

RESEARCH ARTICLE

Analysis of micronutrients in Black cohosh (*Actaea racemosa* L.) grown in North Carolina as a potential herbal supplement

Julia Robinson and Guochen Yang*

Department of Natural Resources and Environmental Design, North Carolina A&T State University, Greensboro, North Carolina, U.S.A.

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Black cohosh (BC), a medicinal plant, is used to treat vasomotor symptoms (VMS) associated with menopause. Because it is not a prescription drug, but an herbal supplement (HS), it is not regulated by the FDA and whole plant parts are being consumed. The objective of this research was to measure the average amount of micronutrients found in rhizomes of BC and estimate the daily recommended dose of BC HS. Seed rhizomes were planted at North Carolina A&T State University farm greenhouse, one seed rhizome per 2-gallon pot, under 80% shade cloth. Rhizomes were harvested, washed, dried, and ground to fine powder. Micronutrients were measured using inductively coupled plasma optical emissions spectrometer (ICP-OES) and analyzed using SAS PROC MEANS and PROC ANOVA. Recommended daily amount of micronutrients for women who are experiencing VMS were compared to estimate amount of micronutrients in a daily dose of BC HS. The highest to the lowest amount of micronutrients found in BC rhizomes were potassium, calcium, magnesium, iron, manganese, and zinc, only manganese and zinc were not significantly different. Compared with the recommended dose, none of the micronutrients exceeded it. However, although the daily dose was not exceeded, health professionals should still be knowledgeable of micronutrients in HS. Menopause, osteoporosis, and the associated symptoms of these diseases decrease supply of micronutrients in the body. Thus, science-based data of micronutrient contents of BC rhizomes would enable health professionals to recommend precisely increasing micronutrient intake to supplement this loss without risk of potentially leading to toxicity of the micronutrient.

Keywords: Black cohosh; herbal supplement; micronutrients; menopause.

*Corresponding author: Guochen Yang, Department of Natural Resources and Environmental Design, North Carolina A&T State University, Greensboro, NC 27411, USA. Phone: +1 336 285 4853. E-mail: yangg@ncat.edu.

Introduction

Black cohosh (*Actaea racemosa*) is an herbaceous perennial plant, commonly found in eastern North American deciduous forests and is harvested for its roots (rhizomes) to produce dietary supplements [1]. Medical applications of Black cohosh have historically covered a variety of ailments such as delayed menstruation, profuse bleeding, cramps, and pain, in addition to other unrelated ailments like bronchitis,

rheumatism, snakebites, colic, sore throats, fevers, and nervous disorders. Schafer documented Black cohosh and termed it Squawroot because of its use in female related medical issues as an herbal remedy by Eastern Cherokee tribes [2]. Today, this plant is used to treat vasomotor symptoms (VMS) in menopausal women, specifically hot flashes, as well as night sweats that occur in those women experiencing menopause [3]. Black cohosh, like most medicinal plant products, has had many labels on

the market (i.e. traditional herbal medicine, botanical, dietary & herbal supplements, or complementary and alternative medicine) and has not had a standard label attached to it [4, 5]. The National Center for Complementary and Integrative Health states that Black cohosh is legally considered an herbal supplement, which the U.S. Federal government further defines it as a dietary supplement that contains one or more herbs with the intended purpose of supplementing diet [6]. Black cohosh herbal supplements are legally considered a food additive, not a prescription drug, and contain the entire harvested root and rhizomes. Although the FDA regulates dietary supplement labeling that is limited to determining if product labeling is considered misleading or false, most herbal supplements are not regulated by the FDA when it comes to individual chemicals in contrast to prescription drugs which contain purified chemicals, as long as they are considered a natural product [7, 8].

In contrast, countries outside of the United States regulate consumption of medicinal plant products more strictly. In a study conducted by the National Products Study Group of the Spanish Menopause Society in 2022, Black cohosh extract was recognized as an herbal medicinal product, and not a food additive [9]. As an herbal medicinal product, production of this plant is contingent on scientifically driven evidence-based medicine, meaning there is a decreased risk when consuming Black cohosh extract, because it is less likely to be blended with other plants that could be potentially harmful to the human body [9]. The lack of regulation within the United States means that consumers of Black cohosh herbal supplements will consume whole plant parts with little idea of what it contains. The micronutrient amounts of potassium (K), calcium (Ca), magnesium (Mg), iron (Fe), manganese (Mn), and zinc (Zn) found within Black cohosh roots (rhizomes) are all essential in the human body in certain amounts and must be consumed through diet. Balancing nutrient intake can be difficult as too little can lead to health problems and too much can lead to toxicity of that nutrient

in the body. When dealing with a disease that can adversely affect the average amount of micronutrients in the body, such as in the case of menopause, it must take this into consideration. The recommended dietary allowance (RDA) of micronutrients varies by sex and age and are often used when planning adequate diets for individuals [10]. The target consumer of Black cohosh herbal supplements would be women between the ages of 45 and 55, who are either naturally undergoing menopause or are experiencing induced menopause [11].

