Comparison of Sodium and Saturated Fat Content Between Domestic Pasta Sauce and Imported Pasta Sauce in Canada

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Abstract

Background: Recently, a study by Dunford et al. (2019) found out that Canadian processed foods have the highest sodium content than other countries. Out of the twelve countries tested in the survey, Canada was ranked the highest. This survey sparked the interest in comparing the healthiness of domestically processed foods and imported foods available in Canada. Pasta sauce was particularly chosen for this research project. By comparing the sodium and saturated fat content between domestic pasta sauce and imported pasta sauce, the study aimed to determine whether imported pasta sauce is a healthier choice.

Methods: This study focused solely on tomato-based pasta sauce. The sodium and saturated fat data were collected from the nutrition facts table of pasta sauces available in grocery stores throughout Metro Vancouver, BC. A one-way analysis of variance (ANOVA) was used to analyze the data using NCSS 2021 software. Overall, a total of 277 tomato-based pasta sauce samples from Canada, Italy, and the US were collected. As the organic claim of products was considered a potential confounding factor, the samples were further categorized into non-organic and organic.

Results: For the sodium content, the analysis result of the organic samples was inconclusive due to the low power (52.3%). There was a significant difference ($P = 0.007$) in the sodium content between the non-organic US (341 mg/100g) and Italian (286 mg/100g) tomato-based pasta sauce. No significant difference was found between the Canadian (321 mg/100g) US and Italian sauces. For the saturated fat content, the analysis result of the organic samples was again inconclusive due to the low power (35.8%). A significant difference ($P = 0.000$) in the saturated fat content were found between the non-organic pasta sauce from Canada (0.2 g/100g) and the US (0.6 g/100g), and between sauces from Canada and Italy (0.6 g/100g).

Conclusion: In terms of sodium level, non-organic Italian tomato-based pasta sauce seems to be the healthiest choice. On the other hand, non-organic Canadian tomato-based pasta sauce has less saturated fat than sauces from the US and Italy. However, the difference is small, and the level of saturated fat in tomato-based pasta, in general, is too low to cause significant health consequences. Larger sample size and elimination of more confounding factors are required to improve the validity of the result.

Keywords: pasta sauce, tomato, processed foods, sodium, saturated fat

Introduction

Recently, Canadian processed foods were found to have the highest sodium content than other countries (Dunford et al., 2019). Out of the twelve countries tested in the survey, Canada was ranked the highest with a median sodium content of 291 mg per 100 g (Dunford et al., 2019). This survey sparked the interest of comparing the healthiness of domestically processed foods and imported foods available in Canada.

With all the different processed foods, pasta sauce was particularly chosen for this research project. Pasta has always been one of the primary food sources of nutrients. A study by Johnson-Down et al. (2006) showed that "pasta", along with "rice and grains", was ranked second in daily mean energy consumption for Canadian men and women aged 18-34. When Canadians prepared their pasta dishes, many would often use store-bought pasta sauce, thanks to its wide variety available in grocery stores and convenience. The problem is that store-bought pasta sauce is not very healthy. According to the Canadian Nutrient File by Health Canada (Health Canada, 2018a), 100 grams of an average tomato pasta sauce contains 419 mg of sodium and 1.48 g of fat, equivalent to 17.5% and 2.3% daily value, respectively. Therefore, the sodium and saturated fat content in pasta sauce were studied in this research project.

Literature Review

Definition of Pasta Sauce

Tomato-based Pasta Sauce

Tomato-based pasta sauce, also known as marinara sauce, is usually made with tomatoes as the main ingredient and often with other vegetables such as onion, garlic and herbs (Lexico, n.d.). Tomato-based pasta sauce is the most popular pasta sauce, taking about 40% of the share in the market (The Express Wire, 2020). It is an excellent source of vitamin A, vitamin C and lycopene, which is an antioxidant (Wadyka, 2018). However, processed tomato pasta sauce often contains high sodium (Wadyka, 2018), simply because of the salt added by the manufacturer to enhance the flavour. While for the fat content, the most common source from the ingredients is olive oil (Wadyka, 2018).

