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RESEARCH SUMMARY

Commercial Trial: Influence of dietary inclusion of linPRO®-R on animal health, performance and conception rates in early-lactating dairy cattle, and the subsequent economic impact

Summary

Supplementing early-lactating dairy cattle with linPRO®-R resulted in reduced incidence of mastitis, increased milk production, improved milk component yields

Date: 2017

Project code: OT16_13A

Abstract

Feeding dairy cattle, the flaxseed-based product known as linPRO-R (O&T Farms Ltd.), has associated with immunological benefits (Fetter et al., 2017) and improvements in animal production (Moats, 2016). In some cases, feeding flaxseed-based products to dairy cattle has been linked to improvements in reproductive performance (Petit et al., 2001; Anderson et al., 20007). A large-scale commercial study was conducted to evaluate the effects of linPRO-R on milk production, animal health, and reproductive performance in dairy cattle. Due to facility restrictions, transition-cow treatments were not possible; therefore, only early-lactation cow diets were evaluated (14- 150 DIM). A total of 527 cows were used in a randomized block design. Experimental diets consisted of a control diet (no linPRO-R; CTL), a diet containing a low level of the linPRO-R product (2.5% DM; LLPR), and a diet containing a high level of the linPRO-R product (5.0% DM; HLPR). Results of this study reported an increase in milk yield ($P < 0.01$) with LLPR, while milk fat and milk protein yields were maintained across treatments. Total SCC was reduced quadratically in linPRO-R treatments compared to the control ($P = 0.04$). A linear ($P = 0.04$) and a quadratic ($P = 0.04$) reduction in mastitis infections was also observed in linPRO-R treatments. Cumulative conception rates were unaffected by dietary treatment averaging 77.1 % over three services. Economic evaluation of dietary treatments using current California market prices and costs of production suggest an increase in net income when linPRO-R is included in the diet of early-lactating dairy cattle. Overall, data from this study support the inclusion of linPRO-R in early-lactating dairy cow diets.

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Introduction

Scientific advancements have allowed for a deeper understanding of fat metabolism and its associated impacts on production, health and reproduction in dairy cattle. Several studies have shown that adding fat in the diet of transition cows (~ 3 wks pre- and post-calving) can improve reproductive performance and energy balance while lowering incidence of disease (von Soosten et al., 2012; Rodney et al., 2015). Incorporation of a fat supplement during this time-frame is important to elicit a reproductive effect at first service. There is a 180-d interval between the development and activation of preovulatory follicles, thereby making the transition period a critical point in ensuring healthy follicular development and future reproductive success (Ribeiro, 2018; Fair, 2003). Furthermore, the incorporation of a flaxseed-based supplement is considered an ideal strategy based on the high levels of omega-3 fatty acids and lignans which may further contribute to reproduction and overall animal health (Petit et al., 2001; Fetter, 2017)

LinPRO-R is a commercial flaxseed-based feed ingredient manufactured and produced by O&T Farms Ltd. (Regina, SK.). The dry-extrusion processing technology along with a unique blend of ingredients (peas, alfalfa, vitamin E, and flaxseed) make it appealing for commercial dairy applications, especially as it relates to animal health and reproduction. Additionally, dry-extrusion processing provides protection of the omega-3 fatty acids from ruminal biohydrogenation the formation of a protein-fat matrix (Kennelly, 1996), and increases the levels of rumen undegradable protein (RUP). The overall result is a stabilized form of flaxseed-derived omega-3 fatty acids that is stable and can overcome challenges commonly associated with feeding flaxseed to ruminants, in its whole or ground form.

Earlier studies have demonstrated the ability of linPRO-R to optimize animal performance (Moats, 2016) and mitigate inflammatory responses in transition cows (Fetter, 2017). Therefore, incorporating linPRO-R throughout the transition and early-lactation periods could offer substantial economic benefits to producers through improved overall herd performance. In the current study, the use of transition cows was not possible due to facility restrictions; therefore, only early-lactation cow performance was evaluated.

Objective

The objective of this study was to evaluate the impact of feeding different dietary inclusion levels of linPRO-R to early-lactating dairy cattle on milk production and milk composition, animal health, and reproductive performance at a commercial scale.

Methodology

A commercial-scale study was conducted on a 5,000 cow California dairy herd. Experiments were carried out as a randomized block design consisting of three pens holding 315 early-lactating, multiparous, Holstein dairy cattle (14- 150 DIM) over 9 treatment assignment weeks with 527 cows having met all trial criteria. Cows leaving the fresh pen were loaded into trial pens every 3 weeks, ensuring an equal number of cows with high DIM (> 150 DIM) were removed . Additionally, animals and treatments rotated through each physical pen every 30 days thereby eliminating

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"pen" as a variable within the statistical model (Figure1).

