

# REVIEW: Recent Applications of Liquid Feed Supplements in Rations for Lactating Dairy Cows

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## Abstract

Liquid feed supplements (LFS) have traditionally been used in lick tanks as a source of nonprotein nitrogen and energy for dairy replacement heifers and dry cows. Recent applications of LFS in rations for lactating dairy cows were reviewed along with the corresponding research data available in the scientific literature. Liquid feed supplements offer an alternative delivery vehicle for supplemental fat, undegraded intake protein, and rumen-fermentable carbohydrates in total mixed rations for lactating dairy cows. In general, the experiments reviewed did not show a lactation performance advantage to the dietary addition of animal-fat or animal-protein by-products in liquid compared with dry feed supplements. Lactation performance benefits from the feeding of molasses or sugar were not well-substantiated by the literature data, and controlled research is needed to evaluate this aspect of the use of LFS in diets for lactating dairy cows. University and field trials suggest that sorting of total mixed rations fed to lactating dairy cows can occur. Addition of LFS to total mixed rations to reduce sorting of diet components is a new practice on commercial dairy operations,

but controlled research trials evaluating the efficacy of LFS for ameliorating a sorting problem are lacking. Advantages of LFS in convenience and uniformity of ingredient and nutrient delivery can be evaluated relative to cost differences between liquid and dry feed supplements since lactation performance differences between them were minimal.

(Key Words: Liquid Feed Supplements, Dairy Cows, Total Mixed Rations.)

## Introduction

Liquid feed supplements (LFS) have a long history of use in dairy cattle feeding. Initially, LFS were used in lick tanks as a source of nonprotein nitrogen (NPN) and energy for dry cows and replacement heifers. More recently, with the increased popularity of feeding total mixed rations (TMR), LFS have been marketed with the following claims: (i) safe and uniform delivery vehicle for micronutrients to TMR, (ii) safe delivery vehicle for NPN to TMR, (iii) improved NPN utilization, (iv) delivery vehicle for molasses or rumen-fermentable carbohydrates to TMR, (v) reduced dustiness of concentrates and TMR, (vi) reduced sorting of TMR in the feed bunk, (vii) increased intake of TMR, (viii)

increased ruminal fiber digestion and microbial protein synthesis, and (ix) increased bulk density of TMR. Recent research with LFS for dairy cattle has focused on their role as an alternative delivery vehicle for supplemental fat, undegraded intake protein (UIP), and rumen-fermentable carbohydrates to the TMR.

## Review

**Sorting of TMR.** Leonardi and Armentano (8) and Martin (10) observed extensive TMR sorting in the feed bunk in university and on-farm trials, respectively. Data on particle size of TMR and orts and DM intake indicated that cows sorted against the coarse particles (8). This sorting against the coarse particles was more evident for the TMR containing 40% compared to 20% alfalfa hay (DM basis); the variation in sorting among cows was large (8).

Martin (10) determined the particle size of TMR and bunk mix at 6-h intervals post-feeding on a commercial dairy. The percentages on the top screen of the Penn State shaker box (7) for TMR and bunk mix at 6-, 12-, 18-, and 24-h post-feeding were 9.3, 13.7, 21.5, 27.5, and 58.7%, respectively. Factors that may make a TMR prone to sorting include: DM content and particle size

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of forage and mix, variation in bulk density of feed ingredients, cobs in corn silage, amount and quality of hay added to mix, and feeding frequency, bunk space, and feed-access time. Although controlled research data are not available, anecdotal reports from commercial dairies on the addition of LFS to TMR to reduce sorting have been positive. Use of LFS to increase uniformity of nutrient consumption has been evaluated in beef feedlot diets with positive results (16).

**Liquid Feed Supplements for Dietary Fat Addition.** Researchers from The Ohio State University (1, 14) evaluated the efficacy of fat sources in LFS. Two feeding trials were conducted with 60 Holstein cows per trial during wk 4 through 19 of lactation. The LFS contained molasses and corn steep liquor, and either no fat, animal fat, animal fat plus urea, or soy-oil refining lipid. Trial 1 also contained a treatment where animal fat was added directly to the diet rather than through the LFS. In Trial 1 the LFS or animal fat was added to concentrates that were mixed in the TMR, while in Trial 2 the LFS were added directly to the TMR. Cows in both trials were fed individually in tie-stalls. Diets fed in these trials provided LFS intakes ranging from 1.0 to 3.0 kg/cow/d (as-fed basis).

In Trial 1, feeding supplemental fat increased milk yield and reduced milk crude protein (CP) percentage with inconsistent effects on milk fat percentage. There were no statistically significant intake, milk yield, or milk composition advantages ( $P>0.10$ ) to supplementing animal fat in LFS vs adding it directly to the diet. Digestibilities of organic matter, neutral detergent fiber, and fatty acids were unaffected ( $P>0.10$ ) by treatments (1). The primary advantage to feeding animal fat in LFS vs adding it directly to the diet was in improved product handling (1).

In Trial 2, feeding the no-fat LFS increased milk and 3.5% fat-corrected milk (FCM) yields 1.4 and 0.45 kg/cow/d, respectively, compared to the

control. Increasing dietary ether extract content from 3.2% to 4.0–5.3% (DM basis) using LFS increased milk and FCM yields an additional 1.4 to 1.8 and 1.8 to 2.3 kg/cow/d, respectively. Adding LFS directly to TMR in Trial 2 may have improved the response compared to Trial 1 where LFS were added to concentrates that were mixed in the TMR.

