



Haskap:
A small berry with big health benefits!

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1



Haskap:
A small berry with big health benefits!

Outline

- Fruit Bioactives and Bioproducts Research Program at Dalhousie University
- Haskap and Bioactive Composition
- Haskap Health Benefits: An Update of Research

Problems

Solutions

Proportion of deaths due to cancer and other causes, Canada, 2012

Obesity in CANADA
 A Whole-of-Society Approach for a Healthier Canada

Report of the Standing Senate Committee on Social Affairs, Science and Technology
The Honourable John G. Baird, Chairman
The Honourable Michael R. Wilson, Deputy Chairman
November 2016

www.dal.ca/fbb
FRUIT BIOACTIVES & BIOPRODUCTS
 research program

Dietary Factors

→

Overweight & Obesity

→

Chronic Diseases

Flavonoids

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An Interdisciplinary Research Program

established in 2004 at Dal-AC

Agri-Food

- Genotypes
- Value-added Food
- Flavonoid stability

Natural Products Chemistry

- Green extraction
- Metabolomics
- Derivatization

Human Health

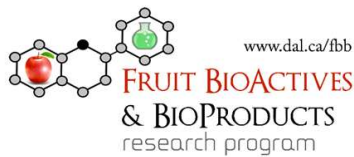
- Cell- and animal-based models of human chronic and metabolic diseases
- Pharmacokinetics and ADME
- Interactions with microbiome

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- 34 MSc/PhD; 14 postdocs;
- >195 Journal articles;
- 5 patent filings; 3 granted;
- 1 license agreement;
- 1 spin-off company

Since 2011 ..

Haskap R&D



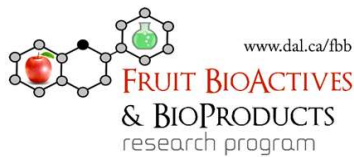
Haskap: Past & Current Research Projects



- K. Bhullar (BSc. 2011): **Antioxidant activity of haskap cultivars**
- M. Boem (BSc. 2013): **Polyphenols profiles and anti-inflammatory activity**
- M. McNeil (BSc. 2016): **Microwave-based pasteurization on anthocyanins**
- J. MacKeil (BSc. 2016): **Light/storage effects on juice bioactives/quality**
- T. Crossman (RA 2015/16): **Optimization of juice manufacturing**
- E. Pace (BSc. 2016): **Anti-cancer properties: HCC and TNBC**
- L. Wiser (GRA 2016): **Haskap juice: food safety**
- K. de Silva (MSc 2017): **Type 2 diabetes**
- M. Amararathna (MSc. 2016; PhD 2017 in progress): **Cancer chemoprevention**
- S. Dharmawansa (MSc. 2019 in progress): **Colon cancer**



Haskap and Bioactive Composition



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Haskap Constituents: Nutritional Facts

Nutrition Facts	
Valeur nutritive	
Serving Size (40 g) / Portion (40 g)	
Servings Per Container 3	
Portions par contenant 3	
Amount	% Daily Value
Teneur	% valeur quotidienne
Calories / Calories 150	
Fat / Lipides 1 g	2 %
Saturated / saturés 0.1 g	1 %
+ Trans / trans 0 g	
Cholesterol / Cholestérol 0 mg	
Sodium / Sodium 5 mg	1 %
Carbohydrate / Glucides 35 g	12 %
Fibre / Fibres 3 g	12 %
Sugars / Sucres 22 g	
Protein / Protéines 2 g	
Vitamin A / Vitamine A	4 %
Vitamin C / Vitamine C	60 %
Calcium / Calcium	4 %
Iron / Fer	6 %



BIOACTIVES:	
FLAVONOIDS	
Anthocyanins	C3G, C35DG, C3R, P3G
Flavonols	Q3Gal, G3G
Flavan-3-ols	Catechin
Proanthocyanidins	Procyanidin
PHENOLIC ACIDS	Chlorogenic acid
ISOPRENOIDS	Amyrin, Stigmasterol, Ursolic acid, Iridoids

* High in Vitamin C and Potassium

MERIEUX
NutriSciences

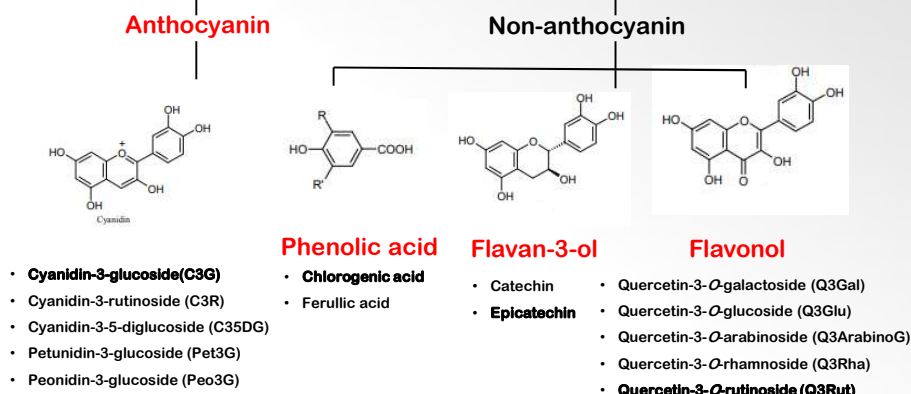
**Value
Proposition!**

Total monomeric
anthocyanins 24 mg
C3GE/g DW

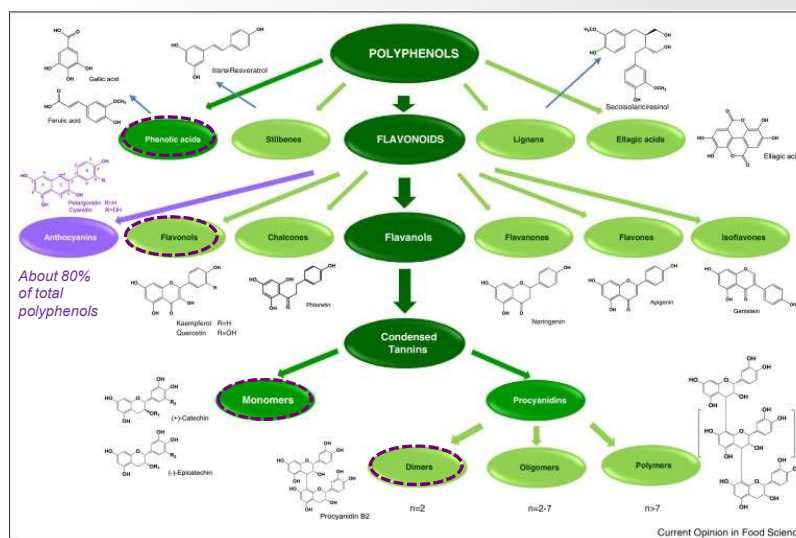
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Polyphenol composition of Haskap