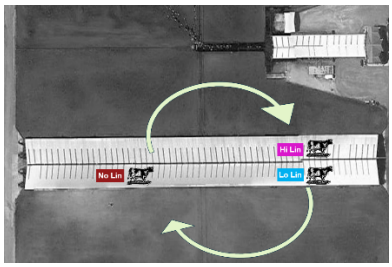

Figure 1. *Animal and treatment rotation pattern used in the current study.*

Animals were de-assigned from the experimental treatments only if the following criteria were met: 1) the cow received an antibiotic treatment, 2) the cow was off-treatment for > 5 days, or 3) the cow died. Animals were cared for, bred, and handled according to facility management standards. The facility uses a timed Double-ovsynch breeding program with a 60-d VMP before first service.

Experimental diets consisted of a control diet ***(no linPRO-R; CTL)***, a diet containing a low level of the linPRO-R product (***2.5% DM; LLPR***), and a diet containing a high level of the linPRO-R product ***(5.0% DM; HLPR)***. The HLPR treatment was added with the objective of evaluating milk fatty acids. These data are excluded from this summary and can be sourced from O&T Farms using project code OT16_13B. Diets were fed twice daily as a total mixed ration (TMR) and were formulated to be isonitrogenous (16% CP DM) and isocaloric (4% EE DM).

Animal performance was measured based on milk production, milk compositional yield and body condition scores. Health incidences were monitored daily and assessed by farm personnel and recorded to the facility's DC305 herd records.

Reproductive performance was evaluated based on first and second conception rates. Third service conception rates were also followed once the animals had been removed from treatment to determine whether a carry-over effect of treatment may exist.

The economic impact of dietary treatments was evaluated based on feed costs, current milk prices, costs associated with breeding and costs associated with health incident treatments.

Reproductive performance was analyzed using standard GLM procedures with treatment and block as fixed effects. Animal performance and health incidences were analyzed by standard MIXED procedures with treatment, block and treatment*block as the fixed effects, and cow as the random effect nested within block.

Results & Discussion

Milk Production & Composition

Dietary effects on milk yield, milk components, and somatic cell count (SCC) are presented in Table 1.

Table 1: Effect of dietary treatment on milk production and milk composition

	Treatment				*P-values*	
	CTL	LLPR	HLPR	SEM	Linear	Quad
DMI, lb/d	67.0	65.9	66.3	0.118	0.17	0.15
Milk Yield, lb/d	105	110	112	0.498	<0.01	0.21
Milk fat, %	3.46	3.39	3.42	0.030	<0.01	0.20
Milk fat, lb/d	3.64	3.72	3.81	0.018	0.42	0.97
Milk Protein, %	2.89	2.86	2.86	0.015	<0.01	0.35
Milk Protein, lb/d	3.02	3.13	3.20	0.012	0.24	0.42
Milk Lactose, %	4.90	4.88	4.87	0.010	<0.01	0.77
Milk Lactose, lb/d	5.16	5.38	5.44	0.023	0.02	0.22
SCC, (x 1000)	132	81.0	110	660	0.32	0.04

CTL: Control diet with no linPRO added
LLPR: low-linPRO-R diet with 2.5% DM in TMR
HLPR: high-linPRO-R diet with 5.0% DM in TMR
* Percentage of cows absent from pen for > 5 d due to health incidence and/ or antibiotic treatments.

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Milk yield increased linearly (P = < 0.01) when linPRO-R was included in the diet of early-lactating dairy cattle. Supplementing dairy cattle with a fat source often results in an increase in milk yield; however, the current study formulated diets to be isocaloric to ensure fat content was maintained across treatments. Therefore, ***these results suggest that the inclusion of linPRO-R into the diet of dairy cattle as a source of omega-3 fatty acids and amino acids may result in improved milk yields.*** Similarly, Moats (2016) reported an improvement in milk yield when linPRO-R was included in the diet of mid-lactating dairy cows.

Dry matter intake (DMI) was unaffected by dietary treatment and averaged 66.3 lb/d among treatments. The maintenance in DMI combined with and increase in overall milk yield, suggests that ***feed efficiency was improved in when linPRO-R was fed compared to the control.*** Similarly, Moats (2016) reported a tendency for improved feed efficiency with linPRO-R was fed to dairy cattle.

A linear reduction in milk fat percentage was observed with inclusion of linPRO-R (*P* <0.01); however, milk fat yield was unaffected. The reduction in milk fat percentage observed is considered small and is unlikely to have negative economic impact on producers. These results agree with Moats (2016) who fed linPRO-R to mid-lactating dairy cattle at 11% DM. The lower percentage value reported in this study is believed to be attributed to the dilution of fat due to increased milk volume.

