

The concentration of *trans*-18:1 in the milk fat increased linearly ( $P < 0.05$ ) as dietary fish oil increased (Table 2). The concentration of *trans*-18:1 is associated with milk fat depression (2), suggesting that the negative effect of fish oil on milk fat percent often reported (1, 4, 7) may be caused by altered ruminal metabolism of dietary fatty acids. Milk fat percentage in our study was not affected by diet, but the percentage of fat for all diets was substantially lower than the average for our herd (approximately 3.7%). The decrease in 18:0 and the increases in *trans*-18:1 and CLA in milk fat suggests that ruminal biohydrogenation of all dietary fatty acids was less complete as dietary fish oil increased; probably a result of the effect of polyunsaturated fatty acids on ruminal microbial metabolism (2).

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**Table 1.** Effect of dietary fat source on intake and milk production and composition.

	Tallow:fish oil <sup>1</sup>				SE
	100:0	67:33	50:50	33:67	
<b>Intake</b>					
DM, kg/d	19.9	21.5	20.8	19.7	1.0
18:0 <sup>2</sup> , g/d	98	79	64	45	4
<i>cis</i> -18:1 n-9, g/d*	302	253	211	169	12
18:2 n-6, g/d*	249	250	212	201	11
18:3 n-3, g/d	60	62	58	57	3
20:4 n-6, g/d*	4	5	6	7	0
20:5 n-3, g/d*	2	18	29	37	2
22:6 n-3, g/d*	ND <sup>3</sup>	8	15	20	1
Total fatty acids, g/d*	1117	1087	1016	953	46
<b>Milk, kg/d</b>					
Fat, %	30.3	33.4	33.5	31.6	1.5
Fat, kg/d	2.74	2.21	2.27	2.25	0.20
Protein, %	0.81	0.75	0.76	0.70	0.07
Protein, kg	3.18	3.21	3.28	3.19	0.09
	0.99	1.07	0.99	1.00	0.06

<sup>1</sup>Proportion of supplemental fat (3% of dietary DM) from tallow and fish oil.

<sup>2</sup>Number of carbons:number of unsaturated bonds.

<sup>3</sup>Not detectable.

\*Linear effect of fish oil ( $P < 0.05$ ).

The increase in milk 20:4 and 20:5 (Table 2) when fish oil was fed reflects the intake of these two fatty acids. Although intake of 22:6 was increased ( $P < 0.05$ ) by fish oil and was much greater than intake of 20:4, essentially no 22:6 was found in the milk. For cows fed fish oil, the transfer of dietary 20:5 to milk fat averaged

4% and was similar to previous results (3). The high transfer efficiency for 20:4 may be an artifact of the very low intake (small denominator) of that fatty acid. Increasing the consumption of fish oil fatty acids by humans may have health benefits but the low transfer efficiency for those fatty acids into milk will limit use

**Table 2.** Effect of dietary fat source on milk fatty acid composition (% of total fatty acids) and efficiency of transfer from diet to milk.

Fatty acid <sup>2</sup>	Tallow:fish oil <sup>1</sup>				SE
	100:0	67:33	50:50	33:67	
≤14:0	18.76	18.35	19.64	20.87	0.22
16:0	30.41	31.33	32.17	31.67	0.61
16:1*	2.65	3.40	3.65	3.59	0.26
18:0*	10.52	8.38	7.80	6.36	0.75
<i>t</i> -18:1*	5.32	8.08	7.69	9.80	1.05
<i>c</i> -18:1 n-9*	24.13	20.38	18.14	14.78	0.78
18:2 n-6	2.28	2.82	2.94	2.83	0.27
18:3 n-3*	0.53	0.55	0.62	0.62	0.03
CLA*	1.10	1.78	1.86	2.24	0.19
20:4 n-6*	ND <sup>3</sup>	0.05	0.17	0.49	0.15
20:5 n-3 <sup>†</sup>	ND	0.06	0.12	0.30	0.10
22:5 n-3*	ND	0.01	0.09	0.24	0.07
22:6 n-3	ND	ND	0.02	ND	0.01
<b>Transfer efficiency<sup>4</sup></b>					
20:4 n-6*	0.000	0.075	0.215	0.490	0.147
20:5 n-3	0.000	0.032	0.015	0.065	0.030
22:6 n-3	0.000	0.040	0.022	0.000	0.007

<sup>1</sup>Proportion of supplemental fat (3% of dietary DM) from tallow and fish oil.

<sup>2</sup>Number of carbons:number of unsaturated bonds. CLA = Conjugated linoleic acid, includes total conjugated dienes and 20:1 n-9, if present.

<sup>3</sup>Not detectable.

<sup>4</sup>Grams of fatty acid output in milk/grams of fatty acid consumed.

\*Linear effect of fish oil ( $P < 0.05$ ); <sup>†</sup>( $P < 0.10$ ).

of milk as a source. However, the increased concentration of CLA caused by feeding fish oil may have positive human health implications.

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