Major phenolic bioactives

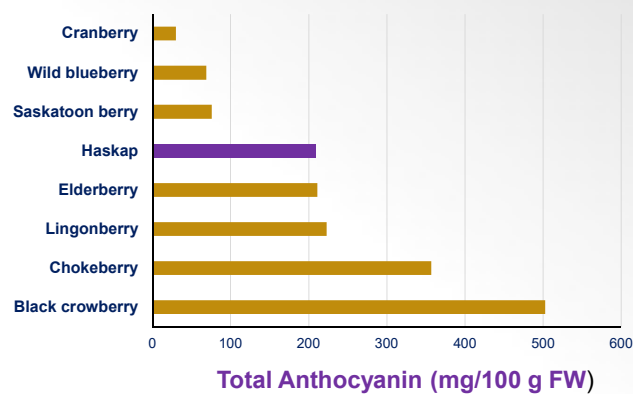


Polyphenol composition of Haskap



Haskap and other berries:

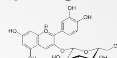
Anthocyanins



Dudonno et al. (2015) JFCA 44:214-224

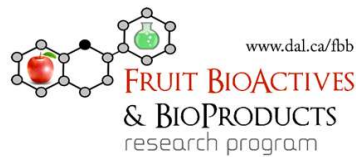
Haskap and other berries:

C3G (Chrysin) (Chrysanthemin)

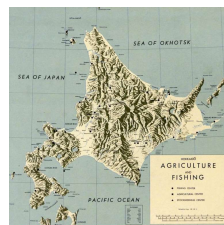


Fruit species	Cultivar and Location	C3G Concentration (mg/100 g FW)	Reference
Haskap	Wojtek and Brzowa in Poland	82-124	Ochmian et al., 2012
	Berry Blue, Borealis, Tundra, Indigo Gem of NS, new breeding lines AAFC, and Tundra and Indigo Gem of SK, Canada	68-170	Rupasinghe et al., 2015
	Zielona in Poland	221	Skupien et al., 2007
Bilberry	Finland	49	Kahkonen et al., 2003
Blackcurrant	Finland	17	Kahkonen et al., 2003
Wild Blueberry	Three clones of Nova Scotia, Canada	15	Gibson et al., 2013
Black Chokeberry	Norway	10	Slimestad et al., 2005
Cowberry	Finland	2.2	Kahkonen et al., 2003

Haskap and Health Benefits



Haskap and Health: Historical Facts



Native Habitat - Boreal Regions



- Native to mountainous areas of Hokkaido (Japan) and North Russia.
- Japanese Ainu aboriginal people has used for centuries for a variety of therapeutic purposes.
- Considered as **“the elixir of life”** and used for:
 - Prevention of blood pressure, **heart attack**, and anemia;
 - Cure for malaria and gastrointestinal disease.
 - **Longevity** and better eyesight.

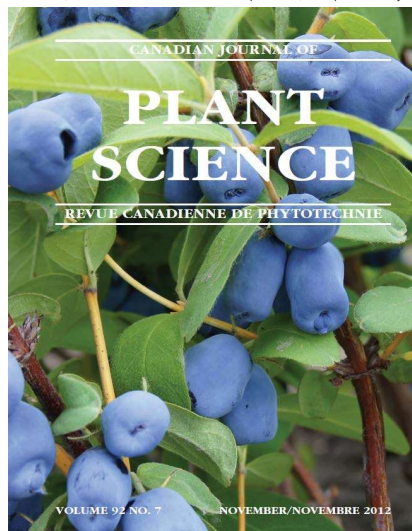
Great story for branding!

Thompson (2006) J. Am. Pomol. Soc. 60:164-168

SHORT COMMUNICATION: Haskap (*Lonicera caerulea*): A new berry crop with high antioxidant capacity

H. P. Vasantha Rupasinghe¹, Li Juan Yu¹, Khushwant S. Bhullar¹, and Bob Bors²

¹Department of Environmental Sciences, Faculty of Agriculture, Dalhousie University, Truro, Nova Scotia, Canada B2N 5E3 (e-mail: vrupasinghe@dal.ca); and ²Department of Plant Sciences, University of Saskatchewan, Saskatoon, Canada S0K 3A0. Received 1 April 2012, accepted 30 July 2012.



Potential Health Benefits of Haskap: Role of Cyanidin-3-O-glucoside



Contents lists available at ScienceDirect

Journal of Functional Foods

journal homepage: www.elsevier.com/locate/jff



The potential health benefits of haskap (*Lonicera caerulea* L.): Role of cyanidin-3-O-glucoside

