FACETS
a multidisciplinary open access science journal

RESEARCH ARTICLE

Substitute foods are more likely than their traditional food counterparts to display front-of-package references

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Abstract

Innovative, highly processed foods are often designed to "substitute" for traditional, less-processed items in the diet. Yet, concerns about the unhealthfulness of diets high in highly processed foods are growing. Their dominance in the diet has been hypothesized to relate, in part, to the strategic use of on-package nutrition promotion. Our goal was to compare front-of-package (FOP) labelling on highly processed products that appear to have been explicitly designed as substitutes for traditional foods with the FOP labelling on their traditional counterparts. FOP references were recorded from packaged foods in three major Toronto grocery stores ($N = 20520$). Foods were categorized as substitute or traditional counterparts if these had (1) immediate interchangeability within the diet, (2) inherently different formulation, and (3) the substitute was more heavily processed than its traditional counterpart. Eight substitute–traditional pairs were identified, comprising 18% of products in the data set. Substitute foods were more likely than traditional products to bear FOP nutrition, "organic", and "natural" references. Substitute foods bore 1.21 times more FOP references, the majority of which highlighted nutrients inherent to the traditional counterpart. Our findings support the contention that highly processed foods may be displacing less-processed foods at least in part through the use of strategic on-package marketing.

Key words: product innovation, substitute foods, traditional foods, front-of-package labeling, nutrition marketing

Citation: Christoforou A, Dachner N, Mendelson R, and Tarasuk V. 2018. Substitute foods are more likely than their traditional food counterparts to display front-of-package references. FACETS 3: 455–468. doi:10.1139/facets-2017-0094

Handling Editor: Charles Couillard

Received: June 30, 2017

Accepted: January 16, 2018

Published: April 26, 2018

Published by: Canadian Science Publishing

Introduction

In Canada, as in other jurisdictions, there has been a proliferation of innovative, novel food and drink products on grocery store shelves (Traill and Meulenberg 2002; Agriculture and Agri-Food Canada 2011; Bigliardi and Galati 2013; Dachner et al. 2015). These products are characterized by deliberate modifications through nutritional engineering to alter conventional formulations and (or) the introduction of novel ingredients (e.g., phytosterols in fat spreads and beverages with non-essential amino acids) (Earle 1997; Health Canada 2002; Carayannis et al. 2003, Moskowitz et al. 2006). Innovative foods typically reflect a high degree of processing and are thought to be designed to displace or substitute for traditional, less-processed options (Scrinis 2008; Monteiro 2009; Scrinis 2012). One early example of such product innovation is the introduction of margarine in the mid-1960s, a development fueled by a perceived need to provide a healthier and lower-cost, plant-based alternative to

butter (Heick 1991). Butter and margarine are similar in their use (e.g., cooking and baking), but differ in their formulation and fat content (Heick 1991).

The proliferation of innovative, substitute foods has been aided by technological advancement in food manufacturing and nutritional engineering. In Canada, some product innovation has further been enabled by regulatory amendments that encourage product development through expanded opportunities for discretionary fortification, permitting greater nutrient additions to foods irrespective of public health need (Health Canada 2002; Health Canada 2014; Tarasuk 2014). However, the proliferation of innovative, substitute foods may also relate to their nutritional promotion. It has been argued that highly processed products have displaced more traditional items in the diet, in part through the use of aggressive and strategic marketing (Monteiro 2009; Mallarino et al. 2013; Scrinis 2016). Manufacturers are able to promote their products through the practice of front-of-package (FOP) nutrition labeling (Health Canada 2010), and such labeling is much more prevalent on highly processed foods than lesser-processed foods sold in Canadian supermarkets (Christoforou et al. 2017). Although some of these nutrition references, such as nutrient content claims and those that highlight the health and "functional" benefits of a product, are regulated through compositional criteria (Health Canada 2010; CFIA 2016), other, often more ambiguous, references to nutrition are unregulated. All nutrition messaging provided to the consumer on the FOP, however, in addition to other information about product quality (e.g., "organic" and "natural" characteristics), is displayed at the manufacturer's volition. There is now considerable evidence to suggest that the presence of these FOP references can influence consumer's purchasing behavior (Volkova and Mhurchu 2015; Cao and Yan 2016).

