The benefits of using new, more digestible alfalfa for Quebec's dairy farms

Duration: 2018-2021

Highlights

- The general objective of the project is to evaluate the benefits of using more digestible alfalfa for Quebec dairy farms.
- The digestibility of the potentially more digestible alfalfa cultivars (conventionally selected) was similar to the controls. Compared to the controls, the cultivars that were genetically modified (GM) for increased digestibility did, in fact, had a higher in vivo digestibility of NDF fibre and a similar performance.
- The use of GM alfalfa cultivars could extend the harvest period and make it less subject to weather-related hazards while maintaining a comparable digestibility of NDF fibre. Compared to a control alfalfa harvested earlier, GM alfalfa harvested later had a higher yield and similar in vitro digestibility of NDF fibre, but a higher NDF fibre content and a lower crude protein content.
- The use of the potentially more digestible, conventionally selected alfalfa cultivar, (i.e., non-GM) had no effect on the in vivo digestibility of NDF fibre or on dairy cow performance when compared to that of a control cultivar.
- In addition, the animal test demonstrated that it is possible to reduce the supply of metabolizable proteins in the ration without negatively affecting dairy cow productivity at the beginning of lactation, provided the ration meets their needs for essential energy and amino acids. Such changes to the ration help lower the nitrogen emitted into the environment, thereby reducing the environmental impact of milk production.
- Based on our partial budget estimates, there is an economic interest in using GM alfalfa, especially if it is harvested to increase quality and the increase in cow production is associated with quota purchasing.
- Although the use of more digestible GM alfalfa may be cost-effective in certain scenarios, its use remains controversial in terms of social acceptability. The research team will produce an objective opinion on the performance of this alfalfa in the Quebec context.

Objectives

The general objective of the project is to evaluate the benefits of using more digestible alfalfa for Quebec dairy farms. The specific objectives included:

1) To evaluate a number of more digestible alfalfa cultivars and populations (CONV or GM) in Quebec's bioclimatic conditions for their yields, nutritional values and persistence (plant component);
2) To evaluate the impact of using a more digestible alfalfa cultivar as well as lower metabolizable protein content and variable energy intake on dairy cow performance (animal component);
3) To evaluate the technical and economic impacts of using this alfalfa cultivar on dairy farms in Quebec (technical/economic component).

Results and potential benefits

Plant component: All cultivars survived winter conditions well. Results from the first year of production show that all cultivars had comparable seasonal yields to the controls, except for the cultivar selected for improved enzyme degradability of the stem (-13%). The GM cultivars had an *in vitro* digestibility of NDF fibre (NDFd) of 4.7 percentage units higher and an NDF fibre content of 1.0 percentage units lower than the controls. The conventionally selected alfalfa cultivars had a similar NDFd to the controls. The GM cultivars also offered greater harvesting flexibility, making it possible to delay harvesting in order to increase yield while maintaining a level of digestibility similar to the controls. With one less cutting per year when harvested at the early flowering stage, the GM cultivars had a seasonal yield of 1.0 t DM/ha higher and a similar NDFd, but a lower crude protein content (-3.1 percentage units), higher NDF level (+5.6 percentage units) and a higher lignin content (+0.16 percentage units) than those of the control cultivars harvested at the early budding stage.

Results and potential benefits, suite

Animal component: The use of the potentially more digestible, conventionally selected alfalfa cultivar had no effect on the *in vivo* digestibility of NDF fibre or on dairy cow performance when compared to that of a control cultivar. It was also demonstrated that a reduced metabolizable protein supply is possible if the essential amino acid and energy needs are met in dairy cows fed alfalfa-rich diets. Compared to a control ration, decreasing the metabolizable protein supply and maintaining the same energy balance improved the efficiency of the animal's protein use by 21.5%, while maintaining energy-corrected milk production as well as the production of fat and true milk proteins. In addition, this ration resulted in a 24.0% decrease in nitrogen excretions. Such changes to the ration help lower the nitrogen emitted into the environment, thereby reducing the environmental impact of milk production.

Technical/economic component: When the GM alfalfa and the control alfalfa are harvested at the early flowering stage, the GM alfalfa is more digestible. In the economic analysis conducted in the partial budgets, two options were considered to manage the increased cow productivity generated by an increased ingestion of more digestible alfalfa, quota purchasing, or cow sale. In the quota purchasing scenario, the net profit of an average farm with corn silage would increase by $7,884/year ($80/cow/year) as a result of the use of GM alfalfa. At the time of the cow sale, net farm income would then increase by $3,769/year ($38/cow/year) as a result of the use of GM alfalfa. Harvesting of GM alfalfa may be delayed to allow for a better yield while maintaining a fibre digestibility similar to that of control alfalfa harvested earlier, but the crude protein content is then reduced and the NDF fibre content is increased. The annual net profit increase associated with the use of a GM alfalfa cultivar would be lower in this scenario ($731/year for the farm, $7/cow/year). GM alfalfa cultivars could be economically attractive when used to increase the digestibility of NDF fibre, and the additional net benefit is greater when increased cow productivity is associated with quota purchasing.