Alfredo-based Pasta Sauce

Alfredo sauce is a type of pasta sauce mainly made with butter, cream, and cheese (Drake, n.d.). Therefore, the sauce is usually white in colour. Similar to tomato pasta sauce, alfredo sauce often contains high

sodium as well to enhance the flavour. Moreover, the fat content is higher than tomato sauce as the main ingredients are dairy products, which are high in saturated fats (Lordan et al., 2018).

Nutritional Value of Organic vs Non-organic Pasta Sauce

With the organic food trend constantly growing in Canada, organic alternatives of many food products are becoming more available. Organic food is often perceived as a healthier choice than its conventional counterpart by the public (Prada, Garrido, & Rodrigues, 2017), but in reality, whether organic food is actually more nutritious is still a debatable topic. Research by Smith-Spangler et al. (2012) suggests that there is a lack of significant evidence that organic food is healthier than conventional foods. On the other hand, Dall'Asta et al. (2020) studied food products in Italy and suggested that although organic claims should not be used as an indication of healthier food, some organic products do have significantly different nutritional value than the conventional products. For example, organic "pasta, rice and cereals" had lower energy, protein and higher saturated fat than conventional ones. Since it is unclear whether an organic claim can impact the sodium and saturated fat content of pasta sauce in Canada, it is treated as a possible confounding factor in this study.

Canadian Dietary Intake

Sodium

Most Canadians consume too much sodium. According to Health Canada (2018b), an average Canadian adult consumes about 2760 mg of sodium per day. Although the average dropped by 8% compared to data collected in 2010, it is still well above the recommended maximum daily intake, which is 2300mg (Health Canada, 2018b). Based on the data from Health Canada (2018b) half of Canadians have already consumed too much sodium growing up since one year old. More male Canadians consume excessive sodium even after reaching adulthood, with the age group of 19-30 peaking at 96%. The number slowly declines after the males reach the age of 31. Females, in general perform better than males. After the number peaks at 63% with the age group of 9-13, more females consume less sodium as they get older.

Fat

Health Canada (2010) recommends the acceptable macronutrient distribution range (AMDR) of total fat to be 30-40% of total energy intake for 1-3 years old, 25-35% for

4-18 years old, and 20-35% for 19 years old and older, while controlling saturated fats and trans fats to be as low as possible. On the other hand, the WHO (2020) recommends limiting total fat intake to less than 30% of total energy intake and less than 10% of total energy intake for saturated fats. Harrison et al. (2019) found that 10.4% of total energy intake for average Canadian adults is from saturated fats, which is slightly above the WHO recommendation.

Health Significance

Sodium

Sodium is one of the essential nutrients that naturally occurred in many foods. Adequate sodium is vital to our health as it acts as an electrolyte that maintains the fluid balance and cellular homeostasis in our body (Farquhar et al., 2015). In cooking and food processing, sodium is used as an additive called sodium chloride, commonly known as table salt. Because table salt is a cheap taste-enhancer and can be used as an anti-spoilage agent in food preservation (Gutiérrez, 2013), processed foods often are high in sodium. Excessive sodium intake can cause high blood pressure, loss of calcium in bones, which causes osteoporosis. It also elevates the risk of stroke, cardiovascular disease and stomach cancer (Health Canada, 2017).