Longitudinal studies of new product launches have documented an increased prevalence of FOP references on these products in recent years (Van Camp et al. 2011; Stanton et al. 2015), and there is some indication that FOP references are particularly prevalent on novel, substitute foods. An examination of "novel beverages" sold in Canadian grocery stores, for instance, found that nearly all energy drinks, vitamin waters, and nutrient-enhanced fruit beverages displayed some form of nutrition reference, in stark contrast to research reporting that only a third of traditional fruit juices bore nutrition references (Dachner et al. 2015). Similarly, an earlier study of margarines found that over half of these products displayed a nutrient content claim (Ricciuto et al. 2005). To date, however, there has been no systematic comparison of the on-package nutrition promotion of products explicitly designed to substitute for more traditional foods in the diet with the on-package promotion of their traditional counterparts. Drawing on a survey of packaged foods in Canadian supermarkets, our objective was to compare the extent and nature of FOP labelling on highly processed products that appear to have been explicitly designed as substitutes for traditional foods with the FOP labelling on their traditional counterparts.

Materials and methods

Data collection

Our study drew on a larger survey of FOP references found on foods and beverages sold in three large grocery stores in Toronto conducted between July 2010 and August 2011 (Sacco et al. 2013; Sumanac et al. 2013; Christoforou et al. 2017). A single store was selected from each of the top three food retailers in Canada (Loblaws, Metro, and Sobeys), representing 71% of the total Canadian retail market share (Canadian Grocer 2009). Although these retailers operate multiple store banners, this sample comprised conventional stores in recognition of their dominance both in market share and retail square footage (Canadian Grocer 2009). Data collectors systematically recorded all descriptive text on the front of packaged foods, including product identifiers (i.e., brand and product name, variety, and product size), nutrient content claims, quantitative statements, generic and product-specific health claims, third-party- (e.g., The Heart and Stroke Foundation of Canada's *Health Check*) and

manufacturer- (e.g., Kraft's *Sensible Solutions*) developed symbols and summary systems, as well as any other descriptive or implied references emphasizing the presence or absence of a specific nutrient. References to "natural", "pure", or "real" (henceforth all referred to as "natural"), and "organic" references were also noted.

Fresh produce, meat, poultry and fish, and dried herbs and spices were not included in the data collection because they were unlikely to bear FOP labelling. Products found in the pharmacy and infant food sections were also excluded because these products are designed for specific population subgroups and special dietary usage. After removing duplicate products, 20520 unique packaged items were captured in the database. Products were considered unique if they differed from similar products on the basis of any product identifier (e.g., different product names, package sizes, etc.).

Data analysis

For the purposes of this study, substitute products were defined as foods that (*i*) are designed to function as alternates or substitute foods for traditional foods in the diet, (*ii*) have been created through the use of novel or unusual ingredients and (or) formulation processes (Carayannis et al. 2003; Moskowitz et al. 2006), and (*iii*) are more highly processed than their traditional counterparts (Monteiro 2009; Moubarac et al. 2017). All products were classified by food category ($n = 52$) using The Bureau of Nutritional Sciences' food grouping developed by Health Canada (Bureau of Nutritional Sciences, Food Directorate 2004). This categorization was expanded to 79 groupings to more fully capture major differences in composition, variations in modes of preparation, and form of presentation (e.g., frozen fruit versus dried fruit). All foods were coded for level of processing using the NOVA framework developed by Monteiro et al. (2013), which classifies foods into four groups along a continuum based on the nature, extent, and purpose of industrial food processing (Moubarac et al. 2017). Food categories were then screened to identify foods that comprised substitute–traditional pairs, defined as foods that had interchangeable use within the diet but inherently different formulations such that the substitute member had innovative ingredients and (or) formulation processes, resulting in a higher degree of product processing when compared with its traditional counterpart. Following these criteria, products that differed by a single adulteration (e.g., plain yogurt and yogurt with inulin or probiotics, or plain milk and lactose free milk) were not included in the analysis (**Table S1**).

