

THE EFFECT OF FEEDSTUFF ON MILK FLAVOR

Valerie Kurka and Scott Rankin
Department of Food Science, University of Wisconsin – Madison
Madison, Wisconsin, USA

Abstract

Milk flavor is composed of a variety of chemical compounds, derived from numerous sources. Some compounds found in milk are directly linked to the diet of the animal producing the milk. In many cases, it is uncertain where the compounds originate. Two main hypotheses are that they originate in the plants eaten by the animal or they are products of digestion of precursors. Common animal feeds, such as TMR (Total Mixed Ration), pasture, corn, and hay, as well as a combination of them, can influence milk flavor and composition. Various feedstuffs also affect the performance of the producing animal. In general, TMR-fed cows have greater milk production, body weight, and body condition compared to pasture fed cows. Pasture-fed cows' milk contains more odor-active compounds than TMR-fed cows.

Introduction

Due to the small market for goat and sheep milk, a limited amount of information is available on the effect of feedstuff on sheep and goat milk composition and flavor. Given the complexities of flavor analysis, even cow milk research is very limited. However, most of the details presented in this paper relate to bovine milk. It should be noted that while sheep and goat milk have different composition and functional characteristics compared to cow milk, similarities in diet and milk production exist.

Feedstuff

A variety of feeding techniques exist for milk-producing animals. They include a strict pasture or grass-fed diet, a total-mixed-ration feed (TMR), or a combination of the two. Pasture fed animals generally have a varied diet from one region to the next due to different plant-life in different regions, as well as the influence of weather and other environmental factors. A TMR mix typically contains a variety of grains, seeds, and protein supplement. According to Bargo, "Energy is the primary limiting nutrient for high-producing dairy cows on pasture (Bargo 2002)". Grazing alone may not yield enough energy for high yielding animals, so it is common for farmers to supplement the animals' diet. Alternative supplementation to animal diet may include corn silage or hay silage. Advantages of corn supplementation and/or hay silage include cost efficiency as well as seasonal availability of pasture (Holden 1995).

Milk Flavor Composition

The flavor of milk is composed of a variety of compounds. Numerous studies (Carpino 2004, Bendall 2001, Mariaca 1997, Gordon 1979) have been conducted measuring different compounds associated with milk flavor. In particular, aromatic flavor compounds called alkylphenols greatly influence the "feed flavor" of milk. A few additional chemical compounds

that contribute to the feed flavor in milk composition include methyl sulfide, acetone, butanone, isopropanol, ethanol, and propanol (Gordon 1979).

One study (Carpino 2004) used cheese to identify odor-active compounds in the milk of differently fed cows. Gas chromatography was used to analyze the amount present in the cheese. In particular, more aldehyde, ester, and terpenoid compounds are found in pasture fed cows than TMR fed cows (Carpino 2004). Terpenoids in plants are products of secondary metabolism and may be considered as biochemical indicators to characterize highland cheese (Mariaca 1997). There is a small debate as to whether it is specific compounds found in milk that give it its flavor, or whether it is a concentration of a certain set of chemicals that give it its flavor.

Origin of Aromatic Flavor Compounds

Milk flavor is directly influenced by the diet of the animal producing the milk. For example, in Switzerland it has been known that a “pasture rich in dicotyledons, mostly located in the highland, is said to give cheese a different flavor from that produced from pasture rich in gramineae, located in the lowland (et al Sehovic, 1988, 1991).” This study demonstrates that the flavor of milk is directly influenced by the diet of the animal due to the differences in plant life consumed by the animal.

Knowing that the diet of animals influences their milk flavor, questions arise as to where the flavor compounds in the milk originate. It is possible the flavors in milk are found originally in the plant matter eaten by the cows. One particular study (Carpino 2004) used cheese to analyze the flavor compounds found in milk and suggests that “most of the odor-active compounds ... from pasture-fed cows appeared to be compounds created by oxidation processes in the plants that may have occurred during foraging and ingestion by the cow (Carpino 2004).” In other words, they are present in the milk due to the degradation or alteration of compounds in the plants consumed by the cow. The results of this study demonstrate “clearly that some unique odor-active compounds found in pasture plants can be transferred to the cheese (Carpino 2004).”