The aims of this study were to provide science-based data on the micronutrient content of Black cohosh rhizomes grown in North Carolina that can be sold as herbal supplements, and to provide knowledge on the contents found within these herbal supplements. The amounts of specific micronutrients found in Black cohosh rhizomes were measured in this study to determine the amount of the daily dose of Black cohosh herbal supplement.

Materials and methods

Black cohosh sampling

Seed rhizomes were obtained from Blooming Branch Farm (Burnsville, NC, USA) in May 2017. Plants were arranged in a Completely Randomized Design (CRD) with one seed rhizome planted per 2-gallon pot with a total population size of 18 plants before being placed under 80% shade cloth at the North Carolina A&T State University farm greenhouse. The potting substrate used was a 2:1 Metro Mix:Compost soil mixture that was pre-fertilized with Fusion 360 Gold SunBurst Company Fertilizer (FG-32 1-0-2) (Fusion 360, Turlock, CA, USA).

Measurement of Micronutrients

Micronutrient measurements were conducted using inductively coupled plasma optical emissions spectrometer (ICP-OES). At the end of the growing season, when more than 90% of the plants had reached full maturity, roots (rhizomes) were harvested (Figure 1), thoroughly washed,



Figure 1. (A) Top-down view of Black Cohosh rhizome freshly harvested. (B) Black cohosh plants from study in 2-gallon sized pots, under shade cloth bench.

subsequently dried at 55°C for one week, and then ground into a fine powder at the University Farm for the measurement of micronutrient contents. Sample powders of 0.20 (-0.01) g were weighed and placed in a labeled 50 mL centrifuge tube before being sent to the Analytical Service Lab at North Carolina A&T State University for analysis. The contents of K, Ca, Mg, Fe, Mn, and Zn were measured and converted from PPM to mg/kg using the following equation.

$$\text{Total Element Amount} \left(\frac{\text{mg}}{\text{kg}} \right) = \frac{\text{Total PPM of Element} \times \text{Final Solution Volume (mL)}}{\text{Initial Weight of Plant Tissue (g)}}$$

Statistical analysis

Statistical Analysis Software (SAS) University Edition (SAS, Cary, NC, USA) and Microsoft Excel (Microsoft, Redmond, WA, USA) were employed for analyzing elements. All samples collected were analyzed to determine if there was an average and/or consistent amount of micronutrients in roots (rhizomes) of Black cohosh using PROC ANOVA and PROC MEANS statements in SAS. Associated graphs and tables were formatted in Microsoft Excel.

Results and discussion

Analysis of Micronutrients in roots (rhizomes) of Black cohosh

The data analysis using SAS comparing the micronutrients in Black cohosh roots (rhizomes) indicated that there was a significant change between the amount of each individual micronutrient with the highest to lowest average amounts as $K > Ca > Mg > Fe > Mn > Zn$ (Figure 2). The only micronutrients that were not significantly different were Mn and Zn. The distribution range of Ca was between 8,195 mg/kg and 30,417 mg/kg with a more consistent average of 13,769 mg/kg, while K had a range between 4,138.81 mg/kg and 34,965 mg/kg with a more consistent average of 20,780. Other micronutrients showed more precise readings with a smaller range between the highest and lowest amounts (Figure 2A and 2B). The average amounts of Fe, Mg, Mn, and Zn were 3,409.77 mg/kg, 7,505.78 mg/kg, 110.3 mg/kg, and 102.78 mg/kg, respectively.