Each product was coded for the presence of any form of nutrition reference (e.g., summary systems and symbols, quantifying statements, nutrient content, and health claims). To investigate the nature of the nutritional promotion, these references were further classified as "negative" or "positive". Negative references were defined as those that conveyed the reduction or absence of a nutrient for which there is public health messaging to limit exposure (e.g., "low sodium", "trans fat free", and "no added sugar") (Trans Fat Task Force 2006; Sodium Working Group 2010; Health Canada 2014). Positive nutrition references were those that highlighted the presence or addition of a nutrient deemed beneficial (e.g., "good source of calcium", and "high in fibre"). FOP nutrition references were also categorized as being regulated (e.g., nutrient content and disease risk reduction claims) or unregulated, following previous work that suggests that the use of unregulated references may signal lower concentrations of a particular nutrient than is found in a product displaying regulated references (Sacco et al. 2013; Metcalfe and Elliott 2015). Regulated nutrition references were identified based on the prescribed wording and permitted wording variations outlined in the Canadian Food and Drug Regulations (Government of Canada 2003) and Canadian Food Inspection Agency's Guide to Food Labelling and Advertising (CFIA 2014). All other FOP nutrition references, including quantifying statements (e.g., "x grams of protein") and those that appeared to more deliberately avoid compositional requirements through wording manipulation (e.g., regulated "plus energy" versus unregulated "energy+") were classified as unregulated. To more explicitly compare the nature of the nutritional

messaging found within substitute and traditional pairs, all FOP nutrition references on substitute foods were additionally dichotomized as highlighting a compositional attribute that was either inherent to its traditional counterpart or one that reported a formulation that was unattainable by the traditional food. The total number of references on the FOP, including nutrition, "organic", and "natural" references, on each product was also coded for each product. In addition, the number of references on substitute and traditional foods that relayed information about nutritional attributes inherent to the traditional counterpart was recorded.

Multilevel logistic regression modeling using PROC GLIMMIX was conducted in SAS statistical software package (version 9.4, SAS Institute, Cary, North Carolina) to assess the relationship between the presence and nature of FOP references on substitute versus traditional products, accounting for the fact that products are nested within their individual substitute–traditional pairs. The extent of FOP labelling (i.e., total number of the nutrition, "organic", and "natural" references) on substitute and traditional pairs was compared by fitting a negative binomial distribution, appropriate for count outcome variables of this nature (e.g., values of 0,1,2,3 . . .) (Gardner et al. 1995), to the PROC GLIMMIX model. The model was repeated to compare the number of nutrition references on substitute and traditional foods that referred to compositional characteristics inherent to the traditional foods.

Recognizing that the direction of one of these pairs (fruit/vegetable drinks and juices) diverged from the pattern observed in the others, a detailed examination of the nature of FOP nutrition references on these products was undertaken (Table S2). Multilevel logistic regression modeling was repeated excluding this pair as a robustness test to confirm that the effect of this divergent pair was to attenuate the findings of the analyses described above (Tables S3 and S4).

Results

Eight substitute–traditional food pairs were identified (Table 1), representing 18% ($n = 3746$) of the 20 520 products in the database. Table 1 describes these pairs and displays the proportion of products with FOP nutrition references and the frequency of specific nutrition references within pairs. A description of the types of products found within substitute–traditional food categories is presented in Table S1. All substitute food products fell into the NOVA category of ultra-processed products, whereas traditional products were classified into lesser-processed categories (i.e., minimally processed, foods processed for preservation, and processed food products). Substitute foods represented 9% ($n = 973$) of the 10 260 ultra-processed products in the database. In seven of the eight pairs, substitute foods had a greater proportion of nutrition references than did their traditional counterparts (Table 1). An inverse relationship was seen in the fruit/vegetable drinks–fruit/vegetable juices pair, where juices bore a greater proportion of nutrition references than their more formulated drink counterparts (Table 1; Table S2).

Substitute foods were 1.44 times more likely to bear a nutrition reference than traditional foods (Table 2). Examination of the nature of these references similarly showed substitute foods to be more likely than their traditional counterparts to display a negative or positive nutrition reference and to assert nutrition references using both regulated and unregulated language (Table 2). Substitute foods were also more likely than traditional products to bear "organic" and "natural" references (Table 2). When these analyses were repeated after removing drinks/juices from our models, recognizing that this pair was an anomaly, the magnitude of our observed effects was strengthened (Tables S3 and S4).

An in-depth examination of the nature of nutrition messaging found on substitute and traditional pairs revealed that, in some instances, references on substitute products denoted food attributes not found on traditional products (Table 1). These included claims such as "trans fat free" on non-dairy milks, for instance, and claims highlighting the presence of vitamins on enhanced water

Table 1. Presence of front-of-package nutrition references for eight substitute–traditional pairs ($N = 3746$).

