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Research Article

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Study on the factors affecting selenium-rich vegetables based on ISM

Zhou Zaohong

School of Tourism and Urban Management, Institute of Poyang Lake Eco-economics, Jiangxi University of Finance & Economics, Nanchang, China

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ABSTRACT

Vegetables which rich in selenium are a hot issue of the current research. There are many factors affect its development. This thesis adopts structure analysis model to research and analyze 10 factors contribute to selenium-rich vegetables. This paper analyzes the internal relationship of system elements, establishes interpretative structural modeling of selenium-rich vegetables realizes hierarchy of system structure and put forward some feasible suggestions about it.

Key words: Selenium-rich vegetables; influencing factors; ISM

INTRODUCTION

Selenium, one of the most important microelements that human body needs, has sufficient meaning to the prevention of disease, improving health and anti-aging [1]. Selenium is honored as life protection agent [2]. Lacking for selenium for long term will lead to endemic disease, such as cardiovascular disease, Keshan disease and Kaschin-Beck disease. Research shows that our country has 72% counties (city) exist selenium deficiency phenomenon in different degrees [3]. Selenium in plants is considered to be the main source of human intake of selenium [4]. Selenium content of selenium-rich vegetables is obviously higher than normal vegetables. And selenium in selenium-rich vegetables mainly exists as organic selenium which is absorbable by the human body as its high physical activity and prevents and treat some human diseases related to selenium. Feeding biological selenium is the safest and the most effective way to supply selenium. Thus, selenium-rich vegetables open up a new direction for human health care [5]. At present, there are a lot of researches of selenium-rich crop at home and abroad [6].

VEGETABLES RICH SELENIUM RESEARCH STATUS AT HOME AND ABROAD

Previous studies found that selenium can promote the germination of vegetable seeds, and there is a close relationship between the function and selenium concentration. The suitable concentration of selenium treatment can promote the germination of vegetable seeds but high concentration of selenium does harm to seeds. The effect of selenium on vegetable growth and development is different according to the concentration of selenium, applying way, type of vegetables and harvesting time [7].Selenium has regulating effect both on vegetable seeds and plant development, and this effect related to selenium treatment. Proper or lower selenium plays a driving role, high concentration of selenium restrains the growth of vegetables.

Duane et al. Research the different concentration of sodium selenite and sodium selenite stress affected on the growth of 4 vegetables, selenium uptake and translocation. Results show that low content of selenite selenium can promote the roots and stems of 4 kinds of vegetables growth, increase the biomass. But excess selenite selenium has obvious harmful effects on vegetables, and sodium selenite toxicity more than selenite [8]. Applying selenium can effectively improve the quality of vegetables by enhancing the content of sugar, the amino

acid, vitamin C and others in vegetables. Wang et al. found that applying selenium to leaf surface, total sugar, carotene, crude fiber and others increase at varying degrees in fleshy root of carrots, the output also increases at a certain extent [9].Selenium has a certain alleviation on adversity stress like soil salinization, heavy metal and so on. Liang et al. supposed that selenium can improve the vitamin C of vegetable's stems and leaves, free amino acid content and leaf carotenoid content, reduce soluble protein content of the stem, leaf soluble sugar content and nitrate content [10]. Guo et al. hold that selenium can inhibit effectively the spinach root on cadmium uptake, enrichment and the translocation to the ground. The main sources of plant absorption of selenium in soil selenium. Whether it is selenium from the original soil or additional selenium, the effective content of selenium level order is: Moisture soil>Cinnamon soil>Brunisolic soil [11]. Previous study found that different kinds of vegetables and different organs of the same kind of vegetables have a certain difference on the absorption of selenium. In general, leafy vegetables like cabbage, lettuce, spinach and so on have richer selenium than solanaceous vegetables, like cucumber, tomato, hot pepper and so on. The edible part of selenium rich ability of different types of vegetables is that: Allium>Chinese cabbage>leaf vegetables>Beans>Melon>Tuber>Solanaceous [12]. 4 kinds of vegetables that Duan et al. tested, Chinese cabbage gets more enrich ability to transfer selenium from underground to the ground and possesses higher biomass over ground; After selenium treatment, selenium is absorbed by the root quickly, and transported to other organs of plants, the absorption and the total translocation ith time gradually increased. In different parts, the distribution order of the total selenium content of plants is : Root>Leaf>Stem. Distribution in leaves is increasing from bottom to top, different parts of plants blossom and bear fruit accumulated sequence is: Root>Fruit>Flower>Stem>Leaf. By the extension of selenium treating time, distribution of selenium in plants in vegetables gradually transfers from the part of low physiological activities to the part of high physiological activities. Distribution of selenium in vegetable tissues has great relations with physiological activities in various parts and the time accepting selenium nutrition. Spraying selenium at fruiting period is the most profitable for vegetables absorbing selenium. While flowering period is in the second place and seedling stage is in the last place. As for the organic selenium conversion, the spraying effect is the best at flowering period, while fruiting period is in the second place and seedling stage is in the last place [14].

