Title: Quality of international oat sources

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Background:

Canada has a high capacity for oat production with yearly averages over 3.3 million tonnes, making it the third largest producer of oats in the world. International trade is by far the largest market for Canadian grown oats, with approximately 70% the oat crop destined for export (Source: Statistics Canada). Canada is currently the number one exporter of oats globally, with the majority being supplied to the United States, but opportunities exist to expand into other growing international markets. However, high quality is also a key factor to maintaining existing oat milling markets and selling more Canadian oats on the basis of nutrition and health benefits sought after by consumers in many countries. For example, beta-glucan soluble fibre found in oats contributes to their cholesterol lowering ability as well as attributing to their low glycemic qualities and government approved health claims for beta-glucan content exist in several countries. Also, the relatively high protein content in oats may be of interest to food manufacturers seeking new ingredients to meet rising consumer demand for plant-based protein sources. It is therefore important to consider the composition of Canadian oats relative to those from other sources in order to ensure production of a competitive product for the global market.

Objective:

The objective of this project was to generate data showing levels of key nutrient components in oats from a variety of international sources, particularly to see how Canadian oats compare. Oats obtained from eight countries including Australia, Brazil, Chile, China, Finland, New Zealand, USA, and the UK, in addition to samples grown in Canada, were analysed for beta-glucan, protein and oil content.

Methodology:

In total 50 samples of oats were analysed from international sources including Australia (n=8), Brazil (n=11), Chile (n=3), China (n=4), Finland (n=5), New Zealand (n=8), USA (n=7), and the UK (n=4), representing 41 varieties. An additional 40 Canadian samples were selected from several crop trials to include 10 commonly grown varieties such as AC Morgan, CDC Dancer,

Souris, Tiactor, Summit, CDC Arborg, CDC Orrin, Nicolas, Leggett and CS Camden from multiple locations in western Canada. Our sample collection technique was informal so there was no consistent source and the number of samples collected from each country varied. Ideally, the same varieties should be grown at multiple international locations, but this was not possible in the scope of this project. Since no type of experimental design could be used, this research activity is therefore more like an informal survey, and formal conclusions cannot be drawn. Oat samples were dehulled using a Codema Lab Dehuller and groats were ground into wholemeal with a Retsch ZM200 Centrifugal Mill equipped with a 0.5 mm screen. All prepared samples were kept frozen until time of analysis. Quantification of beta-glucan on the 90 wholemeal oat samples was accomplished using wet chemistry assay (American Association of Cereal Chemists International Approved Method 32-23). Protein content was determined via the Dumas combustion method using the Thermo Fisher Flash 2000 nitrogen analyser. The oil content was predicted using Near Infrared Spectroscopy (NIR) equations developed in-house. Duplicate analyses were performed on each sample per variety and location. Data was analysed using JMP 14 statistical (SAS Institute Inc., Cary, NC). Sample means were compared using t- test and significant differences determined at $p \leq 0.05$. Principal component analysis was performed to visualize similarities and differences between Canadian grown oats cultivars against those from other parts of the world.

Results:

Results of beta-glucan, protein and oil analysis were summarized by calculating the minimum, maximum and average value obtained for each country of origin as shown in Figure 1 below. The protein content ranged from 11.4 to 21.6 % for all the oats tested (Figure 1a). Canadian oats protein content ranged from 14.4 to 21.0 %. The protein content of Canadian oats was not significantly ($p < 0.05$) different from those grown in the other 8 countries. A coefficient of variation (CV) of ~6.5 % was observed when Canadian bred oat varieties (Leggett, AC Morgan, and AC Dancer) were grown in different parts of the world. This observation confirms the effect of growing conditions on protein content. Also, large CVs were observed at each growing location indicating the effect of oat variety on protein content.

The mean content of beta-glucan (Figure 1b) in the Canadian oats was not statistically different ($p < 0.05$) when compared to those grown in other countries. Small CVs (~3%) were observed in

most varieties that were grown in multiple locations in Canada. Similarly, the mean of beta-glucan content of the Canadian bred oat varieties (Leggett, AC Morgan, and AC Dancer) were not significantly different when grown in different parts of the world. However, large CVs were observed in beta-glucan content at each location suggesting that variety difference is a major determinant. Thus, for beta-glucan, selecting cultivars with high beta-glucan content could help penetrate markets looking for high beta-glucan content.