Substitute–traditional pair	*n*	Any nutrition reference (%)	Nutrition reference	Frequency (%)
Spread				
Margarine	93	85	Omega-3	57
			Trans Fat	56
			Total Fat	52
			Saturated Fat	35
			Vitamin D	13
			Sodium	4
Butter	41	15	Omega-3	5
			Total Fat	7
			Light	7
			Sodium	7
Beverage				
Fruit/vegetable drinks	443	48	Vitamin C	25
			Calories	15
			Sucralose	13
			Sugar	9
			Vitamin A	1
Fruit/vegetable juices	555	65	Vitamin C	40
			Sugar	32
			Unsweetened	26
			Calcium	4
			Vitamin D	3
			Antioxidants	3
			Vitamin A	2
			Fibre	2
			Sodium	2
Milk				
Non-dairy milks	154	96	Calcium	78
			Total Fat	58
			Protein	39
			Cholesterol	32
			Omega-3	27
			Vitamin D	18
			Trans Fat	16
			Vitamin A	15

(*continued*)

Table 1. (*continued*)

Substitute–traditional pair	*n*	Any nutrition reference (%)	Nutrition reference	Frequency (%)
			Lactose	14
Dairy milks	241	78	Calcium	16
			Total Fat	11
			Vitamin D	62
			Vitamin A	51
			Omega-3	6
			Vitamin B	4
Meat				
Meat alternatives	120	77	Total Fat	38
			Protein	37
			Trans Fat	27
			Cholesterol	15
			Iron	5
			Omega-3	3
			Sodium	2
Meats	588	39	Total Fat	17
			Protein	26
			Trans Fat	7
			Sodium	7
			Calories	3
			Vitamin B	3
Egg				
Egg substitutes	11	100	Cholesterol	90
			Total Fat	90
			Protein	45
			Calories	9
			Omega-3	9
Eggs	63	57	Omega-3	32
			Total Fat	12
			Protein	11
			Trans Fat	11
			Vitamin B12	3
Water				
Enhanced water beverages	133	58	Calories	26
			"Vitamins and Minerals"	20

(*continued*)

Table 1. (*concluded*)

Substitute–traditional pair	*n*	Any nutrition reference (%)	Nutrition reference	Frequency (%)
			Vitamin C	17
			Sucralose	17
			Vitamin B	17
			Sugar	14
			Sodium	10
			Vitamin E	2
Bottled water	75	4	Sodium	2
			Minerals	1
			Magnesium	1
Cheese				
Non-dairy cheeses	29	72	Total Fat	72
			Cholesterol	65
			Lactose	50
			Calcium	34
			Trans Fat	17
			Ginseng	5
			Sugar	2
Cheeses	1117	23	Total Fat	11
			Calcium	11
			Calories	8
			Protein	4
			Trans Fat	2
Sweetener				
Sweeteners	48	83	Calories	79
			Sugar	18
Sugar	35	0	—	—

beverages. The majority of references on substitute foods, however, highlighted nutrients or other compositional elements inherent to the traditional products. Meat alternatives and egg substitutes, for instance, displayed "a good source of protein" claims, and non-dairy items highlighted the presence of calcium.

Results from the negative binomial model indicated that substitute foods bore, on average, 1.21 times more FOP references than did their traditional food counterparts (Table 3). When only references to attributes inherent to the traditional foods were considered, substitute foods bore 1.14 times more FOP references highlighting such attributes than were present on traditional products (Table 3).

Table 2. Odds of front-of package reference on substitute versus traditional products ($N = 3746$).

Type of FOP reference	Substitute foods ($n = 973$)		Traditional foods ($n = 2773$)		OR	95% CI
	n	%	*n*	%		
Any nutrition reference	608	62	1146	41	1.44	1.21–1.71
Any negative reference	333	34	511	18	1.89	1.57–2.26
Any positive reference	482	50	824	30	1.31	1.10–1.57
Any regulated reference	497	51	921	33	1.25	1.05–1.49
Any unregulated reference	376	37	589	21	1.65	1.3–1.97
Any organic reference	124	12	145	5	1.64	1.27–2.18
Any natural reference	320	33	562	20	1.92	1.64–2.27

Note: Odds ratios and 95% confidence intervals were derived from multilevel logistic regression models. FOP, front-of-package; OR, odds ratio.