Fat

Fat is a macronutrient that provides energy to the body (Health Canada, 2019). As a type of lipids, it carries fat-soluble flavours and vitamins A, D, E and K (Health Canada, 2019). Fat can mainly be categorized into unsaturated fats, saturated fats, and trans fats. Unsaturated fat is generally regarded as the good kind of fats, which can be further separated into monounsaturated and polyunsaturated fats (Harvard Health Publishing, 2019). Saturated fats are fats with no carbon-carbon double bond on the fatty acid tails (Harvard Health Publishing, 2019). Unlike unsaturated fats, saturated fats increase the level of LDL cholesterol in the body (Harvard Health Publishing, 2019). Therefore, they are harmful to our health. Excess saturated fats have been linked to increasing the risk of cardiovascular diseases and strokes (Health Canada, 2019). Saturated fats can be found in dairy products and meat (Health Canada, 2019).

Purpose

The purpose of this research project is to compare the sodium and saturated fat content between domestic pasta sauce and imported pasta sauce and to determine whether imported pasta sauce can be a

healthier alternative to their domestic counterparts.

Methods and Materials

Materials

The material used for this research project included a smartphone, laptop, Microsoft Excel, and NCSS 2021 (NCSS, 2021). The smartphone was used to take pictures of the pasta sauce products in grocery stores. Laptop and Microsoft Excel were used for data collection, while Statistical Analysis was conducted using NCSS 2021 (NCSS, 2021).

Method

Data was collected from grocery stores located in the Metro Vancouver area, BC, Canada, in January and February 2021. A minimum of three grocery stores in major cities (Vancouver, Richmond, Burnaby, Tri-cities, and Surrey) were chosen for data collection to reduce location bias. The name and locations of the grocery stores were recorded in a Microsoft Excel spreadsheet. Photos showing the front product label and nutritional facts table were taken for each pasta sauce product. The following data were extracted from the photos: product name, types of pasta sauce, country of origin (COO), organic claim, the sodium content and saturated fat content from the nutrition facts table (NFT). These data were tabulated in another spreadsheet.

Inclusion Criteria

All tomato-based and alfredo-based pasta sauces that fulfilled the following criteria were included:

1.a) One must have tomatoes in any form as one of the top three in the ingredient list, or

b) One must have dairy products or dairy substitutes as one of the top three in the ingredient list.

2. The sauce was marketed and intended to be used as pasta sauce. Sauces like ketchup and tomato purée were not accepted.

Exclusion Criteria

Some of the samples were removed despite fulfilling the inclusion criteria above due to the following reasons:

• Rosé pasta sauce: It was a pasta sauce with a significant amount of tomato and cream in the ingredient. Differentiating whether it was a tomato-based or alfredo-based sauce was too difficult.

• Pasta sauce from the Philippines: A few of the tomato-based pasta sauces were made in the Philippines. Although their main ingredient was still tomato, the nutrient

content was different from the typical pasta sauce, and they were mostly purchased by a niche population.

• Pasta sauce with no salt added: Having little to no sodium content would heavily skew the data.

Results

Description of Data

In this study, continuous ratio data, multichotomous nominal data, and dichotomous nominal data were collected. The continuous ratio data were the sodium and saturated fat content of pasta sauce samples expressed in per unit weight – mg/100g and g/100g, respectively. The multichotomous nominal data collected were the COO and types of pasta sauce. Organic claim, the potential confounding factor, was the only dichotomous nominal data collected.

Descriptive Statistics

A total of 277 tomato-based pasta sauce samples and 16 alfredo-based pasta sauce samples were collected.

31% of the alfredo-based sauce collected were imported (n = 5) and 69% were domestic (n = 11). Due to the small sample size, the alfredo-based sauce samples will not be further analyzed as it would result in a large beta error, which deems the analysis meaningless as there is a high chance of producing a false negative result.

Tomato-based pasta sauce samples were categorized in Figure 1 based on the COO, which are Canada, the US, and Italy. 45% of the tomato-based sauce were from Canada (n = 124), 20% were from the US (n = 56), and the remaining 35% were from Italy (n = 97).