Estimated average amount of micronutrients in Black cohosh herbal supplements

The comparisons of average micronutrient amounts found in Black cohosh to average daily

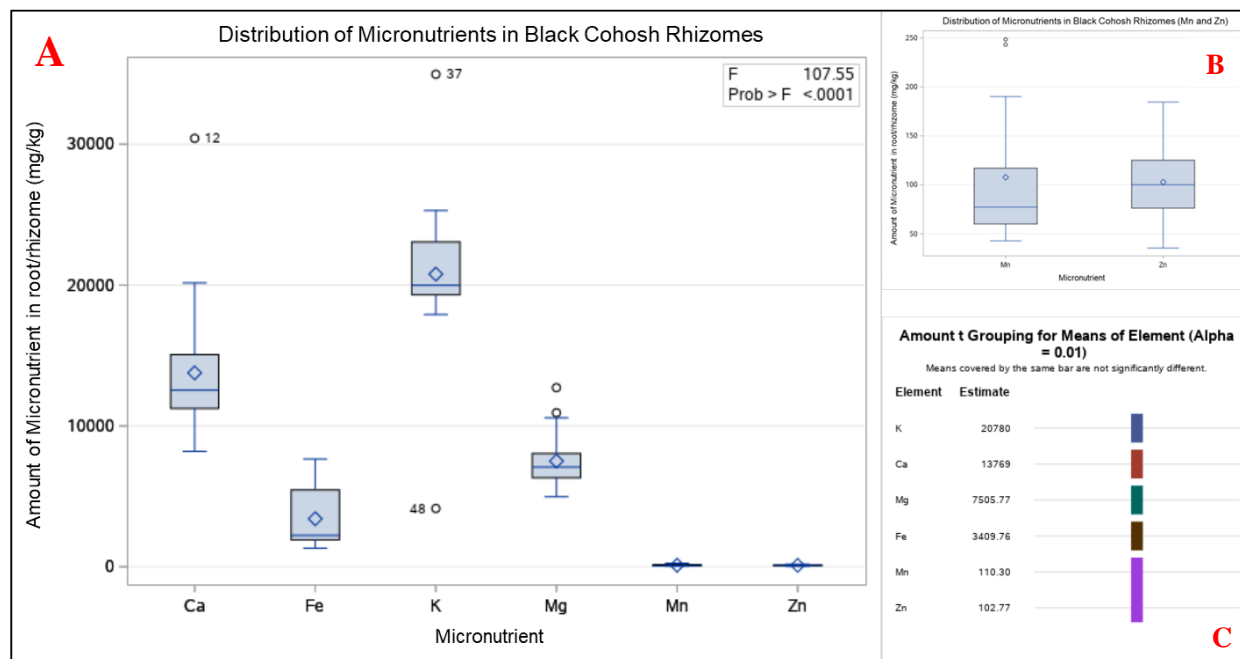


Figure 2. Distribution of micronutrients in Black cohosh (BC) roots (rhizomes). **A.** Comparison of all micronutrients in BC roots (rhizomes). **B.** Focused representation of Mn and Zn micronutrient distribution in BC roots (rhizomes). **C.** Mean comparison of micronutrients at the 0.01 level of significance.

doses of micronutrients recommended by the National Institutes of Health (NIH) Dietary Supplement Fact Sheets and the recommended average daily amounts of micronutrients in Black cohosh herbal supplement were shown in Table 1 [10, 12]. The specific recommendations regarding the amount of micronutrients consumed by women in NIH Dietary Supplement Fact Sheets were for 19+ years old, while the amounts for Ca and Fe were only for ages 19-50. The average amount of each micronutrient measured in this study was recorded as mg/mg, which was the mg of each element per mg of dried Black cohosh root (rhizome) samples. These average amounts were then converted to determine the Total Element Amount as mg/kg. The range of dosages recommended by medical professionals for those taking Black cohosh herbal supplements was also listed in Table 1 [17]. The average amount of each micronutrient in Black cohosh by the recommended dose in mg was then determined through multiplying the recommended daily dose of Black cohosh root/rhizome by the average amount found in

Black cohosh rhizome. When compared with the recommended amount of micronutrients for women 19+ years old, none of the micronutrients found in Black cohosh herbal supplements exceeded the daily recommended dose. When compared to a range of daily herbal supplement dosage (40 – 80 mg/day), the amount ranges of K, C, Mg, Fe, Mn, and Zn were 0.8312 – 1.662 mg, 0.5508 – 3.015 mg, 0.3002 – 0.6005 mg, 0.1364 – 0.2728 mg, 0.0044 – 0.0088 mg, and 0.0041 – 0.0082 mg, respectively.