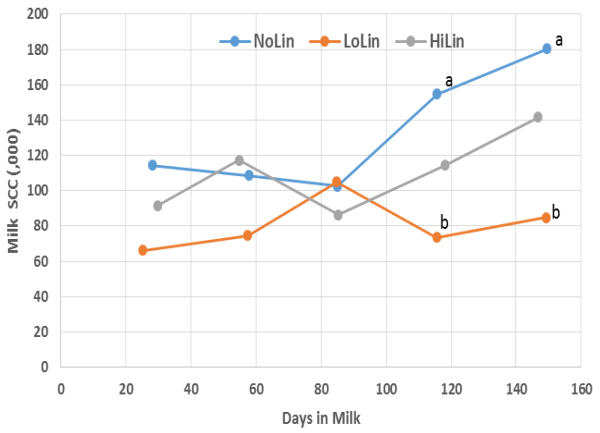

Figure 2. *Effect of dietary treatment on SCC (x 1000; Robinson and Swanepole, unpublished 2016)*

A quadratic reduction in SCC was observed (P = 0.04) when linPRO-R was included in the diet. These results provide additional support for the beneficial effects of linPRO-R on incidence of mastitis which are described later in Table 2. When evaluated throughout the treatment period (Figure 2), the linPRO-R treatments maintained a consistent, healthy SCC within compared to the increasing SCC observed in the CTL.

Health Incidences

In the current study, ***both a linear (P = 0.04) and a quadratic (P = 0.04) reduction in mastitis infections was observed*** when linPRO-R was offered to early-lactating dairy cattle (Table 2). Mastitis is a major source of economic loss within the dairy industry resulting in reduced milk yields, involuntary culling, and treatment costs. It is an inflammatory disease within the mammary gland primarily caused due to immune response to bacterial infection of the udder. Earlier work reported a reduction in inflammatory genetic markers when

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transition cows were fed linPRO-R (Fetter et al., 2017), which is in agreement with the reduced SCC and incidence of mastitis observed in this study.

Table 2: Effect of dietary treatment on health incidences in early-lactating dairy cattle.

	Treatment				*P-values*	
	CTL	LLPR	HLPR	SEM	Linear	Quad
Mastitis, %	10.3	3.1	4.5	1.17	0.04	0.04
Lameness, %	8.80	7.40	8.20	1.58	0.83	0.64
Total culls*, %	22.3	14.5	19.8	2.46	0.57	0.13

CTL: Control diet with no linPRO added
LLPR: low-linPRO-R diet with 2.5% DM in TMR
HLPR: high-linPRO-R diet with 5.0% DM in TMR
* Percentage of cows absent from pen for > 5 d due to health incidence and/ or antibiotic treatments.

Furthermore, the total number of cows that were removed from the trial due to health incidences was lower in the LLPR and HLPR treatments compared to the CTL at 14.5%, 19.8% and 22.3%, respectively. Although these data were not statistically significant, any numerical reduction in involuntary culls can have large economical benefits to a dairy operation.

Reproductive response:

Reproductive response to dietary treatment is described in Table 3. As expected, no benefits in first- service conception rates were observed in the linPRO-R treatments. It is well known that a 180-d interval exists between the primordial development and activation of preovulatory follicles (Ribiero, 2017), making these follicles susceptible to potential negative insults during the entire dry-off and transition phases. Therefore, the any insults to follicular development which could occur during these periods can negatively influence first service conception rates (Lussier et al., 1987; Fair, 2003). For these reasons, the inclusion of linPRO-R at 14 DIM, as in this study, was not expected to have any impact on first-service conception rates.

Both a linear and quadradic reduction was observed in first service conception rates for the linPRO-R treatments (P <0.01 and P= 0.05, respectively). Second service, and third-service conception rates rebounded.

Table 3: Effect of dietary treatment of conception rates (CR) in high producing Holstein Cows

	Treatment				*P-values*	
	CTL	LLPR	HLPR	SEM	Linear	Quad
1st Service CR	55.0	39.5	36.2	1.77	<0.01	0.05
2nd Service CR	36.1	42.2	40.3	6.68	0.68	0.650
3rd Service CR	23.0	40.0	27.0	N/A	N/A	N/A
Cumulative	78.8	80.0	73.0	N/A	N/A	N/A

CTL: Control diet with no linPRO added
LLPR: low-linPRO-R diet with 2.5% DM in TMR
HLPR: high-linPRO-R diet with 5.0% DM in TMR
* Conception rates from 3rd service were not statistically analyzed and were recorded for post-trial observational purposes