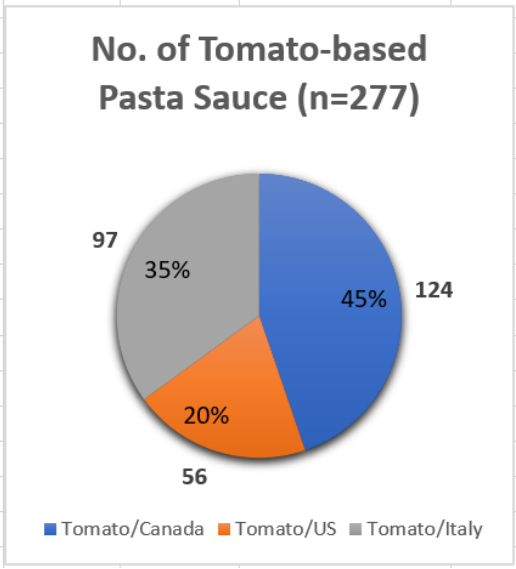

Figure 1. Pie Chart of Tomato-based Pasta Sauce Collected.

The tomato-based sauce samples were further separated based on the organic claim of products. Out of the 277 tomato-based sauce samples, 51 were organic, and 226 were non-organic. The data were displayed in Figure 2 and Figure 3. For the organic samples, both Canada (n = 20) and the US (n = 20) had 39% of the total collected, and

the remaining 22% were from Italy (n = 11). On the other hand, 46% of the non-organic samples were from Canada (n = 104), 16% were from the US (n = 36), and 38% were from Italy (n = 86).

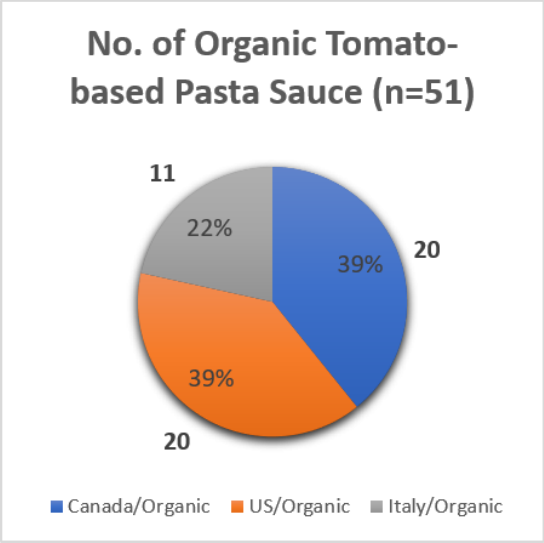

Figure 2. Pie Chart of Organic Tomato-based Pasta Sauce Collected.

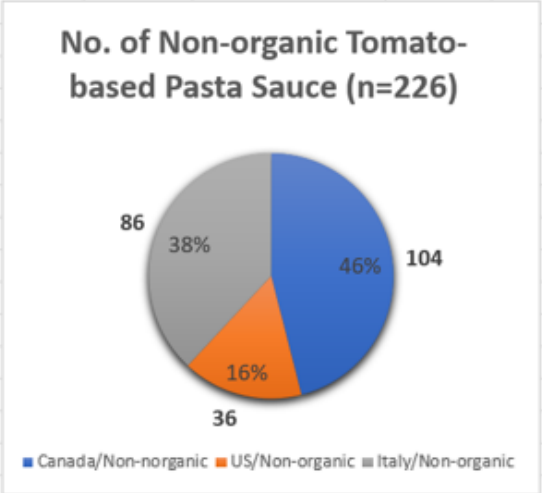

Figure 3. Pie Chart of Non-organic Tomato-based Pasta Sauce Collected

All the sample means of sodium and saturated fat content in tomato-based pasta sauce were summarized in Table 1 below.