However, a different study suggests “differences in milk flavor are primarily caused by concentration differences of a common set of flavor compounds rather than by the occurrence of compounds uniquely associated with a particular feed (Bendall 2001).” This suggests there are basic compounds found in all milk, and different feed types produce different ratios of such compounds, instead of different compounds associated with different feed existing in the milk.

An additional hypothesis is that “volatile plant odors that are inhaled by the cow during consumption of the plants pass quickly through the bloodstream to the milk (Dougherty et al., 1962).”

Effect of Feedstuff on Animal and Milk

Numerous studies (Carpino, 2004, Holden 1995, Polan 1985, Bargo 2002, Kolver 1998) have shown that cows fed with TMR have greater milk production, body weight, and body condition compared to pasture fed cows. In addition, TMR-fed cows’ milk contains a higher milk fat content and protein content. Milk production and milk fat lowered only slightly when cows were

fed a mixed diet (Kolver 1998, Holden 1995.). However, the same study showed there are up to twenty-seven odor-active compounds identified in milk from pasture-fed cows. In mixed-ration fed cows, only thirteen active compounds were detected. Pasture-fed cows contain a greater number of odor-active compounds than mixed-ration-fed cows did (Carpino 2004).

Corn silage is another feedstuff used for milk-producing animals. One corn silage study (Polan 1985) conducted over a period of three years concluded corn silage was not as effective in maintaining milk production but enhanced milkfat. The same study also concluded limited hay or hay available in paddocks did not increase milk production or milk fat concentration.

Research is still needed to further explore these areas such as originating flavor compounds. In addition, more research may be performed with a variety of animals such as goat, sheep, and cows in other regions. Overall advancement of this knowledge may help farmers produce an optimum product for consumers in the most economic manner worldwide.

Bibliography

- Bargo, F., L.D. Muller, J.E. Delahoy, T.W. Cassidy. 2002. Performance of High Producing Dairy Cows with Three Different Feeding Systems Combining Pasture and Total Mixed Rations. *J. Dairy Sci.* 85: 2948-2963.
- Bendall, J. 2001. Aroma Compounds of Fresh Milk from New Zealand Cows Fed Different Diets. *J. Agric. Food Chem* 49 4825-4832.
- Carpino, S., S. Mallia, S. LaTerra, C. Melilli, G. Licitra, T.E. Acree, D.M. Barbano, and P.J. Van Soest. 2004. Composition and Aroma Compounds of Ragusano Cheese: Native Pasture and Total Mixed Rations. *J. Dairy Sci* 87:816-830.
- Dougherty, R.W., W.F. Shipe, G.V. Gudnason, R.A. Ledford, R.D. Peterson, R. Scarpellino. 1962. Physiological mechanisms involved in transmitting flavors and odors to milk. I. Contribution of eructated gases to milk flavor. *J. Dairy Sci.* 45: 472-476.
- Gordon, D.T., M.E. Morgan. 1979. Principal Volatile Compounds in Feed Flavored Milk. *Journal of Dairy Science* 55: 905-912.
- Holden, L.A., L.D. Muller, T. Lykos, T.W. Cassidy. 1995. Effect of Corn Silage Supplementation on Intake and Milk Product in Cows Grazing Grass Pasture. *Jour of Dairy Science* 78: 154-160.
- Kolver, E., L. Mueller. 1998. Performance and Nutrient Intake of High Producing Holstein Cows Consuming Pasture or a Total Mixed Ration. *J. Dairy Sci.* 81: 1403-1411.
- Mariaca, R G., T. Berger, R. Gauch, M. Imhof, B. Jeangros, J. Bosset. 1997. Occurrence of Volatile Mono- and Sesquiterpenoids in Highland and Lowland Plant Species as Possible Precursors for Flavor Compounds in Milk and Dairy Products. *Jour of Agricultural Chemistry.* 45: 4423-4434.
- Polan, C., R.E. Blaser, C.N. Miller, D.D. Wolf. 1985. Utilization of Pasture by Lactating Cows. *J. Dairy Sci.* 69:1604-1612
- Sehovic, J. Secondary metabolites in some plants of grassland forages. *Rech. Agron. Suisse* 1988, 27, 153-165.
- Sehovic J. Consideration on the chemical composition in the quality estimation of the natural grassland forages. *Rev. Suisse Agric.* 1991, 23, 305-310.