

Comparing the Caffeine Content of Caffeine-Containing Dietary Supplements in British Columbia

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Abstract

Background and Purpose: The use of dietary supplements is on the rise in Canada. This raises questions about the safety of the supplements when taken in the recommended dosage. One ingredient of concern in dietary supplements is caffeine, which can cause adverse health effects when consumed in great enough quantities. Given the lack of research into the caffeine content of dietary supplements, along with few regulations that exist regarding labelling or limits on caffeine content within Canada, a major concern is whether or not these supplements pose a risk to the public. The purpose of this study is to compare the caffeine content of various types of dietary supplements, and to determine if the caffeine content warrants a risk to the public.

Methods: Supplement stores within the Vancouver Metropolitan Area were visited online and in person, and supplements were categorized as an energy drink, pre-workout supplement, energy bar, fat-loss supplement, or caffeine pill or capsule. The caffeine content per recommended dosage of each supplement was recorded from the label.

Results: It was found that the caffeine content did vary between supplement categories (Kruskall-Wallis one way ANOVA test had a p-value < 0.000), and that fat-loss supplements and pre-workout supplements had the highest caffeine content with a mean 221.19mg per serving and 249.68mg per serving respectively. Caffeine pills had a mean of 186.90mg per serving, energy drinks had a mean of 166.84mg per serving, and energy bars had a mean of 85.06mg per serving.

Discussion: Health Canada recommends that healthy adults not exceed 400mg of caffeine per day. Exceeding this limit can lead to adverse health reactions, such as anxiety, insomnia, heart palpitations or more serious symptoms such as convulsions or death. It was found in this study that 5% of the samples exceeded 400mg, and can be considered hazardous. Taking multiple doses of supplements, or consuming additional caffeine from alternative sources, such as coffee, also puts consumers at a greater risk of exceeding the recommended limits. Currently there are no regulations in Canada regarding how much caffeine is permitted within these products, or any labeling requirements for caffeine in dietary supplements.

Conclusion: Given the increase in popularity of dietary supplements in Canada, along with the limited regulations on labelling requirements, caffeine-containing supplements could potentially pose a risk to consumers. This study shows that the caffeine content differs between types of dietary supplements, and that some supplements exceed the Health Canada guidelines of 400mg. More regulations and guidelines on labeling requirements for these supplements may be necessary to protect the public.

Keywords: dietary supplements, caffeine, caffeine content, workout, labelling, supplement safety, British Columbia

Introduction

Nutritional supplementation has exploded over the last few decades with as many as 45.6% of Canadians aged 1 and older reported to have used at least one supplement in 2015 compared to just 26.3% in 2004 (Statistics Canada, 2017). Nutritional

supplements refer to a large range of products that can include protein powders, multivitamins, pre-workout supplements, caffeine pills, and fat burners. While multivitamins make up most of the supplements consumed by Canadians (23.1%),

supplements geared towards fitness and performance are on the rise (Statistics Canada, 2017). A major ingredient in many fitness supplements is caffeine, which is known to have hazardous side effects in sensitive individuals or in large doses (Health Canada, 2012). Health Canada recommends that healthy adults not exceed 400mg of caffeine per day (2012), but there are currently no requirements on how much caffeine is permitted within pre-packaged food products (Canadian Food Inspection Agency, 2010) with the exception of 200 ppm for cola-type beverages (2010). Additionally, different individuals may have different responses to caffeine, and women who are pregnant or are planning to become pregnant, as well as children, have requirements below 400mg per day (Health Canada, 2012). As such it is possible that many workout and fitness supplements that contain large quantities of caffeine per serving can pose a danger to the public if left unchecked. This project will investigate the caffeine content of different types of dietary supplements in order to determine if there is a difference in caffeine concentration between supplement types, as well as to get a better understanding of the risks they pose to the public.

