



NOTE

Study on Selenium and Other Trace Elements Presents in Selenium-Enriched Strawberry by ICP-MS

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Selenium, as an essential element for human health, plays an irreplaceable role on human aging and disease prevention. Selenium enriched agricultural products which are used as the best way to supplement selenium have wide prospect and are developing rapidly. However China haven't general standards about selenium enriched products and the quality of them is not uniform, selenium enriched products' sustainable development can't be achieved. By researching selenium enriched strawberries from four different greenhouses, we found the contents of selenium can be 2.58 to 8.87 times to common strawberries, which proved the selenium fertilizer is good. But the content of heavy metals in selenium-enriched strawberry exceeded the national standard, so we should pay attention to its food safety when eating selenium-enriched strawberry. Application of selenium fertilizer increased the content of Ca and Zn in strawberry, in which Ca can prevent the rotting fruit during storage and extend the fruit shelf. At the same time studies have shown that the combination of selenium and zinc antagonize cadmium hazards. It is recommended that we should develop national standards for selenium-enriched fruits and other agricultural products as soon as possible to secure food nutrition and food safety.

Key Words: Selenium, Selenium enriched strawberry, Selenium enriched malt powder, Heavy metals, Secondary and micro-nutrition.

Mills and Randall found the first selenium enzyme in the animals-glutathione peroxidase (GSH-Px) and selenium is one of the essential components of GSH-Px. In 1973, the World Health Organization (WHO) announced that selenium is an essential trace element in human and animal life activities and recommended every person supplement 200 µg selenium daily to prevent the high incidence of many diseases. Selenium, as the essential component of GSH-Px, has an important role in the prevention and treatment of cardiovascular and cerebrovascular diseases, anti-aging, antioxidant and protecting the liver, selenium is known as the king of cancer of trace elements. Selenium affects cellular immunity, humoral immunity and nonspecific immunity to increase the body's immune function; in addition, selenium also has the functions of detoxification, promoting growth, protecting eyesight and other functions¹. But 42 countries and regions lack selenium and 72 % of land area and 700 million people lack selenium in China².

The incidence of Keshan disease of China was significantly prevented by the use of oral sodium selenite tablets (Na₂SeO₃) and adding selenium in salt and water. But inorganic selenium was restricted to use because low absorption, utilization and bioavailability, high toxicity, a small range between the amount of poisoning with the requirements³. So today the most

important method to supplement selenium is food selenium, which contains organic selenium.

Selenium can alleviate the injury of heavy metal in certain concentrations. Wu *et al.*⁴ found Se had synergistic effect on Zn, Fe and Mn, antagonistic role on Pb and Hg by spraying the selenium fertilizer on fresh tea leaves. Tan *et al.*⁵ found that low concentrations of Se can reduce the heavy metals of Pb, Cd, Cr in rice. Liu Yan and Jiang Guangxia study found that low selenium (less than 15 mg/L) help to reduce the adverse effects of Pb and Cd on rapeseed, increased chlorophyll content; but high concentration selenium increased the heavy metal stress and exacerbated by the reduction of chlorophyll content⁶.

The right amount of selenium not only can effectively improve the nutritional quality of agricultural products, but also improve fruit flavour and extend shelf life⁷. Selenium-enriched tea can prevent the oxidation of vitamin C and improve the preservation quality of tea⁸. Applying selenium can increase protein and amino acid content in vegetable, in particular, the essential amino acids content, but also improve other nutritional ingredients⁷. Luo's studies have proved that applying sodium selenite can reduce the concentration of organic acids in navel orange, but also increased the reducing

sugar, into sugar, sucrose, total sugar content and vitamin C content in the navel orange, therefore improve the taste and quality of the navel orange⁹.

Selenium-enriched agricultural products have broad prospects, but the uneven quality of selenium-enriched agricultural products influenced its sustainable development. The main purpose of this study is to solve the following problems: 1) The selenium content in selenium-enriched berry; 2) The effects of the use of selenium fertilizer on the contents of heavy metals in the edible portion of berry, such as chromium, cadmium, lead and arsenic; 3) The effects of the use of selenium fertilizer on the contents of other trace elements of berry.