Table 3. Results of the negative binomial regression model on the total number of front-of-package references on substitute versus traditional products ($N = 3746$).

	n	Mean	SD	Model			
				β	SE	exp (β)	*p*
Total number of FOP references							
Traditional foods	2773	1.70	2.37	—	—	—	—
Substitute foods	973	3.09	3.27	0.19	0.046	1.21	<0.0001
Total number of FOP references highlighting qualities inherent to the traditional product							
Traditional foods	2773	1.70	2.37	—	—	—	—
Substitute foods	973	2.83	3.17	0.13	0.046	1.14	<0.0001

Note: FOP, front-of-package.

Discussion and conclusions

The results of this study revealed that FOP references, irrespective of their nature, were more common on highly processed products with innovative ingredients and formulations that had been designed to substitute for traditional foods. The compositional elements highlighted on-package were, not surprisingly, specific to a particular pairing. However, further investigation into the nature of nutrition references found on substitute foods revealed that this messaging primarily highlighted nutrient composition that was inherent to their traditional counterpart, with far fewer products highlighting nutrient enhancements unattainable by the less processed, more conventional foods.

Although it is to be expected that substitute foods, which are designed as alternatives to traditional counterparts, would market themselves as nutritionally equivalent, the scarcity of similar references promoting the inherent nutritional qualities of traditional foods creates a clear marketing bias. Motivated consumers can use the mandatory Nutrition Facts table to compare the nutrient content of substitute and traditional items, but the importance of FOP references in establishing a product's nutritional benefits hinges on the visibility and simplicity of this information. Studies have indicated

that many consumers lack the nutrition literacy required to critically appraise the nutrient content of a product or its value in the diet and prefer the simplified messaging present on the FOP in their food selection (Canadian Council of Food and Nutrition 2008).

We found that substitute foods were also more likely to display "natural" and "organic" references than their traditional counterparts, although "natural" references appeared at three times the rate of "organic" references. Foods differentiated along these axes have resulted in expanded consumer demand in recent years (McGill 2009; COTA 2013), owing largely to perceptions that these products are "healthier" and safer, with fewer additives and less adulteration than conventional products (Hughner et al. 2007; Sax and Doran 2016). However, the fact that much of this labelling is found on highly processed, innovative products is counter-intuitive and may reflect manufacturers' attempts to blur the processed/unprocessed food distinction. Although organic labelling must comply with strict regulatory standards, the term "natural" is undefined, and its use is entirely unregulated (CFIA 2014), which may account for the much greater prevalence of "natural" than "organic" references in our sample. However, consumers associate "natural" foods with organic foods (Padel and Foster 2005; Abrams et al. 2010; Haroldson and Yen 2016), and manufacturers therefore may seek to use "natural" on labels as a means to confer the notion of quality without adhering to organic certification processes.

Examining individual substitute–traditional pairs revealed that the pattern of FOP references observed overall differed in one instance. The greater proportion of nutrition references on traditional juice products than on their more formulated drink counterparts can be explained by a high prevalence of references to the absence of added sugars and the presence of vitamin C claims on juices. Manufacturers' highlighting of the inherent nutrient profile of juices may be a strategy to compete with fruit and vegetable drink products, which are often enriched with vitamins or formulated with artificial sweeteners and promoted as such (Gardner 2014). The anomaly observed within the existing juice-drink pairing with respect to the concentration of FOP references may also speak to price differences between drink and juice products. Since fruit drinks are priced up to a third lower than more natural, whole juice products (Todd et al. 2011), it may be that product innovation here has been intended to construct a value offering. Given evidence that the price of a product trumps nutritional quality in food purchasing among low-income, price-conscious consumers, it is less probable that value offerings would bear FOP references or be marketed for their nutritional attributes (Campos et al. 2011; Mhurchu et al. 2013; Darmon et al. 2014). More research is needed, however, to examine the price of substitute food products in relation to the display of FOP references.