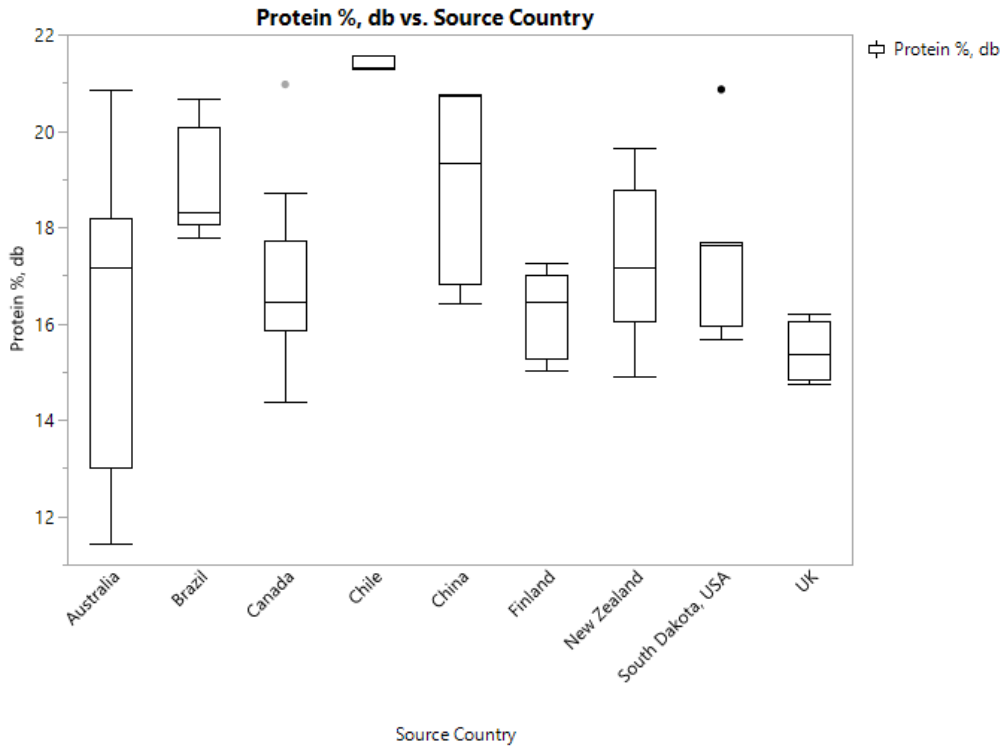
The oil content ranged from 5.2 to 12.2 % across all the cultivars tested (Figure 1c). The oats grown in Canada had the lowest oil mean content but was only significantly different from those grown in Brazil and Australia ($p < 0.05$). The oil content varied greatly at each growing location with CVs ranging from 4.1 to 25%. This observation shows that oil content is highly dependent on oat cultivar. However, looking at the data on Canadian bred oat varieties but grown in different parts of the world, growing location appears to influence the oat oil content as well. For example, a coefficient of variation of 8.6% is observed for AC Morgan and CDC Dancer when grown in different locations.

The variation among samples (among genotypes and growing locations), suggests that it may be beneficial to identify specific varieties for introduction into new international markets. However, we used principal component analysis (Figure 2) to visualize how Canadian grown oats could possibly be separated from those grown from other countries. Principal component 1 (50.9%) could explain protein (84%), beta-glucan (64 %) and NIR oil (63 %) and principal component 2 (31.2) explains beta-glucan (-68%) and oil (69 %) according to the loading matrix. Thus, low oil and medium protein and beta-glucan contents was the uniqueness of the oats grown in Canada as shown in the Figure 2.