Canada

	Organic	Non-organic	Total
Sodium (mg/100g)	260	321	309
Sat. Fat (g/100g)	0.1	0.2	0.2

US

	Organic	Non-organic	Total
Sodium (mg/100g)	285	341	325
Sat. Fat (g/100g)	0.1	0.6	0.4

Italy

	Organic	Non-organic	Total
Sodium (mg/100g)	352	286	299
Sat. Fat (g/100g)	0.2	0.6	0.6

Table 1. Summary of Means of Sodium Content and Saturated Fat Content in All Tomato-based Pasta Sauce.

Inferential Statistics

Because the samples were from three different COO (Canada, the US and Italy), one-way analysis of variance (ANOVA) was used to analyze for any statistical significance in the mean sodium content and saturated fat content among the three different groups of samples (Kent State University, 2021).

Organic samples were also analyzed separately from non-organic samples to study the influence of organic claim as a potential confounding factor on sodium and saturated fat content in pasta sauce.

The following table summarizes all the hypotheses, test results, and conclusions of the tests:

Test #	H_o and H_α	Statistical Test Used	Result	Conclusion
T1	**H_o 1:** There is no significant difference in the mean sodium content among **all** Canadian, US, and Italian tomato-based pasta sauce. **H_α 1:** There is a significant difference in the mean sodium content among **all** Canadian, US, and Italian tomato-based pasta sauce.	Kruskal-Wallis One-Way ANOVA on Ranks	P = 0.108	Do not reject H_o. Therefore, there is no significant difference in the mean sodium content among all Canadian, US, and Italian tomato-based pasta sauce. Power is 24.0% which indicates a high chance of beta error.
T2	**H_o 2:** There is no significant difference in the mean sodium content among the **organic** Canadian, US, and Italian tomato-based pasta sauce. **H_α 2:** There is a mean significant difference in the sodium content among the **organic** Canadian, US, and Italian tomato-based pasta sauce.	Welch's Test of Means Allowing for Unequal Variances	P = 0.204	Do not reject H_o. Therefore, there is no significant difference in the mean sodium content among the organic Canadian, US, and Italian tomato-based pasta sauce. Power is 52.3% which indicates a high chance of beta error.
T3	**H_o 3:** There is no significant difference in the mean sodium content among the **non-organic** Canadian, US, and Italian tomato-based pasta sauce. **H_α 3:** There is a significant difference in the mean sodium content among the **non-organic** Canadian, US, and Italian tomato-based pasta sauce.	Kruskal-Wallis One-Way ANOVA on Ranks	P = 0.007	Reject H_o. Therefore, there is a significant difference in the mean sodium content among the non-organic Canadian, US, and Italian tomato-based pasta sauce. The Scheffe's Multiple-Comparison Test shows the mean sodium content in the US tomato-based pasta sauce is significantly different from the Italian tomato-based pasta sauce. There is no significant difference between the sodium content in Canadian and the US tomato-based pasta sauces, as well as Canadian and Italian tomato-based pasta sauce. Power is 78.4% which indicates a small chance of beta error.
T4	**H_o 4:** There is no significant difference in the mean saturated fat content among **all** Canadian, US, and Italian tomato-based pasta sauce. **H_α 4:** There is a significant difference in the mean saturated fat content among **all** Canadian, US, and Italian tomato-based pasta sauce.	Kruskal-Wallis One-Way ANOVA on Ranks	P = 0.000	Reject H_o. Therefore, there is a significant difference in the mean saturated fat content among all Canadian, US, and Italian tomato-based pasta sauce. The Scheffe's Multiple-Comparison Test shows the saturated fat content in Canadian tomato-based pasta sauce is significantly different from the US and Italian tomato-based pasta sauce. There is no significant difference between the saturated fat content of the US and Italian tomato-based pasta sauce. Power is 100% which indicates that beta error would not be possible.