Because of many kinds of vegetables and influencing factors, not only growth factors of vegetables but also the environmental factors. If we make up a system of vegetables and their growing environment ,and then constructively analyze the main influencing factors in this system, it is certainly a new research perspective. Based on upon, this research begins with vegetables and system of the environment. Then, gets elements of influencing rich selenium of vegetables as a target and applies interpretative structural modeling to explore elements of influencing vegetables of rich selenium. Finally, provides a reference for production practice.

INFLUENCING FACTORS OF RICH SELENIUM OF VEGETABLES

Basic on existing documents research and group visits the related personnel who participate in rich selenium of vegetables; the author invites 12 representative specialists. Among them, 4 is in the field of production,1 is in administration department and 7 is engaged in correlational research. Then using Delphi to select 10 essential influencing factors of rich selenium of vegetables. Detailed influencing elements see Table1.

Table1 Elements of the Code and Full Name

Code	Full Name of Elements	Descriptions of Elements
S1	Seeds germination	Selenium can promote vegetable seeds germination
S2	Growth of plant	Selenium can promote the plant of vegetable growing
S3	Increasing output	Selenium can increase the output of vegetables
S4	Improving quality	Selenium can effectively improve quality of vegetables
S5	Relieve stress	Selenium has a certain alleviation on adversity stress like soil sanitization, heavy metal and so on
S6	Enrichment capacity	Vegetables can enrich selenium from underground to over ground
S7	Enrichment part	The order that selenium-rich plant is transfer from low physiological activities to high physiological activities
S8	Enrichment period	Spraying selenium is more profitable at breeding period than vegetative period for vegetables absorbing selenium
S9	Diversity of variety	Selenium-rich ability in order is: Allium> Chinese cabbage> leaf vegetables> Beans> Melon> Tuber> Solanaceous
S10	Diversity of soil	The order that effective selenium content is: Moisture soil>Cinnamon soil>Brunisolic soil

ESTABLISHING INTERPRETATIVE STRUCTURAL MODELING OF INFLUENCING FACTORS OF RICH SELENIUM OF VEGETABLES

Interpretative structural modeling, a set of means to analyze the related issues of a complicated social and economic system, divides complicated system into multiple subsystems. Uniting the practice, cognition and experience of

people and through the complicated operation of electronic computer, finally there will be a model of multilevel hierarchical structure which makes the researchers analyze the fundamental problems more clearly. The current study indicates that elements of influencing rich selenium of vegetables can be divided into two aspects. One is its own characteristic and the other is its growing environment.

3.1 Establish an Adjacency Matrix in a Binary Relation

Considering vegetables and their environment as a system and combining the actual condition of rich selenium of vegetables and related theoretical knowledge to analyze mutual influence concern of 10 influencing factors.

Establish a binary relation matrix: In the system, there must be certain contact information between mutual elements, which constitute systematize structure. In the structuring system of vegetables and their environment, we consider interest relationship between elements as a logical structure. For example, seeds germination is in favor of growth of plants, growth of plants is in favor of increasing output and so on. Using this kind of analysis to explore the structure of this system. According to this analysis way, judging from the following rules: If row Si has directly or indirectly advantageous affection to column $S_j(i,j=1,2,\ldots,10)$, the assignment equals to 1; If row Si has no direct or indirectly advantageous affection to column S_j, then the assignment equals to 0.Establish an adjacency matrix A in a binary relation, as showed in Figure 1.

	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	S_9	S_{10}
S_1	0	1	1	1	1	1	1	0	0	0
S_2	1	0	1	1	1	1	1	1	1	0
S_3	0	0	0	1	1	1	1	1	0	0
S_4	1	1	1	0	1	1	1	1	1	1
S_5	1	1	1	1	0	1	1	1	1	1
S_6	1	1	1	1	1	0	1	1	1	1
S_7	1	1	1	1	1	1	0	1	0	0
S_8	1	1	1	1	1	1	1	0	0	0
S_9	0	1	1	1	1	1	1	1	0	1
S_{10}	1	1	1	1	1	1	1	1	0	0

Figure 1 an adjacency matrix A in a binary relation between each elements

Establish a Reachable Matrix: Reachable matrix means using a matrix form to reflect directly connecting each point in the chart arrives with a degree after a certain length of access. Its principle is that basic on the adjacency matrix, using the Boolean algebra operation rule (means 0＋0＝0,0＋1＝1,1＋0＝1,1＋1＝1,0×0＝0,0×1＝0,1×0＝0,1×1＝1), and following formula we get the reachable matrix M:

$$(A+I)^{K-1} \neq (A+I)^K = (A+I)^{K+1}, K \geq 1$$

In that, I is an unit matrix which is the same order with adjacency matrix. According to the operation, we get a reachable matrix $M=(A+I)^K$