Literature Review

Effects of Caffeine

Caffeine is one of the most common drugs that is consumed by the public. Currently the primary source of caffeine is coffee for adults and soft drinks for children (Frary C., et al, 2005). A survey by Mahoney et al. (2018) of 1,248 U.S. college students found that some of the major reasons stated for caffeine use was to feel more awake, enjoyment of the taste, and to improve concentration and physical energy. These findings were similar to those found by another study of one hundred forty athletes at the 2005 iron man championships where the main stated reasons for consuming caffeine was improved endurance and concentration when performing (Desbrow and Leveritt, 2007). These reports are backed by experimental evidence that showed that sprint performance among athletes was seven percent faster for those who received 6mg of caffeine per kilogram of bodyweight compared to a placebo (Schneiker et al., 2006). Additionally, improved performance on reaction time tasks, rapid visual information processing tasks, and performance tests was observed in twenty three test subjects given caffeine compared to a placebo in a double-blind within-subjects study (Smitt and Rogers, 2000). This could help explain why more athletes and young adults are turning to nutritional supplements containing caffeine (Health Canada, 2012).

There are some potentially harmful side effects of

consuming too much caffeine. A comparison study of twelve individuals given a 250mg dose and a 500mg dose in a randomized, double-blind, single-dose crossover study saw an increase in anxiety, insomnia, irritability, heart palpitations, and restlessness in the 500mg dose over the 250mg dose (Kaplan et al., 2013). Another study of thirteen men performing resistance training varied caffeine doses to 3mg/kg, 6mg/kg, and 9mg/kg and found that side effects, such as tachycardia, heart palpitations and gastrointestinal disturbances increased moderately from the 3mg/kg dose to 6mg/kg, but spiked when given the 9mg/kg dose (Pallares et al., 2013). These and other studies suggest that the dose of caffeine is largely responsible for the health effects experienced by the users. Indeed, Health Canada (2012) recommends that the limits for healthy adults should be 400mg of caffeine per day, women of childbearing age 300mg per day, children aged four to six 45mg per day, children seven to nine 62.5mg per day, children ten to twelve 85mg per day, and children thirteen and older should limit their consumption to 2.5mg/kg of bodyweight per day.

In extreme cases overdoses of caffeine can lead to vomiting, convulsions, coma, and death as was seen in a case study of two deaths involving a thirty nine year old woman who was found to have a blood caffeine concentration of 192mg/L, and a twenty nine year old male who had a blood caffeine concentration of 567mg/L (Kerrigan and Lindsay, 2005). Another case study by Jabbar and Hanly (2013) describes a thirty nine year old man who consumed 12g of caffeine in a dietary supplement and died with a blood caffeine concentration of 350mg/L. Beauchamp, Amaducci, and Cook (2017) state that caffeine may be fatal at doses of 150mg/kg of bodyweight. For most people this requires approximately ten grams of caffeine to be ingested (2017). It is highly unlikely to ingest this much caffeine from coffee as one cup contains approximately 135mg (Health Canada, 2012) and would require drinking seventy five cups. However, consuming fifty caffeine pills with 200mg each of caffeine or consuming one tablespoon of caffeine anhydrous powder can reach levels high enough to kill (Beauchamp et al., 2017). Deaths related to caffeine may be rare. An analysis of 83,580 forensic autopsies in Sweden from 1993 to 2009 (Thelander et al., 2010) found that caffeine only contributed to 20 of the deaths. However, the current lack of regulation and knowledge about caffeine in nutritional supplements, combined with the increased use of supplements by athletes and young adults, may result in an increase in caffeine-related deaths and illness.

Regulations and Guidelines

In Canada caffeine is considered a food additive and is governed by the Food and Drugs Regulation under the Food and Drugs Act. Under this regulation caffeine must be listed in the ingredient list of food and

beverages, however the amount of caffeine allowed is only restricted in cola-beverages in section B.16.100 (Food and Drugs Regulation, 2018), and foods labeled as decaffeinated in section B.05.003. Additionally, caffeine from natural sources, such as guarana and teas, are not required to be listed in the ingredient list (Health Canada, 2010).

As of March 2010, Health Canada has begun the process of establishing labeling guidelines for caffeinated pre-packaged foods in addition to the guidelines for daily caffeine consumption that already exists (Health Canada, 2010). In these new guidelines Health Canada proposes to include instructions on how to label pre-packaged foods and to include the quantity of caffeine from all sources that are in the product. This would allow consumers to more accurately track their caffeine intake and to make better decisions regarding its use.