In lactating dairy cows grazing orchardgrass-clover pasture, Polan et al. (15) evaluated concentrate mixtures containing either ground corn-soybean meal control, control partially substituted with molasses-animal fat LFS plus corn gluten meal, control partially substituted with molasses-animal fat LFS plus fish meal, or control partially substituted with whole cottonseed plus fish meal. The concentrate mixtures were fed twice daily. Cottonseed or animal fat supplied fat equal to 0.45 kg/cow/d. Milk yield was 1.5 and 2.5 kg/cow/d higher for LFS plus corn gluten meal and LFS plus fishmeal treatments, respectively, than for the whole cottonseed plus fishmeal treatment.

**Liquid Feed Supplements for Dietary Fat and Carbohydrate Addition.** Maiga et al. (9) evaluated four diets during wk 4 through 16 of lactation in 40 Holstein cows. Diets were fed as TMR containing 25% corn silage, 25% alfalfa hay, and 50% concentrate (DM basis). Treatments were no supplemental fat, 2% animal fat, 2% animal fat from LFS containing molasses and condensed whey, and 2% animal fat plus dried whey. Feeding supplemental fat increased DMI and milk yield 1.4 and 1.8 kg/cow/d, respectively. There were no intake, milk yield, or milk composition advantages ( $P>0.10$ ) to supplementing animal fat in LFS vs alone. Intake of LFS was 3.0 kg/cow/d, which may have been too high for an optimal response. The feeding rate of corn was reduced for LFS and dried whey treatments compared with the animal fat treatment, and DM intake and milk yield were not different ( $P>0.10$ ).

**Liquid Feed Supplements for Dietary Carbohydrate Addition.**

Holden et al. (2) evaluated LFS in grazing dairy cows. Control cows were fed 4.5-kg concentrate DM per cow per day in the barn. Treatment cows were substituted with ad libitum access to LFS in lick tanks. The ingredient composition of the LFS was not included in their abstract. Consumption averaged 4.5-kg DM per cow per day. Cows were in mid-to-late-lactation and the trial lasted 6 wk. There were no significant differences ( $P>0.10$ ) in milk or component production between dry concentrate and LFS-supplemented cows. When economical, LFS in lick tanks may provide a convenient option for supplementing grazing dairy cows.

Hoover and Webster (3) suggested that dairy cows might benefit from the feeding of sugar supplements. Morales et al. (11) evaluated the lactation response to dietary addition of cane molasses. Thirty-six mature Holstein cows in mid- to late-lactation were used. Molasses was substituted for ground corn in TMR at 0, 4, or 8% of diet DM. With 35% alfalfa silage diets, 8% added molasses depressed DMI, milk yield, and milk fat, and CP percentages were comparable to control and 4%-added molasses diets. Milk fat test was increased 0.2 percentage units with 4%-added molasses compared with the control. With 65% alfalfa silage diets, 8%-added molasses increased DMI and reduced milk CP percentage. There was no effect ( $P>0.10$ ) of 4%-added molasses in 65% alfalfa silage diets. With 30% cottonseed hull diets, molasses addition at both levels increased milk yield and milk fat percentage. The efficacy of molasses in the diet depended on the type and amount of roughage fed and the concentration of molasses in the diet. Also, adding molasses directly to TMR for cottonseed hull diets may have improved the response to molasses compared with the alfalfa silage diets where molasses was added to concentrates that were then mixed in the TMR.

Direct addition of dietary sugar did not improve lactation performance either as 1.5% brown-sugar

product in a TMR (12) or as 1.5% sucrose in a TMR (13). Lactation performance benefits from the feeding of molasses or sugar were not well-substantiated by the literature data, and controlled research is needed to evaluate this aspect of the use of LFS in diets for lactating dairy cows. Partial substitution of dietary starch with sucrose has been found to increase ruminal microbial protein production (4, 5), but ruminal and total-tract fiber digestion may be reduced (6).

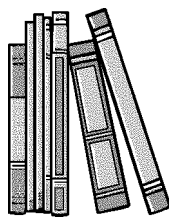
**Liquid Feed Supplements for Addition of Dietary Undegraded Intake Protein.** Wattiaux et al. (17) evaluated the lactation response to UIP from animal-protein by-products (APB) in LFS. Six diets were fed to 60 mature Holstein cows during wk 4 through 17 of lactation. Diets containing 60% alfalfa silage were formulated to contain 18.5% CP with either 5.0, 5.6, 6.2, or 6.8% UIP (DM basis). Diets were formulated using soybean meal, APB, urea, or a combination. The APB were provided in LFS.

Cows fed the APB-based LFS consumed less DM and produced less milk than cows fed the soy-based dry supplement. Animal-protein by-products from LFS comprised 2.7 to 7.0% of diet DM. Use of LFS did not overcome the depressing effects on DMI of high-level supplementation of APB in early-lactation cows. The high levels of APB fed in this trial may have precluded a better response to LFS. High concentrations of APB used in LFS were found to cause mixing, suspension, and handling problems.

## Implications

Liquid feed supplements offer an alternative delivery vehicle for supplemental fat, UIP, and rumen-ferment-

able carbohydrates to the TMR for lactating dairy cows. These applications are in addition to the traditional role for LFS as a source of NPN and energy in lick tanks for dairy replacement heifers and dry cows. Advantages of LFS in convenience and uniformity of ingredient and nutrient delivery can be evaluated relative to cost differences between liquid and dry-feed supplements since lactation performance differences between them were minimal. Although the use of LFS to increase the uniformity of nutrient consumption in beef feedlot diets has been common, addition of LFS to the TMR to reduce sorting of dietary components is a new practice on commercial dairy operations. There is experimental evidence of the sorting of TMR fed to lactating dairy cows (8, 10), but controlled research trials are needed to evaluate the efficacy of LFS for ameliorating a sorting problem.



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