Trace elements in agricultural products were determined by inductively coupled plasma mass spectrometry (ICP-MS), which has advantages of high sensitivity, high accuracy and it can determine a variety of elements simultaneously¹⁰. In this experiment, the ICP-MS instrument is Thermo-X7 produced by Thermo Electron Corporation of USA.

Sample preparation: Drying and grinding berry; weighing a certain amount in a small flask and add 6 mL of concentrated nitric acid soaking for 12 h, then add 2 mL 30 % H₂O₂ solution soaking for 4 h; digesting and heating to boiling of the sample until remaining 1 mL, transferring to a 15 mL centrifuge tube. Constant volume to 10 mL.

Preparing standard curve, measuring elements by ICP-MS: The experiment was personally conducted by professionals of the Institute of High Energy Physics, Chinese Academy of Sciences.

Strawberry were picked from Xiaoxin village of Xingshou town, Changping District of Beijing city. The control is strawberry grown without selenium fertilizer; the selenium-enriched strawberry was sprayed selenium fertilizer produced by Beijing sevkon ecological science and technology limited company, from the flowering stage, spray once every 10 days. Four greenhouses were selected for CK and selenium-enriched strawberry and three sampling points were selected in each greenhouse.

Selenium levels in selenium-enriched strawberries: The results showed that the selenium concentrations selenium-enriched strawberries from four greenhouses were all significantly higher than CK (Table-1). According to local standards of Hubei Province "DB42/211-2002, selenium content in selenium-enriched fruit should be higher than 0.01 mg/kg, selenium-enriched strawberries in this experiment meet the local standards and is a high-selenium food. All these data proved that the selenium fertilizer of Beijing sevkon ecological science and technology limited company is good for strawberry.

Sample	Content of Se	ERSe/CK
CK	0.063	-
ERSe 1	0.164	2.58
ERSe 2	0.229	3.61
ERSe 3	0.562	8.87
ERSe 4	0.291	4.59

Relationship between selenium and trace elements: The contents of trace elements in selenium-enriched strawberry were shown in Table-2. All the results showed that only As

did not exceed the national standard, Cr, Se, Cd and Pb are excessive, 48.4, 522, 550 and 990 % higher than the standard respectively (GB18406.2-2001; GB 2762-2005). The reason exceeding the national standard could be heavy metals in soil or spraying pesticides in the cultivation process, application of fertilizer, irrigation and water pollution.

Sample	Cr	As	Se	Cd	Pb	Ca	Fe	Zn
CK	0.966	0.118	0.0634	0.171	20.6	0.764	29.4	7.04
ERSe	0.742	0.163	0.311	0.185	20.0	1.76	34.6	11.4
Ratio	0.768	1.38	4.91	1.08	0.971	2.30	1.18	1.62

Compared with controls, concentrations of Cr, As, Se,, of Cd and Pb in selenium-enriched strawberry is 0.768, 1.38, 4.91, 1.08, 0.971-times of CK respectively, as shown in Table-2, significant analysis showed that only As significantly increase with the increase of Se (P < 0.01).

Concentrations of Ca, Fe and Zn in selenium-enriched strawberry is 2.30, 1.18 and 1.62-times of CK respectively and all the three elements reached significant level (P < 0.05).

Conclusion

From the above results, Se content in selenium-enriched strawberries was significantly higher than the CK, which proved the selenium fertilizer is good. But the content of heavy metals in selenium-enriched strawberry exceeded the national standard, so we should pay attention to its food safety when eating selenium-enriched strawberry. Application of selenium fertilizer increased the content of Ca and Zn in strawberry, in which Ca can prevent the rotting fruit during storage and extend the fruit shelf, at the same time studies have shown that the combination of selenium and zinc antagonize cadmium hazards¹¹. Today, there is no uniform national standards for selenium-enriched fruits in China, only a few areas developed local standards which can not meet production needs of selenium-enriched fruits all over the country. Therefore, it is recommended that we should develop national standards for selenium-enriched fruits and other agricultural products as soon as possible to secure food nutrition and food safety¹².

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