Many dietary supplements containing caffeine are regulated as Natural Health Products in Canada (Health Canada, 2016). Natural Health Products can include vitamins and minerals, herbal remedies, probiotics, amino acids, and essential fatty acids (2016). Natural Health Products must be licensed by Health Canada and are governed by the Natural Health Products Regulation (2016). Under section 5(d) of this regulation manufacturers are required to provide a qualitative list of non-medical ingredients, a statement about the purpose or intent of the ingredient, and information that demonstrates the safety of the product when used in the recommended dosage when applying for a license (Health Canada, 2018). Since caffeine is a non-medical ingredient, the quantity does not need to be submitted for review.

Caffeinated energy drinks are currently listed as a natural health product, but efforts are underway to transition them to a food product to be regulated under the Food and Drugs Regulation (Canadian Food Inspection Agency, 2018). In the meantime caffeinated energy drinks must have a Temporary Marketing Authorization Letter (TMAL) that can be issued by Health Canada (2018). In order to receive a TMAL the total caffeine content from all sources must be provided and listed on the label.

In British Columbia the guidelines for food and beverage sales in BC schools (Ministry of Health, 2013) states that beverages and snacks that contain more than 15mg of caffeine, but do not state this on the label, should not be sold in BC schools. No other additional legislation or guidelines exist in BC for caffeine in pre-packaged foods or supplements.

Caffeine in Dietary Supplements

Since there are no regulations requiring most dietary supplements to provide the quantity of caffeine on the

label, many manufacturers have voluntarily added the information on the label. A study by JustaNeves and Caldas (2017) on workout supplements in Brazil found that of 213 samples only 109 actually declared the amount of caffeine on the label. Additionally, the researchers measured the caffeine content of the workout supplements and found that 26.6% of the caffeine labeled samples contained more than 120% of the caffeine stated on the label. After examining the recommended doses listed on the supplements the researchers found that 47.9% would lead to a caffeine intake exceeding 400mg (2017).

Another study of the caffeine content of 53 caffeine-containing supplements in the U.S. found that 89% had caffeine levels within 16% of the stated amount on the label (Andrews et al., 2007). In this study it was found that the mean amount of caffeine per serving in the supplements was 238mg, however caffeine content ranged from 1mg per serving to as much as 800mg per serving (2007). Out of the 53 supplements examined it was found that 15 exceeded the recommended daily intake of 400mg. The supplements examined only included tablets, caplets, and capsules containing caffeine and did not examine energy drinks, workout powders or beverages.

An examination of the labels of sixty four caffeine-based supplements in Portugal found that 22% exceeded 200mg of caffeine per recommended dose and 11% exceeded 400mg (Bassada, Alves, and Oliveira, 2018). The researchers examined several caffeine containing supplements including energy powders, energy drinks, energy bars, energy concentrated liquids, energy gels, and capsules. It was found that energy powders contained the most caffeine per weight (1060mg/100g - 2500mg/100g) and that caffeine content varied widely between the different supplement types. Some of the labels provided clear instructions on dosage and use, but others did not provide information. It was noted by the researchers that caffeine supplements do not require any pre-approval or safety evaluation before commercialization within the European Union and that more regulation and enforcement by health authorities was needed to oversee the sale of the products. From the research it is clear that the caffeine content of dietary supplements can vary widely between different brands and types. In Canada very little oversight and regulations exists to control the caffeine content and labeling of caffeine-containing products. This may be in part because historically food and drinks containing caffeine, such as coffee, teas, sodas, and various snacks, contained very small amounts of caffeine leading to very little risk of harmful effects. As more products are being developed that contain concentrated and more potent forms of caffeine, and the demand and use of such products is increasing, the potential for harm has increased. Currently, very

little research has been done on the caffeine content of dietary supplements sold in Canada. If regulations and guidelines are to be developed regarding these supplements then more information is needed regarding which products contain the most caffeine and have the largest potential to cause harm.

The purpose of this study is to evaluate the caffeine content of dietary supplements based on supplement type. This will assist regulators in determining what regulations, if any, are needed to be developed by comparing the average caffeine content of different supplement types to determine which products pose the greatest risk to consumers.

Methods

Design

This experiment used a cross-sectional research design. The independent variable is the supplement category, and the dependent variable is the caffeine content per recommended dosage written on the label. The hypothesis being tested is that there is a difference in the caffeine content of dietary supplements based on the supplement category.

