Reduced milk fat synthesis on Irish dairy farms

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Summary

- Annual milk fat concentration has made considerable gains over recent years.
- However, there is a consistent reduction in milk fat concentration during the months of April through July.
- Reduced milk fat synthesis is likely multifactorial with both nutritional and non-nutritional factors playing important roles.

Introduction

Milk fat is important for the production of butter, cheese, cream and whole milk powder; hence, it contributes substantially to the economic value of milk. Milk fat is also considered the most variable milk component with many nutritional and non-nutritional factors proposed to affect its production. Data from the Central Statistics Office, reporting monthly co-op intake of cow's milk, demonstrates that Irish annual milk fat concentration has made considerable gains over recent years (4.01% in 2012 compared with 4.39% in 2022). However, further analysis demonstrates a consistent reduction in milk fat concentration during the months of April through July. As this time period coincides with peak milk production, an increase in milk fat concentration during these months, would provide opportunity for farmers to increase the economic sustainability of their system.

Stage of lactation has been proposed as a non-nutritional factor involved in reduced milk fat synthesis. While it likely contributes, previous research has shown that the highest prevalence of a reduction in milk fat concentration occurred in April and May for both spring and autumn calving dairy cows, suggesting that time of year was more important than stage of lactation. The association of a reduction in milk fat concentration with time of year warrants further investigation as it could be related to environmental factors (e.g. day length) or nutritional factors (e.g. diet composition) that are prevalent during this risk period.

Potential nutritional causes of reduced milk fat synthesis

One of the leading theories as to the cause of reduced milk fat synthesis focuses around the dietary intake and rumen biohydrogenation of polyunsaturated fatty acids (PUFA). Biohydrogenation involves the addition of hydrogen to unsaturated fatty acids in the rumen converting them partially or fully to saturated fatty acids. Changes within the rumen environment of the cow can affect this process and results in alternative pathways of biohydrogenation, ultimately producing intermediates that are potent milk fat synthesis inhibiting molecules. Examples of factors that can lead to such changes within the rumen include; 1) high rumen PUFA load 2) low rumen pH, and 3) increased rumen passage rate. Pastures containing high fat concentration and low fibre concentration during the April-July period have been suggested to contribute to these factors in grazing dairy cows. However, data to support this hypothesis are quite limited. In order to overcome this, during 2021 and 2022, 28 commercial dairy farms from a large geographical spread were sampled across the grazing season. In-depth laboratory analysis is currently on-going to quantify the fat concentration, fatty acid profile and fibre concentration of pasture.

Level of concentrate supplementation has also been suggested as a possible theory for reduced milk fat synthesis. High levels of concentrate supplement can reduce dietary fibre concentration and increase the amount of rapidly fermentable carbohydrate consumed by the cow, leading to lower rumen pH. Low rumen pH can negatively impact fibre digestion,

which can lead to a reduction in the amount of acetate and butyrate production from fibre fermentation in the rumen. Acetate and butyrate are major precursor required for milk fat synthesis in the mammary gland.

Lactating dairy cow nutrition research

During 2021, an experiment was performed to investigate the effect of concentrate supplementation level and type on milk fat production. Our hypothesis was that as concentrate supplementation level increased, from 0-4 kg of DM/cow per day, milk fat concentration would decrease. While concentrate supplementation level increased milk fat yield, there was only a tendency for reduced milk fat concentration. This suggests that level of concentrate (up to 4 kg of DM/cow per day) does not have a major impact on milk fat concentration. Concentrate supplement type was also investigated in the experiment. A concentrate containing 10% sodium hydroxide treated straw and a concentrate containing 5% rumen-protected fat (RPF) were compared to an industry standard concentrate. At the inclusion levels investigated, the high fibre and the high RPF ingredients did not have an effect on milk fat concentration. However, the RPF ingredient significantly increased milk fat yield when compared with the industry standard concentrate (1.14 vs. 1.09 kg of fat/cow per day, respectively).

There is a growing body of evidence as to the effectiveness of RPF to increase milk fat concentration and yield for indoor-fed dairy cows. The fatty acid profile of this RPF seems to play an important role with higher palmitic acid concentrations shown to be more effective. During 2022, an experiment was performed at Teagasc to investigate the effect of RPF supplementation on milk fat production in grazing cows during the early to mid-lactation period. The cows received pasture plus one of three concentrate supplements containing either; 1) no RPF, 2) 5% RPF with a medium concentration of palmitic acid (58%); and 3) 5% RPF with a high concentration of palmitic acid (97%). Overall, the higher level of palmitic acid supplementation increased milk fat concentration but did not affect milk fat yield. During this experiment, the effect of animal genotypes on milk fat production was also investigated with three animal genotypes (high EBI Holstein-Friesian (HF), medium EBI HF and purebred Jersey) being incorporated into the experiment. The animal groups differed in terms of their predicted transmitting ability (PTA) for fat percentage with the purebred Jersey highest, high EBI HF intermediate and medium EBI HF lowest (0.54, 0.20 and 0.11 milk fat % PTA, respectively). Animal genotype had a significant effect on milk fat concentration with the purebred Jersey highest, high EBI HF intermediate and medium EBI HF lowest (5.71, 4.62 and 4.24% milk fat, respectively). On commercial farms, the PTA for fat percentage has also been demonstrated to be a strong indicator of milk fat concentration.

Conclusions

Reduced milk fat synthesis is multifactorial with both nutritional and non-nutritional factors playing important roles. This research has quantified some of the impacts of these factors on milk fat production; however, further investigation is required to identify the mechanisms involved and to develop robust mitigation strategies.