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Short Communication

Improving Fatty Acid Profiles in Ruminant Animal Products – Human Health Benefits

Yang WZ*

Department of Agriculture and Agri-Food, Lethbridge Research and Development Centre, Canada

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1. Short Comunaction

Public health concerns are driving research into modifying the fatty acid (FA) profiles of ruminant products including milk of dairy cows and goats, and beef, particularly toward less saturated medium-chain FA and more long-chain polyunsaturated FA (PUFA). There has been growing recognition of health benefits of PUFA in human foods, especiallyn-3 fatty acids and alpha-linolenic acid (ALA). These essential FA have been reported to play important roles in preventing and treating hypertension, diabetes, cancer, and some inflammatory disorders [1]. It was reported that in addition to the amount of essential FA consumed, the dietary ratio of n-6/n-3 PUFA is associated with cardiovascular health [2]. Hence, there is an increased interest in developing animal products with increased amount of n-3 PUFA or decreased ratio of n-6/n-3 to improve their healthy and functional properties for consumers.

Dietary fats are digested in the rumen by the processes of hydrolyzation and hydrogenation. Fat from feeds and tallow or grease is mainly in the triglyceride form. Triglyceride is a molecule of glycerol attached to three FA. In the rumen, the triglyceride is hydrolyze by ruminal bacteria to a molecule of glycerol and three free FA. The glycerol is degraded by the bacteria similar to other feed components. The FA released in the rumen are not absorbed from the rumen and they are hydrogenated to become mainly saturated fatty acids (SFA) because unsaturated FA (UFA) is toxic to rumen bacteria. Therefore, fatty acids available for absorption in the small intestine are mainly the SFA including palmitic and stearic FA. However, the ruminants are not able to synthesize the PUFA and must rely on the absorption in the intestine from feeds and fat supplement. It seems that the simplest way of altering milk or meat fat composition is to supplement the diets of animals with unsaturated lipids if there is no rumen hydrogenation. Therefore, the strategies that could improve FA composition with decreasing SFA and increasing UFA would be either through increasing the FA resistance to rumen biohydrogenation or reducing bacterial activity on the hydrogenation of FA. During last decade, our team has been working on several research projects focussing on improving FA profiles in dairy milk or beef meat by developing several nutritional strategies including dietary manipulation and feed additive development. The objective of this report is to briefly present some recent findings and such information can be helpful to understand how the changes of FA profiles in ruminant milk or meat can be potentially manipulated.

2. Altering FA in Beef by Manipulation of Cattle Diets

Beef FA profiles can be improved by feeding by-products from biofuel industry, named distillers grain (DG). There has been considerably increased the DG feeding in cattle ration during last decade due to intensive increasing ethanol production using corn or wheat grain in North American cattle production. The wheat-based DG contains much higher fat than does the original wheat. We found greater concentration of total PUFA in muscle for beef steers fed diet containing 30% wheat DG than steers fed diet without wheat DG [3]. The results indicate that

***Corresponding Author (s):** *Yang WZ, Department of Agriculture and Agri-Food, Lethbridge Research and Development Centre, Canada, Tel: (403) 317-3427; Fax: (403) 317-2182; E-mail: wenzhu.yang@canada.ca*

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some PUFA were not completely hydrogenated in the rumen, and some degree of protection of the PUFA in DG from ruminal biohydrogenation. In addition, inclusion of wheat DG into the diet increased concentration of conjugated linoleic acids (CLA) and vaccenic acid (VA) in muscle. Up to 90% of CLA c9, t11 detected in meat is originated by the desaturation of VA in the muscle by Δ9-desaturase enzyme, and thus it is suggested that to increase CLA c9, t11 content in beef, the best way is to enhance the VA formation in the rumen and to get it absorbed in the small intestine. Our results suggest that the use of wheat DG in finishing diets could develop value-added beef products by improving some desired FA which benefit human health.

Beef FA profiles can be altered by feeding wheat grain. A study was conducted to evaluate carcass trait and composition of FA in carcass of feedlot steers fed diets containing either barley or wheat grain [4]. The study found that replacing barley with wheat in finishing diets increased c11-18:1 content, but decreased VA in muscle. We also found that among the PUFA in lipids, the linoleic acid (c9, c12-18:2; LA) was the most abundant followed by ALA (18:3n-3) and CLA (c9, t11-18:2).Increased the content of t11-18:1 and decreased the content of VA in muscle by feeding wheat in the place of barley grain in our study were likely resulted from rapidly fermented wheat starch in the rumen.

3. Altering FA in Beef by Feeding Phytogenic Compounds to Cattle

Phytogenics are plant extracts or mixtures of plant-derived compounds from a wide range of plants and plant material including herbs, spices, roots, peel, and tree bark. Their proclaimed modes of action are diverse and have typical antimicrobial property. Feeding phytogenics to ruminants is expected to target specific ruminal bacteria and potentially decrease rumen bacterial biohydrogenationactivity, and thus increase PUFA escaping from rumen. A study was conducted to feed a commercial phytogenic feed additive and the results of this experiment show that feeding phytogenic feed additive reduced SFA and increased PUFA content. This suggests that this phytogenic modulated the biohydrogenation potential in the rumen and possibly the micro biome.

Plant derived essential oil (EO) has potential to modify dairy cow milk FA profiles. Milk FA composition is of great interest for human nutrition, and strategies using EO have been proposed to improve FA composition, decreasing SFA and increasing UFA. The addition of EO in ruminant diets can be an alternative strategy to improve milk FA profiles. Plant derived EO are complex mixtures of secondary metabolites and volatile compounds, extracted from plants through distillation. The EO have been reported to have an antibacterial activity against gram-negative and gram-positive bacteriaa property that has been attributed to the presence of terpenoid and phenolic compounds. Several gram-positive bacteria are involved in ruminal biohydrogeneration of FA, thus suggesting that feeding EO could lower biohydrogeneration of FA because of a decrease in the number of bacteria involved in that process. We evaluated the effects of feeding garlic oil and juniper berry oil to dairy cows, and found increase in the proportions of C18:1 t9 and C18:1 t10 in milk fat compared with cows without feeding EO [5]. Consequently, the proportion of total trans FA was greater for cows supplemented with either garlic oil or juniper berry EO than control cows. The cows supplemented with EO had also higher proportions of CLA t10, c12 in milk fat. The results that supplementation of the dairy cow diet with garlic or juniper berry EO increased the proportion of CLA t10,c12 in milk fat is particularly interested in human health benefits.

4. Conclusion

Public health concerns are driving research into decreaseSFA and increase long-chain PUFA. Whereas, increase PUFA in ruminant products is not always easy because of rumen bacterial biohydrogeneration and toxic effect of dietary PUFA on some rumen bacteria, which particularly adversely affect fibrolytic bacteria activity. Develop nutritional strategies to improve health FA profiles in ruminant products is challenge but is an interested research field. Altering dietary components or use of some phytogenic compounds have been proved to potentially improve the FA profiles in meat or milk fat, which are the area needs to be continuously studied.

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