Materials and Procedure

Sports nutrition and supplement stores within Vancouver metropolitan area were visited in person and online. The stores selected were within Vancouver, Burnaby, New Westminister, Surrey, and Richmond, and were chosen based on popularity on google search results, as well as quantity and variety of supplement selection available at the store. Various supplements and products were selected based on popularity and recommendation from the sales staff, or online using keywords such as “caffeine”, “energy”, and “workout”. The labels of the supplements were analyzed and the products categorized as an: energy drink, pre-workout supplement, energy bar, fat-loss supplement, or caffeine pill or capsule. The caffeine content was recorded per the recommended dosage according to the label. Within stores the caffeine content was read off of the labels, whereas online the content was read off a picture of the label or from the ingredient list provided on the site. This methodology resembles that used by Bessada et. al (2018) in a similar study performed in Portugal. An example of collecting a data point from an online supplement store can be seen in figures 1 and 2 below.

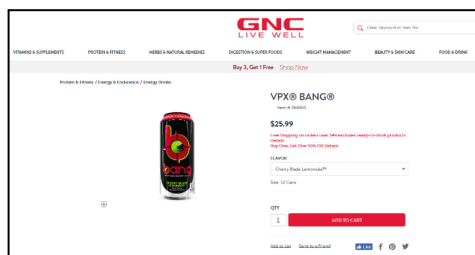


Figure 1: VPX energy drink sold on GNC's online store (taken from GNC online store, November 2018)

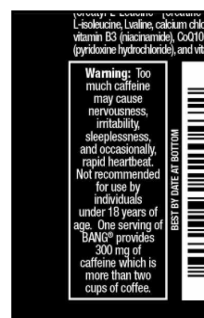


Figure 2: Label of VPX energy drink demonstrating 300mg of caffeine per serving (Taken from GNC online store, November 2018)

An alternative method for performing this research would be to purchase various dietary supplements and test the caffeine content using near-infrared (NIR) spectrometry, such as performed by Wang et al. (2018) on herbal teas, or high pressure liquid chromatography, such as used by Attipoe et al. (2016) when measuring the caffeine content of energy drinks and energy shots.

The proposed method was selected based on the ability to obtain a large sample size for comparison, as well as the ability to complete the study within a reasonable amount of time and at low cost. The materials used in this project included a laptop, microsoft excel, and NCSS statistics package.

Reliability and Validity

A concern of internal validity is whether the caffeine content listed on the labels is representative of the actual caffeine content within the supplements. Inaccurate labels or labels that overestimate or underestimate the caffeine content in the product can lead to errors in conclusions. Andrews et al. (2007) analyzed the caffeine content of 53 supplements and found that 89% of supplements contained caffeine within 16% of the stated caffeine content of the label. Attipoe et al. (2016) found that all products they tested were within 15% of the stated amount on the label. These studies suggest that the caffeine content listed on the label closely resembles the actual caffeine content in the majority of supplements.

Another concern is whether the supplements used in the study are representative of what the majority of

consumers are purchasing and consuming. While many people do select stores based off of google search results, some may select stores based on word of mouth or by another means. This may influence how well the results generalize to dietary supplements that are purchased by consumers. This study focused solely on dietary supplements and stores that are listed online and excluded stores that do not have a website or a google search result. Additionally, only dietary supplements that provide the caffeine content on the label are included in this study, and supplements that do not have a label or do not provide the amount of caffeine on the label are not used. The reliability of the methods used in this study are high as no equipment or measuring devices are used. The probability of a type 2 or Beta error (falsely concluding that there is no difference in caffeine content between supplement categories) can be decreased by taking a large sample of each supplement category. The probability of making a type 1 or alpha error can be reduced by selecting a smaller p-value of 0.01.

Pilot Study

In order to determine the feasibility of the method used in this study five supplements for each category were selected using online stores. This was to determine if caffeine content could be determined from reading the labels using online stores. It was found that most supplements found online did provide a label that included the caffeine content, or an ingredient list that included the data.

Results

The data that was collected in this study is numerical and was analyzed using a one way analysis of variance test using NCSS statistical software. Energy drinks, preworkout supplements, and fat loss supplements each had a sample size of 30. This was to ensure that there was an adequate sample size to increase the power of the study and limit the probability of a type 2 error from occurring. Energy bars had a sample size of 16, and caffeine pills/tablets had a sample size of 21. This was due to there being fewer energy bars containing caffeine and caffeine pills for sale in the Vancouver area. The data was found to not be normally distributed so the results were read using the non-parametric Kruskal-Wallis one way ANOVA test. The mean caffeine content for each supplement category is presented in table 1 and figure 3, along with the median and standard deviation.