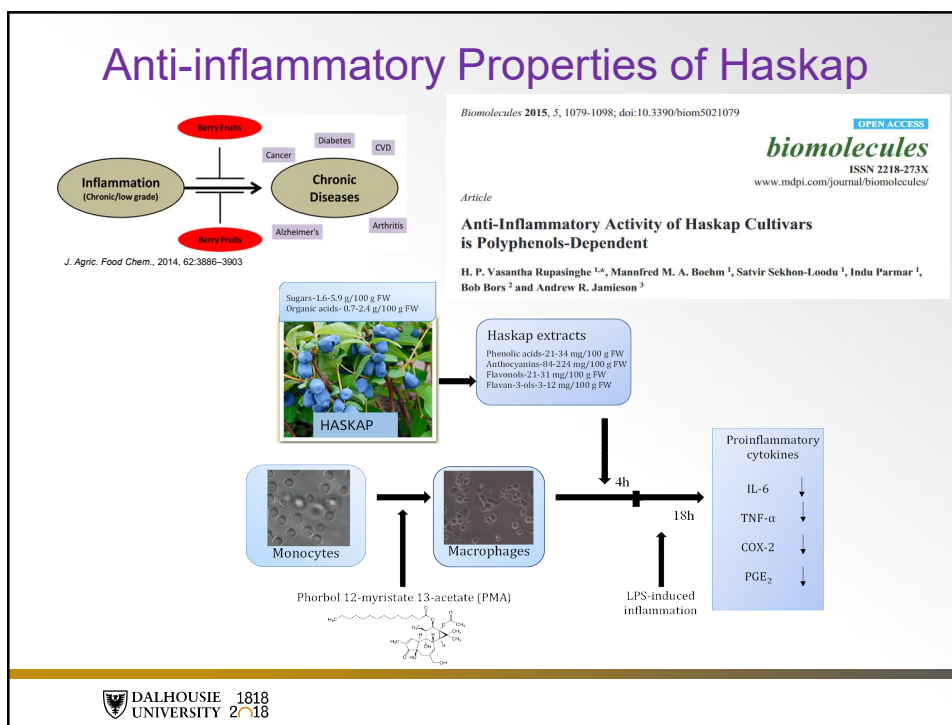
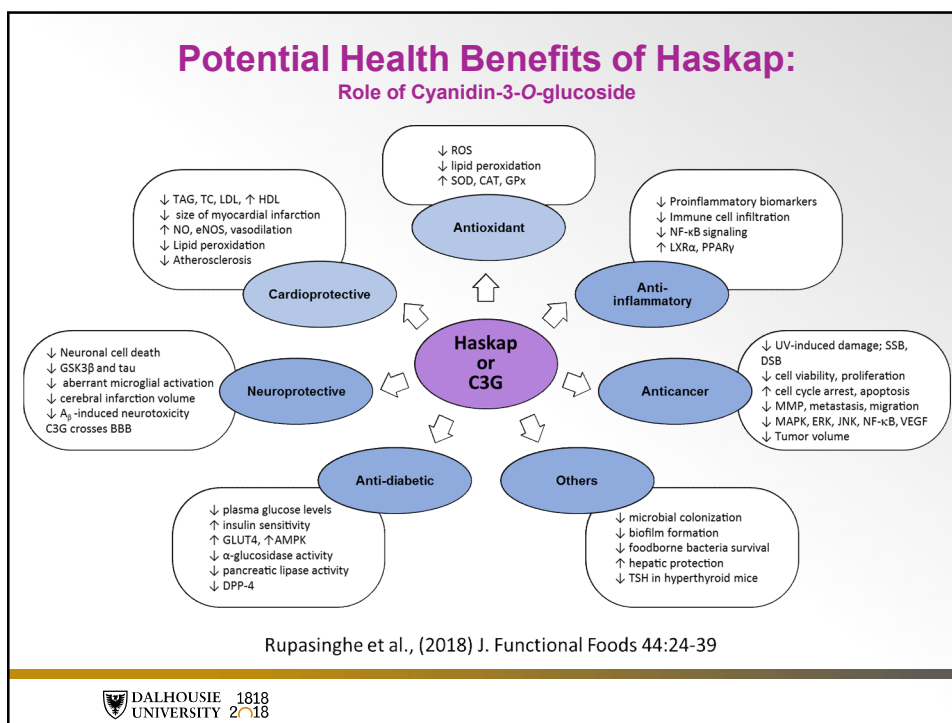
H.P. Vasantha Rupasinghe^{a,b,*}, Niroshaathevi Arumuggam^a, Madumani Amararatna^{a,b}, A.B.K.H. De Silva^a

^aDepartment of Plant, Food, and Environmental Sciences, Faculty of Agriculture, Dalhousie University, Truro, Nova Scotia, Canada

^bDepartment of Pathology, Faculty of Medicine, Dalhousie University, Halifax, Nova Scotia, Canada

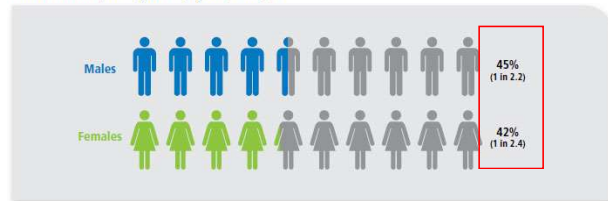


Review of 191 articles



Cancer Statistics in Canada

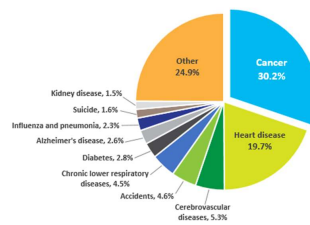
FIGURE 1.1 Lifetime probability of developing cancer, Canada, 2010



1 in 2

Analysis by: Surveillance and Epidemiology Division, CCOP, Public Health Agency of Canada

Data sources: Canadian Cancer Registry, Vital Statistics Death databases at Statistics Canada and Quebec Cancer Registry (2008–2010)



Canadian Cancer Statistics 2018



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Maritime scientists study berry with potential cancer prevention benefits

CTV Atlantic: New tool in cancer prevention?

Learn about the research local scientists are doing surrounding the Haskap berry.

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Dal.ca Home > Faculty of Agriculture > News & Events > News > 2018 > November 2018 > Faculty of Ag Ph.D. student wins top award at Atlantic Cancer Research Conference

NEWS

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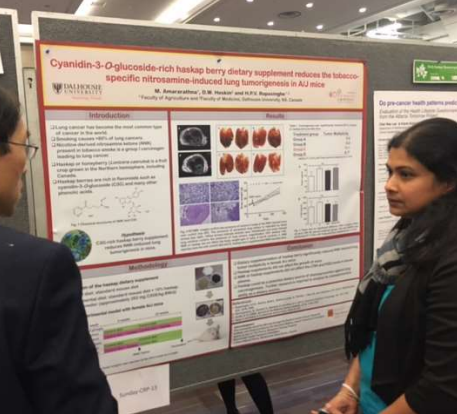
Faculty of Ag Ph.D. student wins top award at Atlantic Cancer Research Conference