Our work is the first to investigate the presence of FOP references on foods constituting substitute–traditional pairs. In the absence of an established definition of substitute and traditional products, a framework was developed here, driven by our understanding of substitute foods as those that could displace existing traditional products from the diet through novel and distinct formulations. There are other products, however, that could be considered as substitutes for traditional foods. Products such as breakfast cereals, for instance, which are known to be marketed for their nutrition properties (Colby et al. 2010; Devi et al. 2014), are difficult to pair with a specific traditional food since they may serve as substitutes for entire meals. Food pairs that differed by only a single ingredient, such as yogurts fortified with inulin or enriched with probiotics, also fell outside our definition as they did not display sufficient heterogeneity to be deemed distinct products; they may otherwise be considered as alternatives to more conventional formulations (i.e., plain yogurts). Fresh, unpackaged foods were excluded from our data set and therefore from this analysis, but certain unpackaged products such as fresh meat could be considered as traditional counterparts to the meat alternatives examined here. Similarly, although we compared fruit/vegetable drinks with fruit and vegetable juices, it could be argued that a more appropriate comparison would be between fruit juices and whole fruits. Nonetheless, the definition of substitute–traditional pairs applied in the current work enabled the

assessment of 18% of products collected and allowed for significant positive associations of the presence of FOP references on substitute, relative to traditional, foods to be observed. More research is needed to elaborate the notion of substitute–traditional pairs, including what consumers choose as substitutes for existing traditional foods in their diets.

Whether product innovation signals a nutritionally superior product is beyond the scope of this study, but the question warrants further investigation. In some cases, the products identified as substitute foods may confer important benefits for some consumers. Non-dairy substitutes, for instance, represent important alternatives for those with lactose intolerance. Similarly, reduced- or no-calorie sweeteners may represent a necessary sugar substitute for people with diabetes. No such argument can be made for the promotion of innovative products such as enhanced water beverages, however, because the micronutrients in these products are generally unrelated to need (Dachner et al. 2015). Although most nutrition references in our sample represented regulated claims, there was also a strong positive association between substitute foods and the display of unregulated references indicating that manufacturers are also more likely to engage in labeling practices that do not require approved nutrient criteria and therefore the relative nutritional quality of a product is not assured.

Although the research presented here represents a novel assessment of food substitutes gleaned from a large number of products, some additional limitations must be considered in the interpretation of our results. Although data collection was situated in three large grocery stores of retail chains representing 71% of the total Canadian retail market-share (Canadian Grocer 2009), it was limited to the Toronto area, so our results may not be generalizable across Canada. Furthermore, the data were collected over a one-year period from 2010 to 2011 and therefore may not reflect the current food marketplace. The development and marketing of innovative, substitute products is a dynamic process, and it is likely that some of the products analysed are no longer present on grocery shelves, whereas others have since been introduced as substitutes to replace other traditional products. Given that our analytic sample comprised substitute products that were not merely "new entrants" but also products introduced several decades ago (e.g., margarine versus butter), we would anticipate that the broader relationship we observed with respect to FOP labeling on substitute–traditional foods would persist in the present-day food supply.

Although the substitute foods examined in this study are only one subset of the highly processed foods in the marketplace, our finding that substitute foods are more likely than their traditional counterparts to display FOP references, with the exception of one pair, is consistent with the contention that highly processed foods are displacing traditional, less-processed foods in the diet, in part through the use of on-package nutritional promotion (Monteiro 2009; Nestle and Ludwig 2010; Mallarino et al. 2013; Nestle 2013; Scrinis 2016). Insofar as food purchasing behaviors are influenced by FOP messaging (Campos et al. 2011; Volkova and Mhurchu 2015), the disproportionate use of nutrition references on substitute foods raises important questions with respect to the utility of this discretionary practice of FOP labelling as a tool for nutritional guidance.

Acknowledgements

This study was funded by an operating grant from the Canadian Institutes of Health Research (MOP – 102655). The authors gratefully acknowledge Dr. Jocelyn Sacco for her initial support in the development of the database.

Author contributions

AC, ND, RM, and VT conceived and designed the study. ND, RM, and VT performed the experiments/collected the data. AC and VT analyzed and interpreted the data. AC, ND, RM, and VT drafted or revised the manuscript.

Competing interests

The authors have declared that no competing interests exist.

Data accessibility statement

All relevant data are within the paper and in the Supplementary Material.

Supplementary material

The following Supplementary Material is available with the article through the journal website at doi:10.1139/facets-2017-0094.

Supplementary Material 1

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