Table 1: Caffeine content of the supplements in milligrams per serving of the different supplement categories

Supplement Type	Mean	Median	Standard Deviation
Energy Drink	166.84	160.00	76.84
Pre-workout supplement	249.68	200.00	99.55
Energy bar	85.06	90.00	40.07
Fat-loss supplement	221.19	200.00	99.23
Caffeine Pill/Capsule	186.90	200.00	33.18

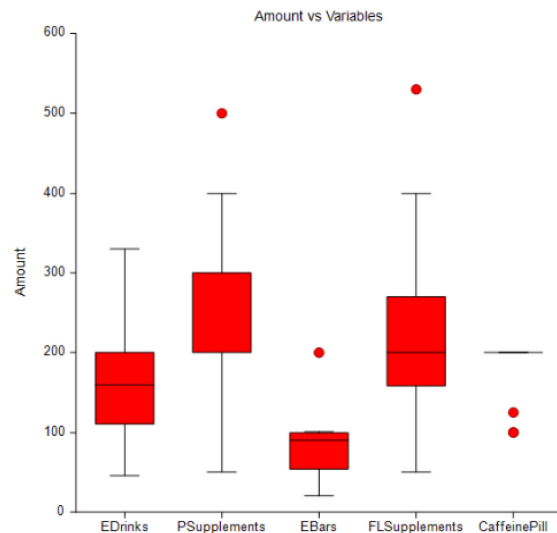


Figure 3: Differences in caffeine content in milligrams per serving of dietary supplements types

The results of the Kruskal-Wallis one way ANOVA (see appendix) showed that the p-value was very small ($p < 0.000$), therefore the null hypothesis was rejected. The results show that there is a difference in the mean caffeine content between supplement categories. The power of the study was very high (Power = 1.000), and the Beta was below the detection of the NCSS software, therefore one can be confident of the validity of the results. A Scheffe's multiple comparison test was run to determine which supplement categories differed from each other. This is summarized in table 2 below.

Table 2: Results of Scheffe's Multiple Comparison Test

Supplement Category	Conclusion
Preworkout Supplements Fat Loss Supplements Caffeine Pills	No statistical difference in mean caffeine content
Caffeine Pills Energy Drinks	No statistical difference in mean caffeine content
Energy Bars	Different from all other supplement groups

Interestingly while preworkout supplements and fat loss supplements were statistically different from energy drinks, caffeine pills were not statistically different from either. This is probably due to the sensitivity of the Scheffe's multiple comparison test. From the descriptive statistics it can be concluded that preworkout supplements, fat loss supplements, and

caffeine pills have the highest caffeine content per serving, followed by energy drinks, and then energy bars.

Discussion

The findings of this study are consistent with Bassada et al. (2018) in that there is a difference in mean caffeine content between supplement types, and that energy powders, such as workout supplements or fat loss supplements, do contain the most caffeine per serving. A reason for this could be the different intended uses of the supplements. While energy drinks and energy bars may only be used to boost alertness or decrease fatigue, and thus require smaller doses of caffeine to achieve this effect, energy powders are mostly geared towards improved athletic performance, and may require higher doses of caffeine to achieve this. The mean caffeine content of all dietary supplements studied was below the Health Canada recommended guidelines of 400mg, and only 7 of the 130 total samples (approximately 5%) contained 400mg per serving or above. This is lower than the 11% observed by Bassada et al. (2018). However, 75 of the 130 total samples (approximately 58%) contained more than 200mg per serving, which is higher than the 22% observed by Bassada (2018). The highest caffeine content observed was the MuscleTech Performance Series Vapor X5 Ripped fat loss supplement, which contained 530mg per serving.

It should be noted that while most supplements contained less than 400mg per serving, this does not take into account that consumers may take more than one serving in a day which could push their daily caffeine intake well over the 400mg limit. People that consume caffeine from other sources, such as coffee, teas, or sodas, would also be at risk of exceeding the daily caffeine content when using most supplements. Additionally, children under 18 years of age and women of childbearing age are at the highest risk of exceeding their daily caffeine intake recommendations. This could lead to health consequences such as anxiety, insomnia, irritability, heart palpitations, and restlessness (Kaplan et al., 2013), or even more severe symptoms such as vomiting, convulsions, coma, and death (Kerrigan and Lindsay, 2005) when taking extremely large doses of caffeine.