Innovative aspects

- The productivity and nutritional value of these potentially more digestible alfalfa cultivars was tested for the first time in the field in the Quebec climate.
- Only the GM cultivars were more digestible than the control cultivars.
- A cultivar that was conventionally selected and marketed as being more digestible was evaluated in cows but was not shown to be more digestible.
- In certain scenarios, the use of more digestible alfalfa would have economic benefits on Quebec dairy farms.
- It is possible to decrease the metabolizable protein supply while maintaining cow performance, thereby reducing nitrogen excretion and the environmental impact of dairy production.

Professionals trained

Master's students:

- **Marie-Soleil Boucher** (U. Laval, master's degree in plant biology with thesis, 2019-2021)
- **Jean-Philippe Laroche** (U. Laval, master's degree in animal science with thesis, 2018-2020)
- **Yatandi Djiguiba** (U. Laval, master's degree in plant biology, 2018-2020)

For further information

Lectures

- Boucher, M.-S.*, G.F. Tremblay, P. Seguin, É. Charbonneau, M. Thériault, J.-P. Laroche, A. Bertrand, A. Claessens, G. Bélanger, R. Berthiaume, and C. Halde. 2021. *Valeur nutritive, rendement et persistance de cultivars de luzerne (Medicago sativa L.) plus digestibles récoltés à différents intervalles de coupe sous les conditions bioclimatiques du Québec*. Master's seminar. April 13, 2021. Virtual format.
- Boucher, M.-S.*, and J.-P. Laroche*. 2021. *La luzerne, peut-elle être plus digestible et comment la valoriser ?* Seminar presented to the Quebec City Research and Development Centre, Agriculture and Agri-Food Canada. April 8, 2021. Virtual format.
- Boucher, M.-S.* 2021. *La luzerne peut-elle être plus digestible ?* Invited speaker at the Ordre des Agronomes du Québec–Québec City Section Déjeuner-Conférence. March 30, 2021 Virtual format. Yvon Lévesque research grant. Invited speaker.
- Boucher, M.-S.*, G.F. Tremblay, P. Seguin, É. Charbonneau, M. Thériault, J.-P. Laroche, A. Bertrand, A. Claessens, G. Bélanger, R. Berthiaume, and C. Halde. 2020. *Est-ce que les cultivars de luzerne potentiellement plus digestibles le sont vraiment et qu'en est-il de leur rendement sous nos conditions ?* Poster presented at the annual conference of the Centre SÈVE – Recherche en sciences du végétal. Nov. 25 and 16, 2020. Virtual format. 1st Prize at the 2020 Student Scientific Poster Competition.
- Boucher, M.-S.*, G.F. Tremblay, P. Seguin, É. Charbonneau, M. Thériault, J.-P. Laroche, A. Bertrand, A. Claessens, G. Bélanger, R. Berthiaume, and C. Halde. 2020. *Assessing performance of alfalfa cultivars with improved digestibility in Quebec, Canada*. Poster presented at the 11th Annual Canadian Forage and Grassland Association. Nov. 18 and 19, 2020. Virtual format.
- Boucher, M.-S.*, G.F. Tremblay, P. Seguin, É. Charbonneau, M. Thériault, J.-P. Laroche, A. Bertrand, A. Claessens, G. Bélanger, R. Berthiaume, and C. Halde. 2020. *Performance and digestibility of alfalfa cultivars developed for improved digestibility in Eastern Canada*. Poster presented at the American Society of Agronomy, the Crop Science Society of America, and the Soil Science Society of America International Annual Meeting. Nov. 9 and 13, 2020. Virtual format.
- Boucher, M.-S.*, G.F. Tremblay, P. Seguin, É. Charbonneau, M. Thériault, J.-P. Laroche, A. Bertrand, A. Claessens, G. Bélanger, R. Berthiaume, and C. Halde. 2020. *Les luzernes plus digestibles: le sont-elles vraiment et qu'en est-il de leur rendement sous nos conditions ?* Poster presented at the Symposium sur les bovins laitiers. Nov. 3 and 4, 2020. Virtual format.
- Laroche, J.-P.*, R. Gervais, H. Lapierre, D.R. Ouellet, G.F. Tremblay, C. Halde, M.-S. Boucher and É. Charbonneau. 2020. *Effet de la réduction des apports en protéines métabolisables dans des rations pour bovins laitiers équilibrées pour les acides aminés et ayant un niveau variable d'énergie*. Master's seminar. May 13, 2020 Virtual format.
- Laroche, J.-P.* 2020. *Nutrition protéique: Peut-on faire plus avec moins ?* Invited speaker, Déjeuner-Conférence de l'Ordre des Agronomes du Québec - Quebec City section. Quebec City, QC, Canada. Feb. 21, 2020. Yvon Lévesque research grant. Invited speaker.
- Boucher, M.-S.*, and J.-P. Laroche*. 2020. *La luzerne peut-elle être plus digestible et comment la valoriser ?* Oral presentation at the Journée laitière des partenaires organized by MAPAQ. Saint-Bruno (Lac-Saint-Jean), QC, Canada. Feb. 12, 2020. Invited speaker.
- Laroche, J.-P.*, R. Gervais, H. Lapierre, D.R. Ouellet, G.F. Tremblay, C. Halde, and E. Charbonneau. 2019. *Nutrition protéique: Peut-on faire plus avec moins?* Poster presented at CRAAQ's Dairy Cattle Symposium (Symposium sur les bovins laitiers), Drummondville, QC, Canada. Oct. 29. 2019. Alain-Fournier Award for the best student poster.
- Boucher, M.-S.*, and J.-P. Laroche*. 2019. *Essai de cultivars de luzerne plus digestibles et leur impact sur la production laitière*. Innovation day on forage plants and field crops at the Université Laval Station agronomique de recherche. Saint-Augustin-de-Desmaures, QC, Canada. July 3, 2019. 100 participants. Invited speaker.
- Halde, C.* 2018. *Quels gains pour les fermes laitières québécoises d'utiliser les nouvelles luzernes plus digestibles ?* General meeting of Novalait shareholders, Holiday Inn, Longueuil, QC, Canada. Nov. 1, 2018. Invited speaker.
- Halde, C.* 2018. *Visit of the more-digestible alfalfa project parcels*. Open house at the Station agronomique de recherche in Saint-Augustin-de-Desmaures, QC, Canada. July 25, 2018. 55 participants. Invited speaker.