Posted by Stephanie Rogers on November 13, 2018 in News



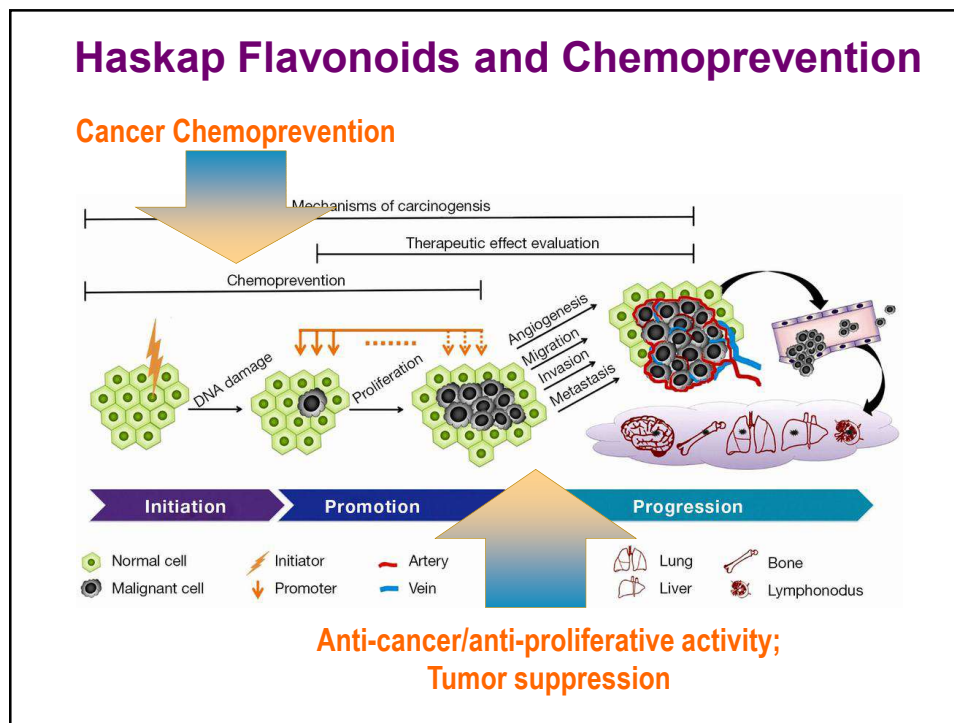
Madu Amararatna was among a few trainees whose abstracts were selected for the platform oral presentations at the 7th Cancer Research Conference in Atlantic Canada sponsored by Beatrice Hunter Cancer Research Institute (BHCRI) and the Terry Fox Research Institute (TFRI).

Madumani (Madu) Amararatna is a second year Ph.D. student of the Interdisciplinary Ph.D. program of Dalhousie University.



Madu Amararatna, PhD student

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Haskap Flavonoids and Chemoprevention

Food and Chemical Toxicology 141 (2020) 111404



Contents lists available at ScienceDirect

Food and Chemical Toxicology

journal homepage: www.elsevier.com/locate/foodchemtox



Anthocyanin-rich haskap (*Lonicera caerulea* L.) berry extracts reduce nitrosamine-induced DNA damage in human normal lung epithelial cells *in vitro*

M. Amararathna^a, D.W. Hoskin^{b,c}, H.P. Vasantha Rupasinghe^{b,c,*}

^a Department of Plant, Food, and Environmental Sciences, Faculty of Agriculture, Dalhousie University, Truro, NS, Canada
^b Department of Microbiology and Immunology, Faculty of Medicine, Dalhousie University, Halifax, NS, Canada
^c Department of Pathology, Faculty of Medicine, Dalhousie University, Halifax, NS, Canada




Article

Cyanidin-3-O-Glucoside-Rich Haskap Berry Administration Suppresses Carcinogen-Induced Lung Tumorigenesis in A/JCr Mice

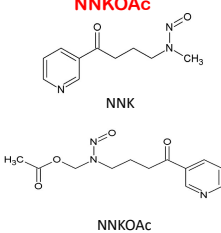
Madumani Amararathna¹, David W. Hoskin^{2,3} and H. P. Vasantha Rupasinghe^{1,2,*}

¹ Department of Plant, Food, and Environmental Sciences, Faculty of Agriculture, Dalhousie University, 50 Pictou Road, Truro, NS B2N 5E3, Canada; madu.ama@dal.ca
² Department of Pathology, Dalhousie University, Halifax, NS B3H 4R2, Canada; d.w.hoskin@dal.ca
³ Department of Microbiology and Immunology, Dalhousie University, Halifax, NS B3H 4R2, Canada
 * Correspondence: vrupasinghe@dal.ca; Tel.: +1-902-893-6623

Prevention of Carcinogenesis:

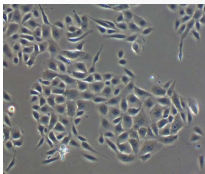
Experimental model of cultured human lung epithelial cells

Tobacco specific carcinogen NNK and NNKOAc

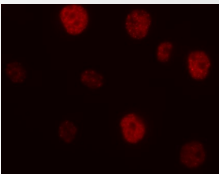


NNK

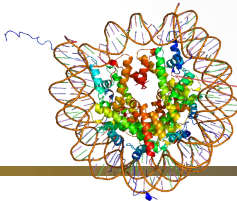
NNKOAc



Healthy lung epithelial cells (BEAS-2B)