Limitations

A major consideration that should be taken into account with this study is that it does not factor in any possible synergistic effects caffeine may have with other ingredients. Some doses of caffeine may be safe on their own, but when combined with the effects of other ingredients could produce potentially dangerous health consequences. Many dietary supplements are

cocktails of many different ingredients, and can contain stimulants or other substances that may interact with caffeine to produce an enhanced effect. Thus the caffeine content per serving should not be the only consideration when examining the safety of dietary supplements.

This study only examined supplements sold in popular brand stores, such as GNC or Popeyes Supplements. These larger retailers may limit their selection of dietary supplements to brands or products that contain smaller quantities of caffeine in order to ensure the safety of their customers or to limit liability. It is possible that supplements purchased from smaller online retailers, or sold within gyms contain caffeine quantities that differ from those observed in this study. It was assumed in this study that the majority of consumers would purchase supplements from popular retail stores within the Greater Vancouver Area, however a survey of users may have shown whether or not this was the case. Additionally, this study relied on self reported data from the manufacturers of dietary supplements, and some manufacturers may over or under report the caffeine content of their products due to marketing or other factors.

Knowledge Translation

Since very few regulations exist in Canada on the labelling of caffeine containing dietary supplements, this research could be used as justification for new regulations to be established. The results of this study show that some supplements do contain caffeine in excess of 400mg per serving, which demonstrates the need for proper labelling so consumers can make smart decisions regarding their use. Regulators may also wish to put limits on how much caffeine is permitted per serving, or to require warning labels be visible on all products. The results of this study also demonstrate that the caffeine content of some dietary supplements may be dangerous to people under the age of 18, which could require regulations that limit or prohibit the sale to minors be established.

Health Canada has guidelines that the public can use to determine the average caffeine content of various food items, such as coffee and chocolates. This research could be used to establish similar guidelines for dietary supplements. The public could then use these guidelines to make informed decisions about regarding the use of dietary supplements.

Future Research Ideas

- Conduct a survey of dietary supplement users in order to assess how dietary supplements are consumed, what supplements are most commonly used, and where do consumers purchase their supplements.
- Measure the actual caffeine content of dietary supplements and compare this to the amount

listed on the label.

- Compare the caffeine content of dietary supplements sold in Canada to those that are sold in other countries.
- Identify an ingredient that could interact with caffeine and compare the quantity of this ingredient between different supplement types.

Conclusions

Caffeine content differs between the types of dietary supplements available on the market. Preworkout supplements, fat loss supplements, and caffeine pills contain the most caffeine per serving, and energy bars have the lowest caffeine per serving. Fifty eight percent of the supplements observed had more than 200mg per serving. If misused, or used in addition to caffeine from other sources, this could lead to a user exceeding the Health Canada recommended limit on daily caffeine consumption. Given the increased use of dietary supplements, especially by younger people, more regulations and guidelines on labelling requirements of dietary supplements may be necessary to protect the public.

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Competing Interest

The authors have no competing interests.

References

Andrews K., Schweitzer A., Zhao C., Holden J., Roseland J., Brandt M., Dwyer, Johanna T., Picciano M., Saldanha, Leila G., Fisher K., Yetley E., Betz J., Douglass L. (September, 2007). The caffeine contents of dietary supplements commonly purchased in the US: analysis of 53 products with caffeine-containing ingredients. *Analytical & Bioanalytical Chemistry*. 389(1): pp 231-239. DOI: 10.1007/s00216-007-1437-2. Retrieved from: <http://web.b.ebscohost.com/ehost/detail/detail?vid=0&sid=3ab263e5-9b4c-4a6a-b6e5-99fb32726bd4%40sessionmgr103&bdata=#AN=26290151&db=a9h>

APA style (2018). Sample One-Experiment Paper. Retrieved from: <https://www.apastyle.org/manual/related/sample-experiment-paper-1.pdf>