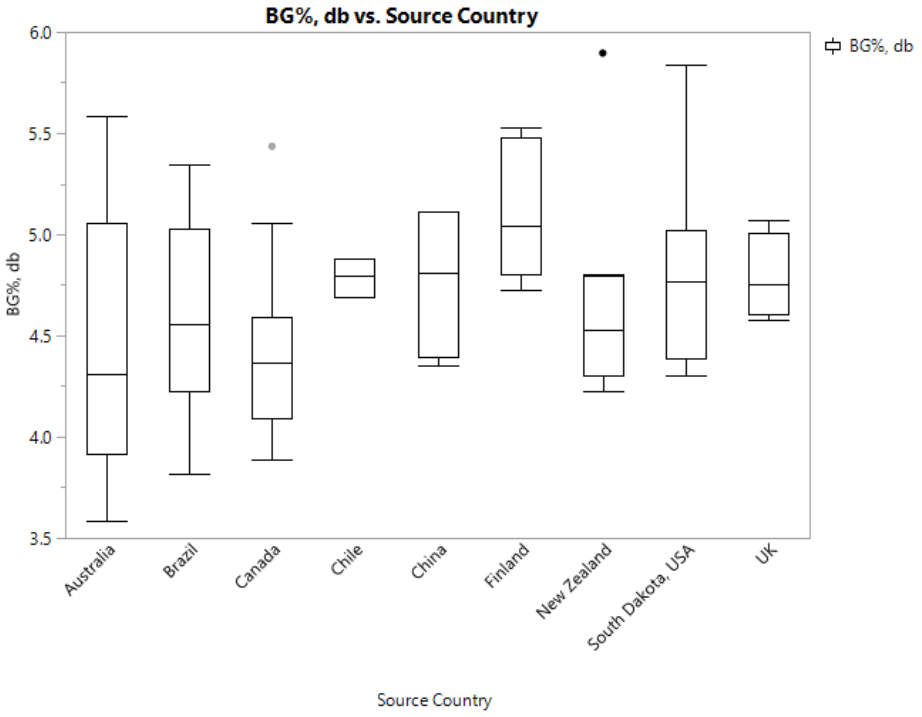
In general, the results suggest that Canadian oats are comparable to those originating from other countries tested. The limitation to this study was sourcing oat samples from different countries to allow direct comparison of oats available on the market. Future studies should aim at obtaining samples that will represent the majority of the oat population mostly grown for human consumption for over at least 3 years. However, these results offer a first glance at how Canadian oats fare against other oats grown in different parts of the world in terms of its nutritional attributes.

Figure 1: Chemical composition of oats grown in different parts of the world (a) protein content, (b) beta-glucan content and (c) oil content

a



b


BG%, db vs. Source Country
BG%, db
6.0
5.5
5.0
4.5
4.0
3.5
BG%, db
Australia
Brazil
Canada
Chile
China
Finland
New Zealand
South Dakota, USA
UK
Source Country

c

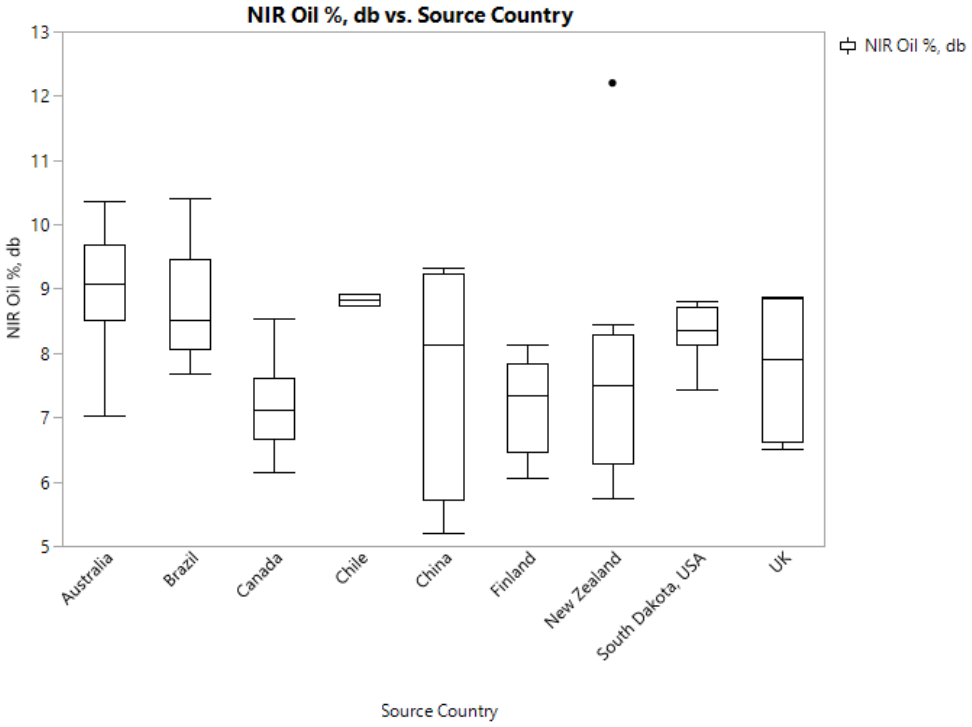

NIR Oil %, db vs. Source Country
NIR Oil %, db
NIR Oil %, db
13
12
11
10
9
8
7
6
5
Australia
Brazil
Canada
Chile
China
Finland
New Zealand
South Dakota, USA
UK
Source Country

Figure 2: Biplot of oats grown in different parts of the world