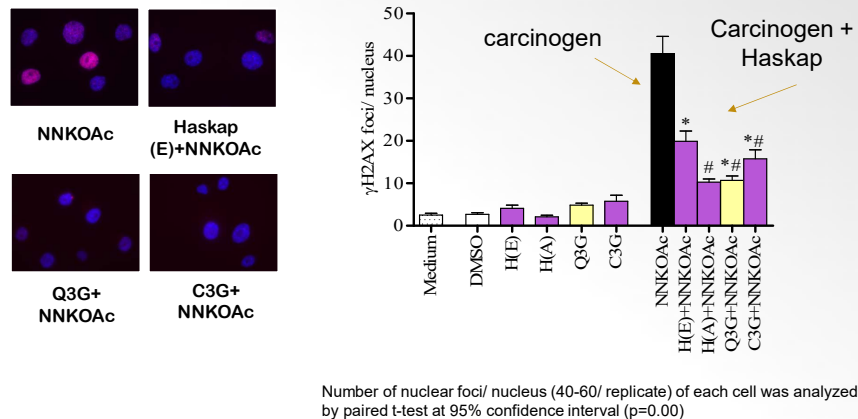
DNA damage in BEAS-2B cells



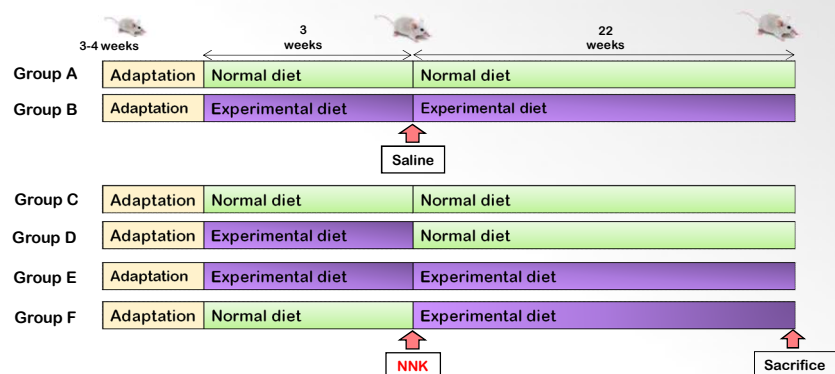
Histone octamer
 H2A (2)
 H2B (2)
 H3 (2)
 H4 (2)

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Haskap flavonoids significantly reduced NNKOAc-induced DNA DSB



Prevention of Tumorigenesis: Experimental model of A/J mice



Prevention of Tumorigenesis:

Experimental model of A/J mice



- Well established model to study chemical-induced carcinogenesis.
- Develop spontaneous lung tumors.
- Form lung denocarcinomas which is common among smokers.
- Individually housed.



Prevention of Tumorigenesis:

Experimental model of A/J mice

Haskap supplement

One pellet = 0.2 g Haskap powder + 1.7 g regular diet + 0.1 g sweetener

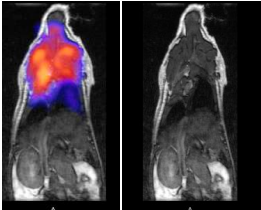
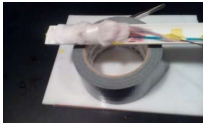
Placebo

One pellet = 1.9 g Regular diet + 0.1 g sweetener

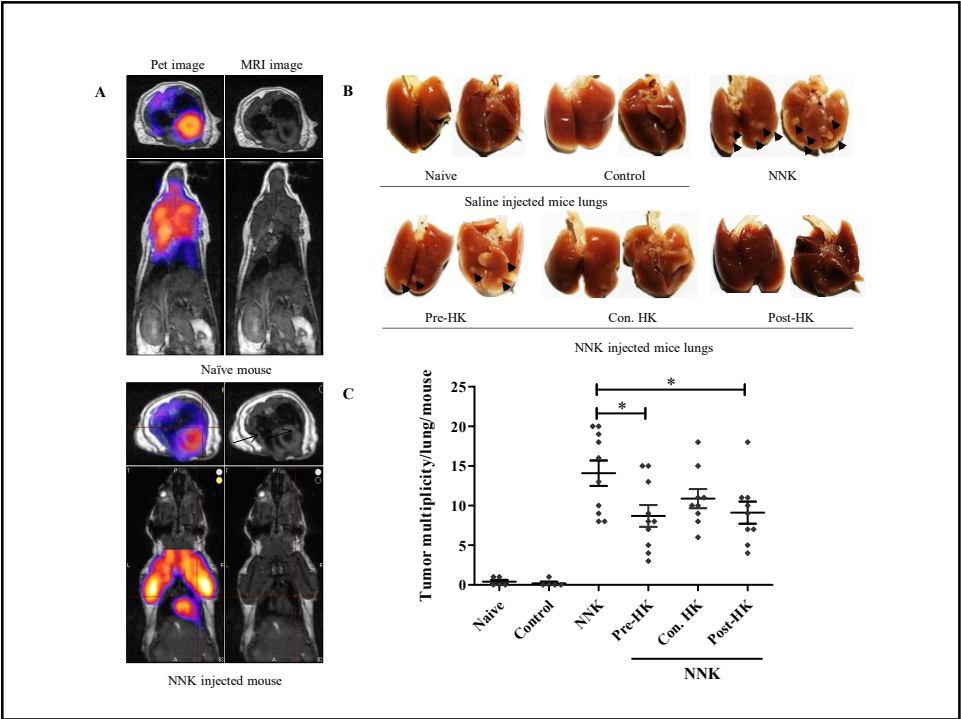


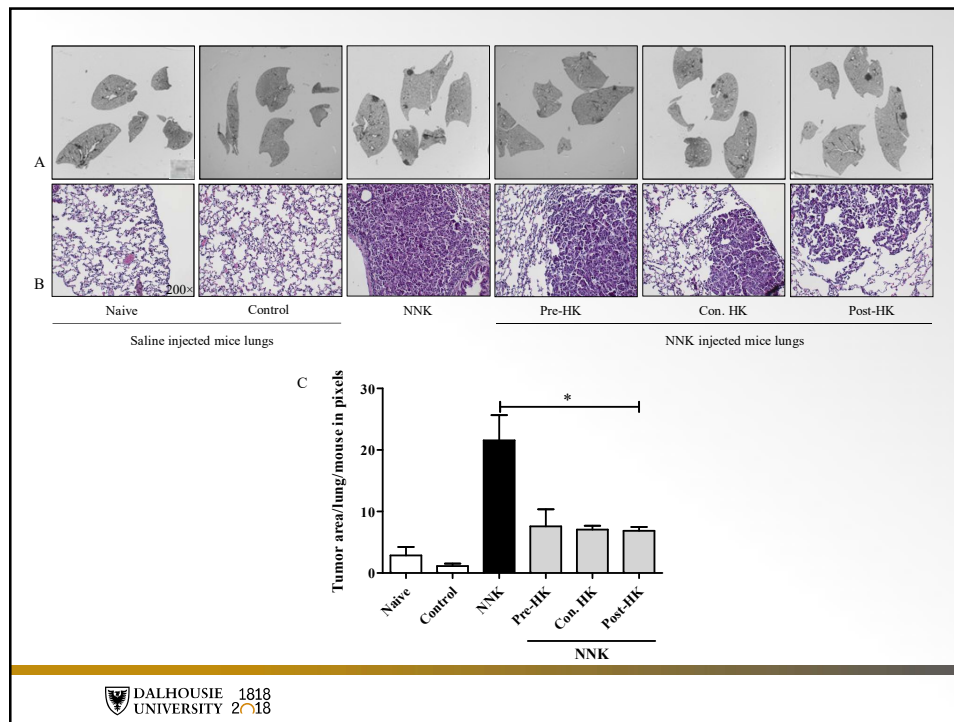
Prevention of Tumorigenesis:

Experimental model of A/J mice



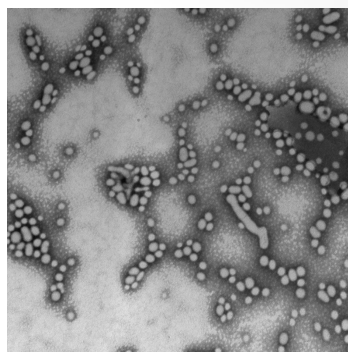
PET/MRI images





Prevention of Tumorigenesis:

Summary & In progress



- Haskap bioactives exhibit potential for **cancer chemoprevention**.
- We have tested haskap bioactives incorporated **nanoparticles** to enhance delivery system to lungs.
- Current research aimed at **mechanism of action** of haskap anthocyanin in cancer chemoprevention.

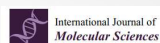
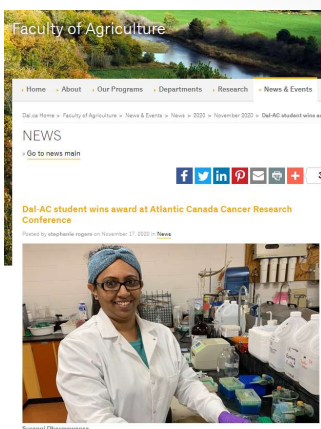
Haskap Anthocyanins & Probiotics



Can they beat colon cancer..?

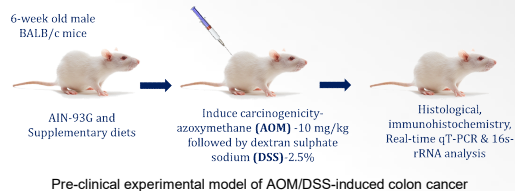


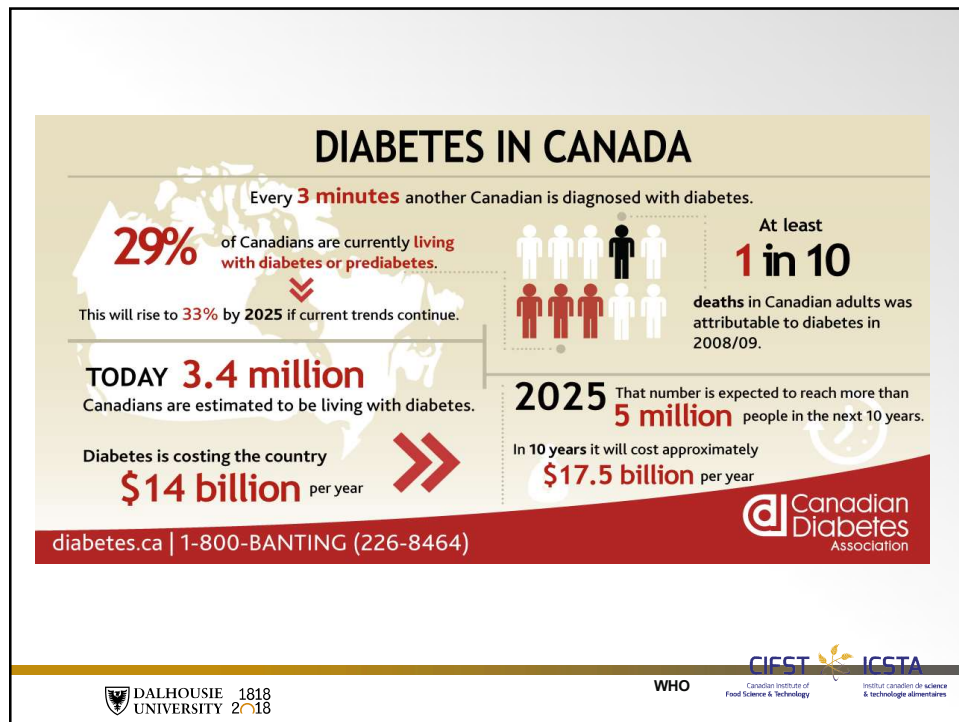
Colon cancer chemoprevention by co-encapsulated anthocyanin and probiotics in-vivo



Review Chemopreventive Effect of Dietary Anthocyanins against Gastrointestinal Cancers: A Review of Recent Advances and Perspectives

K.V. Surangi Dharmawansa ¹, David W. Hoskin ^{2,3} and H. P. Vasantha Rupasinghe ^{1,2,*}





Type 2 Diabetes:

Assessment of Haskap Berry for Improving Glucose Homeostasis and Insulin Sensitivity in Diet-induced Obese Mice



Kithma De Silva
MSc Student

Type 2 Diabetes: Assessment of Haskap Berry for Improving Glucose Homeostasis and Insulin Sensitivity in Diet-induced Obese Mice

Journal of Food Composition and Analysis 88 (2020) 103402



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Journal of Food Composition and Analysis

journal homepage: www.elsevier.com/locate/jfca



Original Research Article

Polyphenols composition and anti-diabetic properties *in vitro* of haskap (*Lonicera caerulea* L.) berries in relation to cultivar and harvesting date

