

Sugar in Diets for Lactating Dairy Cows

Introduction

About 70% of typical diets for lactating dairy cows consist of carbohydrates, of which 37% are structural carbohydrates (neutral detergent fiber; NDF), 30% starch, and 3% simple sugars (free glucose, sucrose, fructose, and other minor sugars). Although each of these fractions is made up mostly of molecules of glucose, the nature of the chemical linkages affects the rate and extent of digestion in the rumen. About 45% to 60% of the NDF, 50% to 60% of the starch, and 100% of the sugar are fermented in the rumen, and the rate of fermentation is from slow to fast, respectively. The rapidly available energy for ruminal microorganisms provided by sugars appears to be beneficial in some situations. Overfeeding starch and/or underfeeding NDF can lead to low rumen pH, reduced fiber digestion, and milk fat depression. Adding additional sugar to diets in substitution for starch, even though sugars are fermented more rapidly than starch, does not increase the risk for lower rumen pH and milk fat depression and may increase NDF digestibility (if diets are adequate in rumen degradable protein) and result in higher dry matter (DM) intake. Supplemental sugar shifts the microbial population in the rumen whereby the lactate-consuming bacteria increase, resulting in increased butyrate production. As a result, milk fat concentration often increases with feeding sugars, but milk fat yield may vary depending on how milk yield responds.

Adding liquid sources of sugar to diets may help reduce sorting against large particles in a total mixed ration (TMR). This is especially a potential benefit when the TMR exceeds 50% DM and/or greater than 10% of the particles are on the top screen of the Penn State particle size separator. In addition, sugar from molasses is sometimes used to enhance the palatability of a feed; for example, adding molasses to calf starters.

Sources of Sugar

Most forages, especially silage, have relatively low concentrations of sugars (Table 1). Fresh forage (e.g., pasture) and hay will have higher concentrations of sugar than silage because they have not undergone the fermentation by microbes during ensiling. Various food processing by-products have moderate concentrations of sugar; for example, beet pulp, citrus pulp, bakery wastes, candy discards, etc. The two commonly used ingredients with the highest concentrations of sugar are molasses and whey. Various commercial liquid feeds will likely contain one or both of these ingredients. The primary sugar in molasses is sucrose, while lactose is the sugar in whey. Each of these two products necessitates special storage and handling equipment, but the handling of both can be challenging during the winter. Molasses is a more stable product than whey; thus, liquid whey must be used rather quickly unless a preservative is used. Whey is extensively used in human foods; thus, its price is often considerably higher than molasses on a DM basis, resulting in molasses being the most common source of supplemental sugar fed to dairy cattle.

Table 1. Concentrations (% of DM) of carbohydrates in feeds.¹

Feed	NDF	Starch	Sugar
Alfalfa (fresh, pasture)	32.0	1.0	8.5
Alfalfa hay	40.0	2.0	6.0
Alfalfa silage	38.0	1.0	2.0
Bakery waste	23.0	18.0	11.0
Citrus pulp	24.0	1.0	26.5
Corn grain	13.0	70.0	0.0
Corn silage	45.0	30.0	1.0
Molasses, cane	0.0	0.0	55.0
Sugar beet pulp	45.0	2.0	14.0
Whey	0.0	0.0	75.0

¹Most of the data in this table were adapted from “Feeding Sugar to Ruminants,” MB Hall (<http://www.extension.org/pages/25322/feeding-sugar-to-ruminants>).

General Recommendations

Generally, added dietary sugar should be held to about 2.5% and certainly should not exceed 5% of diet DM. Dietary sugar greater than or equal to 5% may reduce milk yield to an extent that milk fat yield is adversely affected. When considering the addition of dietary sugars, sugar concentration in the basal diet must be considered, as fresh forage and hay are higher in sugar

concentration than haycrop or corn silage, and by-product feeds vary in sugar content. For best results when feeding additional sugar, adequate forage NDF (19% to 21%), moderate starch (25%) or nonfiber carbohydrate concentrations (includes sugars; less than 40%), and adequate particle size of forages must be provided.

Summary

Carbohydrate fractions and their interactions must be carefully formulated and monitored for diets fed to lactating dairy cows. Feeding additional sugar, regardless of source, between 2% and 5% of the ration DM may result in improved feed efficiency and animal performance. The cost of adding sugar to the diet must be monitored, given that the cost of energy from the sugar may be higher than from starch sources, but animal responses may offset the additional costs. Therefore, monitor income over feed costs when adding such ingredients so that both revenue and cost can be considered.

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