T5	**H_o 5:** There is no significant difference in the mean saturated fat content among the **organic** Canadian, US, and Italian tomato-based pasta sauce. **H_α 5:** There is a significant difference in the mean saturated fat content among the **organic** Canadian, US, and Italian tomato-based pasta sauce.	Kruskal-Wallis One-Way ANOVA on Ranks	P = 0.893 (Corrected for Ties)	Do not reject H_o. Therefore, there is no significant difference in the mean saturated fat content among the organic Canadian, US, and Italian tomato-based pasta sauce. Power is 35.8% which indicates a high chance of beta error.
T6	**H_o 6:** There is no significant difference in the mean saturated fat content among the **non-organic** Canadian, US, and Italian tomato-based pasta sauce. **H_α 6:** There is a significant difference in the mean saturated fat content among the **non-organic** Canadian, US, and Italian tomato-based pasta sauce.	Kruskal-Wallis One-Way ANOVA on Ranks	P = 0.000	Reject H_o. Therefore, there is a significant difference in the mean saturated fat content among the non-organic Canadian, US, and Italian tomato-based pasta sauce. The Scheffe's Multiple-Comparison Test shows the saturated fat content in non-organic Canadian tomato-based pasta sauce is significantly different from the non-organic US and Italian tomato-based pasta sauce. There is no significant difference between the saturated fat content of the US and Italian tomato-based pasta sauce. Power is 100% which indicates that beta error would not be possible.

Table 2. Summary of the Inferential Test Results

Discussion

Sodium Content

The findings partially agree with the research by Dunford et al (2019). Aside from T1 and T2 having inconclusive results, the post-hoc test in T3 suggests that the non-organic US tomato-based pasta sauce has a higher sodium content than those made in Italy, and the sodium content in neither the US nor the Italian sauce is significantly different from the Canadian sauce. Nevertheless, it is worth noting that if Tukey-Kramer Multiple-Comparison Test were used instead of Scheffe's, both the US and Canadian sauce would have a higher sodium level than the Italian sauce, while there would be no significant difference between the US and Canadian sauce. Therefore, it is likely that non-organic Canadian pasta sauce has a higher sodium level than the Italian pasta sauce, though larger sample size is required to have a more confident result.

Overall, Italian non-organic tomato sauce seems to be the healthiest choice among all, with a mean sodium content of 286

mg/100g. The Canadian samples had a mean sodium content of 321 mg/100g, while the US samples had 341 mg/100g. Using Health Canada's 2025 sodium reduction target for tomato-based pasta sauce as a standard, 300 mg/100g (Health Canada, 2020), the non-organic Canadian and US sauces are both considered to have too much sodium. Since pasta dishes are one of the primary dietary sources for Canadians, they could contribute to the excessive sodium consumption problem in Canadian adults. Based on the literature review, consuming these pasta sauces long-term leads to high blood pressure, which potentially causes strokes and other cardiovascular diseases.

Processed foods in North America having a higher sodium level than other countries is not a surprising fact, as similar results were noted in other research as well (Coyne et al., 2017). One possible reason could be that governments in other countries started tackling the sodium issue together with their food industries long before the US and Canada began theirs. In the UK, the government have started introducing voluntary sodium reduction targets back in 2006 (Eyles, 2013). While in Italy, the government and their food industry signed an agreement in 2009, committing to reduce the sodium level in bakery products (WHO, 2013). Health Canada first published voluntary sodium reduction targets in 2012, which was not very successful as the food industry was not committed to the plan, with many categories of processed foods failed to meet the targets (Health Canada, 2020). In the US, the FDA proposed voluntary sodium reduction targets in 2016, but the draft was blocked by Congress, claiming that implementing the plan would cost the food industry 16 billion dollars over ten years (Collins et al., 2019). Food manufacturers in North America are worried that sodium reduction in their products would impact sales, given how important it is as a preservative and flavour enhancer in food.