Micronutrient effect on Black cohosh consumers

During menopause the menstrual cycle will stop, and ovaries will no longer make estrogen. Estrogen affects bone cells by increasing osteoblast activity, while also interfering with osteoblast-osteoclast communication [13]. If the amount of estrogen in the body decreases, as it does during menopause, it can no longer help regulate bone homeostasis. Subsequently osteoporosis occurs because the creation of new bone does not keep up with the loss of old bone. Bone loss can also lead to a decrease in calcium,

Table 1. Comparison of average micronutrient amount measured in Black cohosh to daily recommended dose of Black cohosh (BC) herbal supplement (HS).

Micronutrient	Average daily recommended amount of micronutrient (mg/day) ^a	Average micronutrient measured in BC rhizome (mg/mg) ^b	Recommended dose range of BC HS (mg/day) ^c	Average amount of micronutrient in BC by recommended HS dose (mg)
Potassium	2,600.0	0.020780	40 – 80	0.8312 – 1.6620
Calcium	1,000.0	0.013769	40 – 80	0.5508 – 3.0150
Magnesium	310.0	0.007506	40 – 80	0.3002 – 0.6005
Iron	18.0	0.003410	40 – 80	0.1364 – 0.2728
Manganese	1.8	0.000110	40 – 80	0.0044 – 0.0088
Zinc	8.0	0.000103	40 – 80	0.0041 – 0.0082

^a Average daily recommended amount of micronutrient was cited from the NIH Dietary Supplement Fact Sheets [10] and are specific to women 19+ years of age (Ca and Fe women ages 19-50). The minimum recommended amounts were cited if a range was given, to simplify and keep conservative data. ^b mg/mg: amount of element in milligrams per 1 mg of dried BC root/rhizome. ^c Recommended dose of BC HS was cited from Mahady *et al.* [12].

magnesium, zinc, and, to a lesser extent, manganese and iron, because these nutrients are stored in bones. Potassium is mainly found in all cells, and there has been little research linking menopause or osteoporosis to a decrease of potassium in the body. There were research indicating that those women who experience menopause lose potassium, but the direct reason is not currently known [14]. However, this is supported by the reported increase in blood pressure after menopause as one of the reasons for high blood pressure due to low intakes of potassium [10, 15], which could be due to a decrease in magnesium or calcium, both of which have been reported to affect the level of potassium in the body. Potassium and magnesium have been reported to help prevent the increase of blood pressure and maintain normal cardiac rhythm [16]. It is important to note that Black cohosh naturally contains salicylic acid and isoferulic, which are part of the same class of drugs as aspirin (salicylates) [17]. Therefore, patients should not take additional blood thinners or statins when they are using Black cohosh herbal supplements. Further research would be needed to determine the direct linkage between menopause and potassium levels.

The decrease in micronutrients in the human body has been noted by medical professionals

and most undergoing menopause patients are advised to alter their diet and nutrition plan to increase their micronutrients' levels. Many health care providers recommend that women experiencing postmenopausal osteoporosis take additional Ca supplements in conjunction with vitamin D to mitigate bone loss that can occur. Research has been conducted to find alternative methods of ingesting these micronutrients for those dealing with osteoporosis [18]. Meanwhile Fe, Mn, and Zn are essential in enzyme metabolism with immunomodulatory functions that influence how the body responds to viral infections [10]. All these micronutrients play important roles in the human body, and knowing how much is in herbal supplements is the key for nutritionists advising women going through menopause on their own dietary needs. For those who use Black cohosh herbal supplements, however, these nutrition and dietary plans do not account for the micronutrients found in the whole plant parts in supplements. Therefore, this research is important for nutritionists and health professionals who are currently advising women who are experiencing menopause.

Conclusion

This research measured the average amounts of micronutrients found in Black cohosh rhizomes

grown in a greenhouse. The comparison of these average amounts to the daily recommended dose of Black cohosh herbal supplement found that the average amounts of micronutrients contained in herbal supplements were estimated to be lower than the recommended daily amount for women 19 years old and above. The data has provided useful information on specific micronutrient contents found in Black cohosh herbal supplements that can be used by health professionals when determining dietary plans for women using these supplements to prevent micronutrient toxicity. However, the limitation of this study includes the fact that most herbal supplements are produced from wildy harvested Black cohosh rhizomes, and not commercially produced rhizomes. Future work will focus on measuring micronutrient content within wildy harvested Black cohosh rhizomes.

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