Master's thesis

- Boucher, M.-S. (in progress). *Évaluation de la valeur nutritive, du rendement et de la persistance de cultivars de luzerne plus digestibles et témoins récoltés à différents intervalles de coupe*. Master's thesis. Université Laval, Quebec City (QC) Canada. Submission scheduled for 2021.
- Laroche, J.-P. 2020. *Effet des apports en protéines métabolisables et en énergie de rations à base de luzerne sur les performances de vaches en lactation*. Master's thesis. Université Laval, Quebec City (QC) Canada.

For further information, suite

Popular science articles

- Halde, C., G.F. Tremblay, P. Seguin, M.-S. Boucher, J.-P. Laroche, R. Gervais, A. Bertrand, A. Claessens, G. Bélanger, R. Berthiaume, H. Lapierre, D.R. Ouellet, M. Thériault, and É. Charbonneau. 2021. *The benefits of using new, more digestible alfalfa for Quebec's dairy farms* Factsheet distributed at the Novalait Forum Techno virtual conference. June 8–9, 2021. Forthcoming.
- Boucher, M.-S., G.F. Tremblay, P. Seguin, É. Charbonneau, M. Thériault, J.-P. Laroche, A. Bertrand, A. Claessens, G. Bélanger, R. Berthiaume, and C. Halde. 2021. *Les luzernes vendues comme étant plus digestibles ne le sont pas toutes !* Article in the Écho-Fourrager newsletter published by the Conseil québécois des plantes fourragères (CQPF). January 2021. Number 1. p. 7-8.
- Laroche, J.-P, R. Gervais, C. Halde, M.-S. Boucher, É. Charbonneau, H. Lapierre, D.R. Ouellet and G.F. Tremblay. 2020. *Des rations faibles en protéines pour améliorer l'efficacité des vaches laitières*. Article in the specialized journal *Le producteur de lait québécois*. Oct. 2020. p. 36-37.
- Laroche, J.-P. 2020. *Un apport en protéines diminué sans pénaliser la production laitière*. Article in the weekly publication La Terre de chez nous. May 20, 2020. P. A14.
- Bellavance, A.L., C. Halde, et G. Tremblay. 2017. *Vers une luzerne plus digestible*. Article in weekly La Terre de Chez Nous. Column published by the Conseil québécois des plantes fourragères (CQPF). La Terre de Chez Nous. July 12, 2017. p. A28.

Financial contributions

Special call for proposals in dairy production and processing (2016-2021):

- Quebec consortium for industrial bioprocess research and innovation (CRIBIQ)
- Novalait
- Natural Sciences and Engineering Research Council of Canada (NSERC)

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Contact persons

Project supervisor:

Caroline Halde
Plant Science Department

Université Laval
2425 rue de l'Agriculture
Quebec City (QC) G1V 0A6

418 656-2131 ext. 403528
caroline.halde@fsaa.ulaval.ca

Contributors:

Gilles Bélanger
Agriculture and Agri-Food Canada

Robert Berthiaume
Consultant

Annick Bertrand
Agriculture and Agri-Food Canada

Édith Charbonneau
Université Laval

Annie Claessens
Agriculture and Agri-Food Canada

Rachel Gervais
Université Laval

Hélène Lapierre
Agriculture and Agri-Food Canada

Daniel Ouellet
Agriculture and Agri-Food Canada

Philippe Séguin
McGill University

Gaëtan Tremblay
Agriculture and Agri-Food Canada