Several studies have suggested that feeding a source of fat during the dry period is an effective strategy for priming the metabolic system for more efficient lipid metabolism during early-lactating (Grum et al., 1996; Friggens et al., 2004; Anderson, 2007). According to Anderson (2007), C18:3n-3 has a stimulating effect on perozisomal proliferation activity in the liver which contributed to increased enzymatic activity associated with LCFA beta-oxidation processes. Based on this, it is thought that ***feeding a source of C18:3n-3 during the dry period is an ideal strategy for priming the cow's*** hepatic metabolism of LCFA metabolism after calving and promote positive carry-over effects on animal reproduction. The time of introduction during the dry period does not appear to have any effect on carry-over responses (Badiei, 2014) suggesting the inclusion of these fatty acids at the close-up dry period would be sufficient.

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Blood serum was collected post-insemination, to ensure the reduction in first service conception rates was not caused by a treatment effect on serum progesterone (Figure 3). Results clearly show that serum progesterone levels were not different based on dietary treatment, and therefore can not explain the reduction in conception at first service.

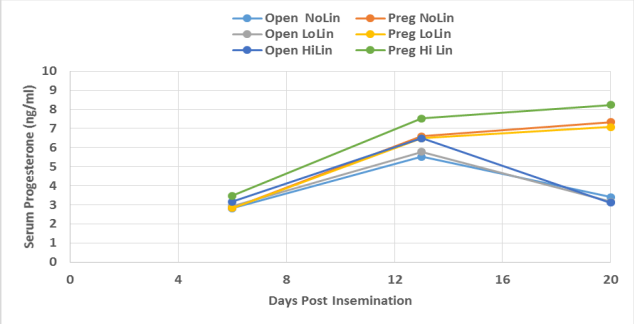

Figure 3. *Effect of dietary treatment on serum progesterone levels in early-lactating dairy cattle post-insemination (Robinson and Swanepole, unpublished 2016)*

According to Ribeiro et al (2016c), risk of pregnancy in dairy cattle using a timed AI program is significantly reduced when BCS of cows is <3, compared to those with BCS of >3.

In the present study, the BCS of cows on the LLPR and the HLPR diets was <3 at the start of the trial (Figure 4). Poor hepatic regulation of lipid metabolism and resulting toxic metabolites associated with a state of NEBAL are a primary risk factor for pre-ovulatory follicles (Rodney et al., 2015; Ribeiro, 2018). In the current study, it was by chance that the LLPR and the HLPR treatments consisted of animals with more severe NEBAL at the start of treatment.

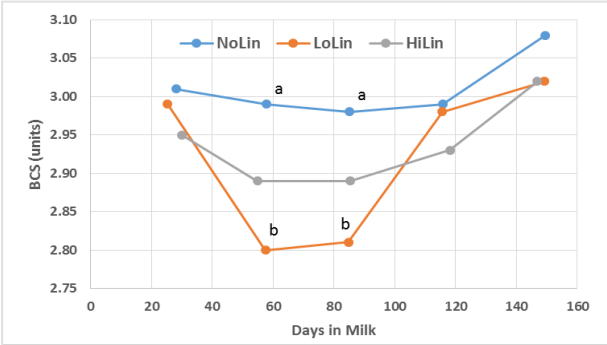

Figure 4. *Effect of dietary treatment on body condition score (BCS; Robinson and Swanepole, unpublished 2016)*

These data further suggest that ***a carry-over effect from the transition period was the causative effect for reduced first service conception rates, and that the linPRO-R product was not a contributing factor.***

Economic Evaluation

An extensive economic evaluation was conducted based on feed costs, breeding costs, health costs, and current state markets for cull cows and milk. In this study, the economics are based on California markets. Overall, results indicate an increase in net income when linPRO-R is included in the diet of dairy cattle (Table 4).

Table 4: Effect of dietary treatment on overall production economics (estimates based on a 100-cow group and expressed in USD)

	Treatment		
	CTL	LLPR	HLPR
Calculated Revenue	$229,012	$240,517	$240,050
Calculated Expenses	$86,920	$90,676	$93,300
Net Income per cow	$1,421	$1,498	$1,468
$ Difference vs CTL	-	$77	$47
Net income per defined group	$447,590	$471,999	$462,263
$ Difference vs CTL	-	$24,410	$14,674

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Conclusion:

Results of this study provide support for the inclusion of linPRO-R into the diet of early-lactating dairy cattle. Milk production and feed efficiency were significantly improved with linPRO-R feeding while milk composition yields were maintained. Incidence of mastitis and involuntary culls were reduced with linPRO-R feeding programs providing further support to immunological benefits of the products. Overall, this study suggests that feeding linPRO-R to dairy cattle represents an economical option for optimizing performance of dairy cattle.

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