Saturated Fat Content

Although there were statistical differences among the saturated fat content of the sauces, the actual differences were minor. Moreover, the amount of saturated fat in most of the tomato-based pasta sauce samples was very low. Using the Italian tomato-based pasta sauce as an example, which would provide 0.8 g of saturated fat in a pasta dish when served according to the serving size of 125 mL (CFIA, 2019). Because one gram of fat provides about nine calories, the pasta sauce would only provide 7.2 calories, which is about 0.36% of a 2000 calories diet. This value is well below the

10% of total energy intake for saturated fats recommended by the WHO (2020). Thus, under normal circumstances, the saturated fat in a tomato-based pasta sauce will not cause any significant health concerns.

That being said, a few of the tomato-based pasta sauce, which were rejected as outliers in the statistical analysis, contained a very high amount of saturated fats, ranging from 2.7 to 5.6 g/100g. These sauces can contribute significantly to the total energy intake, about 1.6% to 3.3% in a 2000 calories diet. These sauces are labelled as "Vodka Sauce" or "Marinara Sauce with Cheese," and they are tomato-based sauces that contain dairy products. Also, some other tomato-based sauces that contain meat have a relatively high amount of saturated fats (about 2 g/100g). These sauces with meats and dairies have a much higher chance of containing a significant amount of saturated fat, leading to the build-up of LDL cholesterol and increased risks of cardiovascular diseases and strokes.

Knowledge Translation

As pointed out in the literature review, Canadians consume too much sodium and saturated fat in their diets. Since pasta is one of the primary sources of sodium and saturated fat for many Canadians, having even just a small reduction of the two nutrients can improve their health in the long term. Health Canada can use the findings to justify why reducing sodium is important and to convince the Canadian pasta sauce manufacturers to lower the sodium level in their products.

In addition, the sodium data from this research can be used to evaluate the process of Health Canada's voluntary sodium reduction target for pasta sauce. In 2017, the measured level sales weighted average of sodium was 353 mg/100g (Health Canada, 2020). The data from this research shows a steady improvement in the sodium reduction process, and it is approaching the 2025 target of 300 mg/100g.

Limitation

This study had two main limitations. First, it was the geographical location of the sampling method. As the sampling of products was restricted to Metro Vancouver, the samples might not be representative enough for Canada. Other provinces could have more selections of imported or domestic pasta sauces that were not available in Metro Vancouver. This

limitation affected the external validity of the study.

The second limitation was the limited product variety available in the market. There were insufficient alfredo-based sauces samples and organic tomato-based sauces in the lower mainland, BC, for the statistical analysis. Thus, the analysis on alfredo-based sauce could not be done, and the power of the tests on the organic sauces was too low, which caused the tests to be inconclusive.

A recommendation to eliminate these limitations would be to collect data outside of Metro Vancouver in various ways. Other provinces may have products that are not available in BC. For example, one could collaborate with researchers from other provinces and compile the data into one research. Simply travelling to other provinces to collect data could be another viable alternative, although this method would be expensive. Any methods that obtain legitimate data across the country could reduce the location bias. By increasing the sample size, the power of the statistical tests will increase as well.

Future Research

The following topics are recommended for future student projects:

- Comparison of sodium and/or saturated fat content in other domestic and imported food products, such as potato chips and canned foods
- Study of the knowledge level of Canadians in terms of the sodium and saturated fat content in pasta sauce

Conclusion

The sodium and saturated fat content in tomato-based pasta sauce were compared between three different countries of origin – Canada, the US and Italy. Non-organic US tomato-based pasta sauce has more sodium than those made in Italy. Non-organic Canadian tomato-based pasta sauce potentially has more sodium than the Italian pasta sauce as well, but more data is required for a more confident result. On the other hand, the saturated fat content in non-organic Canadian tomato-based pasta sauce is lower than sauces from the US and Italy. However, the difference is small, and the level of saturated fat in tomato-based pasta, in general, is too low to cause significant health consequences. Non-organic Italian tomato-based pasta sauce seems to be the healthiest choice in terms of sodium level. Larger sample size and elimination of more confounding factors are required to improve the validity of the result.

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Competing Interest

The author declares that they have no competing interests.

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