Attipoe S., Leggit J., Deuster P. (2016). Caffeine

Content in Popular Energy Drinks and Energy Shots. *Military Medicine*. 181(9): pp. 1016-1020. Retrieved from:

<http://web.a.ebscohost.com.ezw.lib.bcit.ca:2048/ehost/pdfviewer/pdfviewer?vid=1&sid=2c31451a-2d40-43a4-99e8-5669f4c77c5c%40sessionmgr4008>

Bassada S., Alves R., and Oliveira B. (2018). Caffeine-based food supplements and beverages: Trends of consumption for performance purposes and safety concerns. *Food Research International*. 109: pp 310-319. Retrieved from: <https://www.sciencedirect.com.ezw.lib.bcit.ca/science/article/pii/S096399691830334X>

Beauchamp G., Amaducci A., and Cook M. (2017). Caffeine Toxicity: A Brief Review and Update. *Clinical Pediatric Emergency Medicine*. 18(3): pp 197-202. Retrieved from: <https://www.sciencedirect.com.ezw.lib.bcit.ca/science/article/pii/S152284011730040X>

Canadian Food Inspection Agency (March, 2010). Preliminary Guidance for Industry on the Labelling of Caffeine Content in Prepackaged Foods. Retrieved from: <https://www.canada.ca/en/health-canada/services/food-nutrition/legislation-guidelines/guidance-documents/preliminary-guidance-industry-labelling-caffeine-content-prepackaged-foods-march-2010.html>

Canadian Food Inspection Agency (May, 2018). Caffeine as a Food Additive. Retrieved from: <http://www.inspection.gc.ca/food/labelling/food-labelling-for-industry/food-additives/eng/1468420159039/1468420338039?chap=6>

Caroline R. Mahoney, Grace E. Giles, Bernadette P. Marriott, Daniel A. Judelson, Ellen L. Glickman, Paula J. Geiselman, Harris R. (April, 2018). Intake of caffeine from all sources and reasons for use by college students. *Clinical Nutrition*. doi: 10.1016/j.clnu.2018.04.004. Retrieved from: [https://www.clinicalnutritionjournal.com/article/S0261-5614\(18\)30134-1/fulltext](https://www.clinicalnutritionjournal.com/article/S0261-5614(18)30134-1/fulltext)

Desbrow B., and Leveritt M. (August, 2007). Well-trained endurance athletes' knowledge, insight, and experience of caffeine use. *Int J Sport Nutr Exerc Metab*. 17(4): p328-329. Retrieved from: <https://www.ncbi.nlm.nih.gov/pubmed/17962708>

Diana Brito da JustaNeves and Eloisa Dutra Caldas (2017). Determination of caffeine and identification of undeclared substances in dietary supplements and caffeine dietary exposure assessment. *Food and*

Chemical Toxicology. 106: pp 194-202. Retrieved from: <https://www.sciencedirect.com.ezw.lib.bcit.ca/science/article/pii/S0278691517301655>

Frary C., Johnsons R., and Wang M. (January, 2005). Food sources and intakes of caffeine in the diets of persons in the United States. *Journal of the American Dietetic Association*. 105(1): p110-113. Retrieved from: <https://www.sciencedirect.com/science/article/pii/S000282230401702X>

GNC. Online retail store. Retrieved from: <https://www.gnc.com/energy-drinks/VPXBANG.html?cgid=energy-drinks#landing=1&start=1>

Health Canada (July, 2010). Caffeine and Carbonated Soft Drinks. Retrieved from: <https://www.canada.ca/en/health-canada/services/food-nutrition/food-safety/food-additives/caffeine-foods/carbonated-soft-drinks.html>

Health Canada (February, 2012). Caffeine in Food. Retrieved from: <https://www.canada.ca/en/health-canada/services/food-nutrition/food-safety/food-additives/caffeine-foods/foods.html>

Health Canada (June, 2018). Natural Health Products Regulations. Retrieved from: <http://laws-lois.justice.gc.ca/eng/regulations/SOR-2003-196/page-2.html#h-5>

Health Canada (March, 2010). Preliminary Guidance for Industry on the Labelling of Caffeine Content in Prepackaged Foods. Retrieved from: <https://www.canada.ca/en/health-canada/services/food-nutrition/legislation-guidelines/guidance-documents/preliminary-guidance-industry-labelling-caffeine-content-prepackaged-foods-march-2010.html>