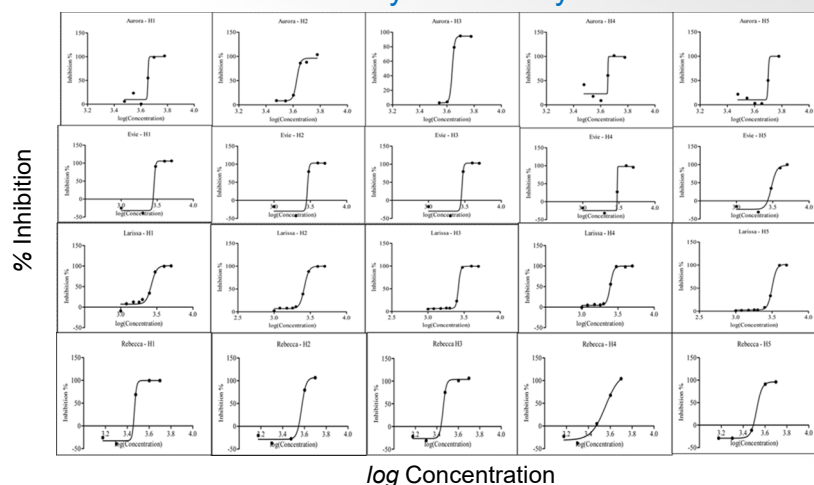
A.B. Kithma H. De Silva, H.P. Vasantha Rupasinghe*

Department of Plant, Food, and Environmental Sciences, Faculty of Agriculture, Dalhousie University, Truro, Nova Scotia, Canada



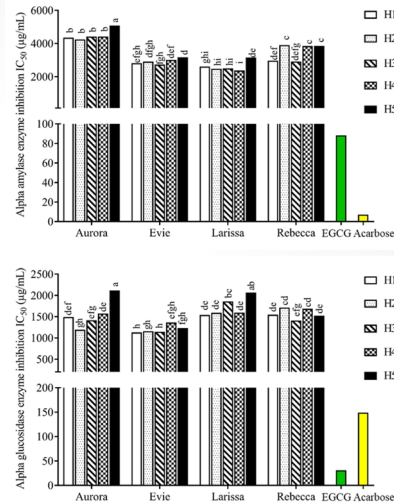
C3G-rich Haskap Extract (CE) inhibits carbohydrate hydrolysing enzymes in a dose-dependent manner

α -Amylase activity



C3G-rich Haskap Extract (CE) inhibits carbohydrate hydrolysing enzymes in a dose-dependent manner

IC₅₀ of inhibition of
 α -Amylase and
 α -Glucosidase activity

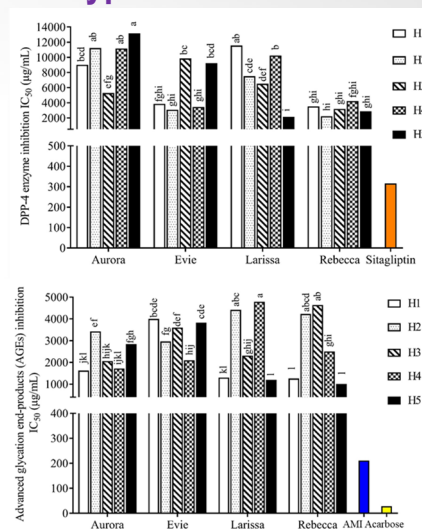


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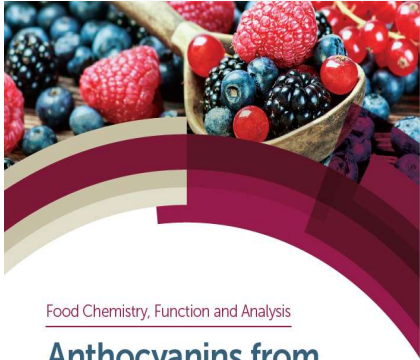
C3G-rich Haskap Extract (CE) and biomarkers of Type 2 diabetes

Promoting Insulin stability

Biomarker of T2D



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Food Chemistry, Function and Analysis

Anthocyanins from Natural Sources

Exploiting Targeted Delivery for Improved Health

Edited by Marianne Su-Ling Brooks and Giovana B. Celli



CHAPTER 5

Health Benefits of Anthocyanins

H. P. VASANTHA RUPASINGHE^{a,b} AND NIROSHAATHEVI ARUMUGGAM^a

^a Department of Plant, Food, and Environmental Sciences, Faculty of Agriculture, Dalhousie University, Truro, Nova Scotia, Canada;
^b Department of Pathology, Faculty of Medicine, Dalhousie University, Halifax, Nova Scotia, Canada
 *Email: vrupasinghe@dal.ca

5.1 Introduction

Among all the subclasses of flavonoids, anthocyanins (ACNs) are unique because they can exhibit different colors while undergoing pH-dependent reversible transformations. ACNs are ubiquitous in plant-based foods; however, they are most predominant in colored fruits and their products, such as red wine. As discussed in previous chapters, ACNs are polyhydroxy 2-phenylbenzopyrylium derivatives constituted by anthocyanidin bound



Rupasinghe and Arumuggam, 2019



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Effect of growing location on anthocyanin content and total antioxidant capacity of haskap (*Lonicera caerulea* L.) berry: A preliminary investigation

H.P. Vasantha Rupasinghe[✉], Aruma B. H. K. De Silva

Haskap has been successfully cultivated in many geographical zones in Canada. We investigated whether the latitude has any impact on the anthocyanin accumulation and total antioxidant capacity in Haskap berry. The measured quality attributes were compared with that of blueberry. Berries of haskap 'Aurora' were collected from Yukon territory, British Columbia, Saskatchewan, and Nova Scotia provinces of Canada, and blueberries were collected from Nova Scotia. Cyanidin-3-O-glucoside (C3G), the most abundant anthocyanin of haskap, total anthocyanins, total polyphenols, soluble solids (°Brix), pH value, total antioxidant capacity, and the moisture content were determined. The results revealed that the total anthocyanin, total phenolic content, and antioxidant capacity of haskap range between 88 to 273 mg C3GE/100 g fresh weight (FW), 256 to 442 mg GAE/100 g of FW, and 27 to 52 µmol TE/g FW, respectively. Liquid chromatography-mass spectrometry (UPLC/MS) analysis revealed that C3G contained in haskap is highly dependent on the harvest stage. Among samples, haskap harvested on July 19, 2019, from Yukon territory had the highest C3G content. Interestingly, the total anthocyanin content of haskap is comparable to that of lowbush blueberry but higher than highbush blueberry. A systematic multi-year experiment employing many cultivars and growing locations is recommended to better understand the latitude effect.