Jabbar S., Hanly M. (December, 2013). Fatal Caffeine Overdose: A Case Report and Review of Literature. *The American Journal of Forensic Medicine and Pathology*. 34(4): pp321-324. doi: 10.1097/PAF.000000000000058. Retrieved from: https://journals.lww.com/amjforensicmedicine/Abstract/2013/12000/Fatal_Caffeine_Overdose_A_Case_Report_and_Review.8.aspx

Kaplan, G. B., Greenblatt, D. J., Ehrenberg, B. L., Goddard, J. E., Cotreau, M. M., Harmatz, J. S. and Shader, R. I. (2013). Dose-Dependent Pharmacokinetics and Psychomotor Effects of Caffeine in Humans. *The Journal of Clinical Pharmacology*. 37: 693-703. doi:10.1002/j.1552-

4604.1997.tb04356.x. Retrieved from: <https://accp1.onlinelibrary.wiley.com/doi/abs/10.1002/j.1552-4604.1997.tb04356.x#>

Kerrigan S., and Lindsay T. (October, 2005). Fatal caffeine overdose: Two case reports. *Forensic Science International*. 153(1): pp 67-69. Retrieved from: <https://www.sciencedirect.com/science/article/pii/S0379073805002057>

Ministry of Health (2013). Guidelines for food and beverage sales in BC schools. Retrieved from: https://www2.gov.bc.ca/assets/gov/education/administration/kindergarten-to-grade-12/healthyschools/2015_food_guidelines.pdf

National Institute of Health (June, 2017). Dietary Supplements for Exercise and Athletic Performance. Retrieved from: <https://ods.od.nih.gov/factsheets/ExerciseAndAthleticPerformance-HealthProfessional/>

Pallares J., Fernandez-Elias V., Ortega J., Munoz G., Munoz-Guerra J., and Mora-Rodriguez R. (May, 2013). Neuromuscular Responses to Incremental Caffeine Doses: Performance and Side Effects. *Medicine and Science in Sports and Exercise*. 45(11). DOI: 10.1249/MSS.0b013e31829a6672. Retrieved from: http://www.pilarmartinescudero.com/dic13/efectos_neurológicoscafeina.pdf

Schneiker K.T., Bishop D., Dawson B., and Hackett L.P. (March, 2006). Effects of caffeine on prolonged intermittent-sprint ability in team-sport athletes. *Medicine and Science in Sports and Exercise*. 38(3):578-585. DOI: 10.1249/01.mss.0000188449.18968.62. Retrieved from: <https://europepmc.org/abstract/med/16540848/reload=0>

Smitt H.J., and Rogers P.J. (October, 2000). Effects of low doses of caffeine on cognitive performance, mood and thirst in low and higher caffeine consumers. *Psychopharmacology*. 152(2): pp 167-173. DOI <https://doi.org/10.1007/s002130000506>. Retrieved from: <https://link.springer.com/article/10.1007/s002130000506#citeas>

Statistics Canada (June, 2017). Use of Nutritional Supplements, 2015. Retrieved from: <https://www150.statcan.gc.ca/n1/pub/82-625-x/2017001/article/14831-eng.htm>

Thelander G., Jonsson A., Personne M., Forsberg G., Lundqvist K., and Ahlner J. (2010). Caffeine fatalities – Do sales restrictions prevent intentional intoxications?. *Clinical Toxicology* 48: pp 354–358. DOI: 10.3109/15563650903586752. Retrieved from: <http://web.a.ebscohost.com/ehost/pdfviewer/pdfviewer?vid=2&sid=608aabf5-ecae-42ce-92ea-4867ecc08e2e%40sdc-v-sessmgr05>

University of Southern California Libraries (2018). Organizing Your Social Sciences Research Paper: Types of Research Designs. Retrieved from:

<http://libguides.usc.edu/writingguide/researchdesigns>

Wang J., Wang Y., Cheng J., Wang J., Sun X., Sun S., and Zhang Z. (2018). Enhanced cross-category models for predicting the total polyphenols, caffeine and free amino acids contents in Chinese tea using NIR spectroscopy. *LWT*. 96: pp. 90-97. Retrieved from: <https://www.sciencedirect.com.ezw.lib.bcit.ca/science/article/pii/S0023643818304262>