Impact Factor (Web of Science):

2019: **0.925**

Q3 – Horticulture

5-Year Impact Factor: **1.068**

SCImago Journal Rank (SCOPUS):

Horticultural Science

Q3 Horticulture

SJR 2019: **0.3**

best quartile

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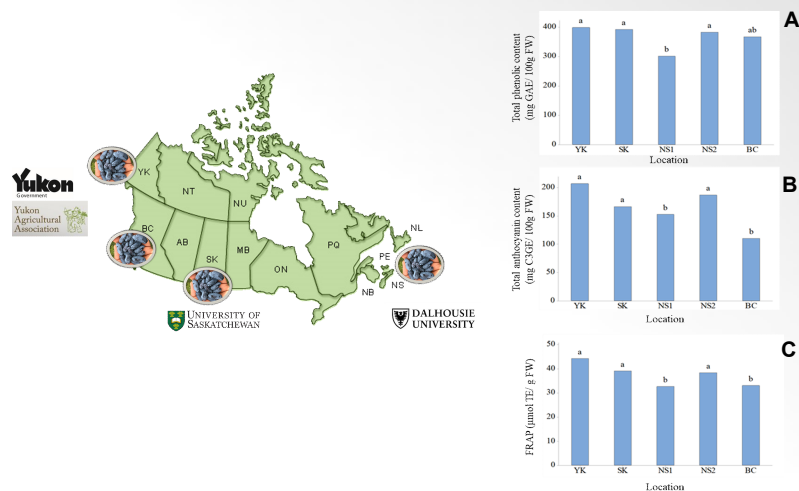
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All the submitted manuscripts are



Impact of Latitude on Antioxidants (Aurora cultivars - 2019 harvest)



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Haskap: when to harvest? (for Nutraceutical Manufacturing)



2017 harvest, In progress with LaHave Natural farms (Cynthia Swimmer)

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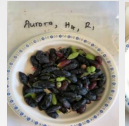
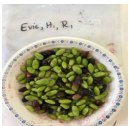
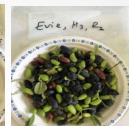
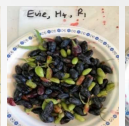
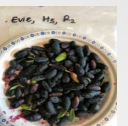
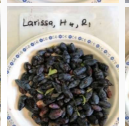
Haskap: when to harvest?



2017 harvest, LaHave Natural farms (Cynthia Swimmer)



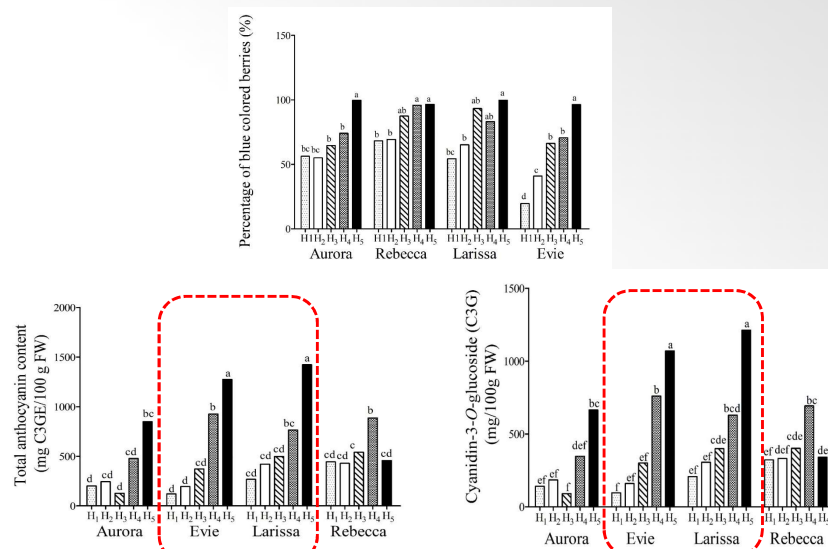
Haskap: when to harvest?

Aurora					
Evie					
Larissa					
Rebecca					
	H1	H2	H3	H4	H5



46

Ripening: color, ACN, and C3G changes



Potential Health Benefits of Haskap:

Role of Cyanidin-3-O-glucoside

Future Directions:

- Haskap and C3G-rich products play a significant role in **health promotion and disease prevention** through alleviation of the risk factors of oxidative stress.
- However, existing evidence from the pre-clinical experiments need to be validated by properly design **human clinical trials**.
- Attention to be paid for the **retention of bioactives** especially C3G during the value-added processing and storage to optimize the health benefits of haskap-derived **supplemented foods and nutraceuticals**.
- The **marketability** of haskap and their value-added products can be enhanced by promotion and knowledge transfer activities.

Acknowledgement



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International Haskap Berry Workshop at the XII International Vaccinium Symposium of ISHS

Date: September 02, 2020

Venue: Prince Edward Island Convention Center, Charlottetown, PEI, Canada

The one-day haskap berry workshop is a part of the 12th International Vaccinium Symposium (<http://www.dal.ca/ishs>). The workshop includes oral presentations, a poster session, a panel discussion, and networking opportunities. The topics of interest include but not limited to berry and new cultivar selection, sustainable crop production systems, value-added food processing health benefits, and marketing of haskap (*Lonicera caerulea*) berry.

Confirmed invited speakers:



Dr. Bob Bors, University of Saskatchewan.
Two decades of breeding haskap to improve the fruit quality



Dr. Andrew Hammermeister, Dalhousie University
Optimization of field production of haskap berry in North America



Zach Miller, Montana State University
Differences among haskap cultivars in yields and berry qualities over four years



Dr. Su-Ling Brooks, Dalhousie University
Haskap berry processing



Dr. Vasantha Rupasinghe, Dalhousie University
Haskap berry anthocyanins and their potential health benefits

Abstracts for oral or poster presentation: submission deadline January 10, 2020

Registration is open for the one-day workshop (\$250) or the full symposium including the haskap workshop (\$750). For details of registration, accommodation and program [Click here](#).
For additional details of haskap berry workshop: Vasantha Rupasinghe (vrupasinghe@dal.ca)