$M =$

	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	S_9	S_{10}
S_1	1	1	1	1	1	1	1	1	0	0
S_2	1	1	1	1	1	1	1	1	0	0
S_3	0	0	1	1	1	1	1	1	0	0
S_4	0	0	1	1	1	1	1	1	0	0
S_5	0	0	1	1	1	1	1	1	0	0
S_6	0	0	1	1	1	1	1	1	0	0
S_7	0	0	1	1	1	1	1	1	0	0
S_8	0	0	1	1	1	1	1	1	0	0
S_9	0	0	1	1	1	1	1	1	1	0
S_{10}	1	1	1	1	1	1	1	1	0	1

Figure 2 Reachable matrixes M

3.2 Generate Hierarchical Ladder Structure Model

After gathering the reachable matrix, the relationship between ranks of elements' system is unclear. Thus, the reachable matrix M should be ordered at administrative levels. In the reachable matrix M, if there are totally the same rows and their corresponding columns (S_1 is totally the same with S_2 while S_3-S_8 is totally the same),

retrenchment is allowed to proceed. Delete row (column) 2 、4、5、6、7、8,then orders the processed matrix at administrative levels. Finally we get mainstay matrix R, as showed in Figure 3.

$$R = \begin{vmatrix} & S_{3-8} & S_{1,2} & S_9 & S_{10} \\ S_{3-8} & 0 & 1 & 0 & 0 \\ S_{1,2} & 1 & 1 & 0 & 0 \\ S_9 & 0 & 1 & 1 & 0 \\ S_{10} & 1 & 1 & 0 & 1 \end{vmatrix}$$

Figure 3 Mainstay matrixes R of influencing factors of rich selenium of vegetables

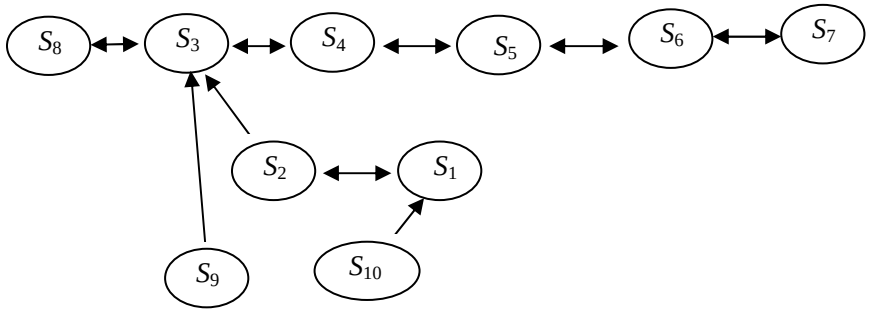
After the partition above, systematized structural modeling can be constituted. Seen from mainstay matrix, the influencing factors of rich selenium of vegetables can be divided into 3 parts:

First: Increasing output S_3、Improving quality S_4、Relieve stress S_5、Enrichment capacity S_6、Enrichment part S_7、Enrichment period S_8.

Second: Seeds germination S_1、Growth of plant S_2.

Third : Diversity of variety S_9、Diversity of soil S_{10} .

Thus, the structural modeling of elements of rich selenium of vegetables is established (As shown in the following Figure 4):



3.3 Analysis of Structural Modeling

Judging from ISM structural modeling, rich selenium of vegetables is directly affected by 6 elements called S_3-S_8 from the first part .This part of influencing factors is basic factors of directly influencing rich selenium of vegetables and has an obvious function to rich selenium of vegetables. These elements should link to field management of vegetables in the practice. Hence, the most fundamental measure to finish the target of rich selenium of vegetables is improving field management of vegetables.

The second part of elements is deep elements that influencing rich selenium of vegetables. Seeds germination S_1 and growth of plant S_2, these two factors are acting path that realizes rich selenium of vegetables. Seeds germination is the carrier of realizing rich selenium of vegetables and growth of a plant is the premise of realizing rich selenium of vegetables.

The third part of elements is seeming factors of influencing rich selenium of vegetables, which includes the variety of vegetables S_9 and the variety of soil S_{10}.Although these factors are no such direct influencing rich selenium of vegetables like the elements upon, it will convey a negative influence to rich selenium of vegetables without these two elements.

These three parts reflect logic relation of influencing rich selenium of vegetables. Based on this modeling, distinguish mutual relation among each influencing factors and dividing seeming factors, deep factors and basic factors of influencing rich selenium of vegetables is advantageous to know the forming and developing mechanism of rich selenium of vegetables. Starting from basic factors and deep factors, enhancing field management of vegetable production is the basic way of rich selenium of vegetables which offers theoretical instruction for production strategy of rich selenium of vegetables.

SOME SUGGESTIONS FOR INFLUENCING RICH SELENIUM OF VEGETABLES

4.1 Enhancing Field Management of Vegetable production

Improving yielding potential of vegetables and activating physiology activity of vegetables is important and it can efficiently promote rich selenium of vegetables. Pay special attention to actively increasing source of selenium as vegetables' breeding season. For example, spraying liquid selenium at flowering and fruiting period to let vegetables gather more selenium.

4.2 Improving Management at Seedling Period

Deep elements of rich selenium of vegetables are seed germination and growth of plant, and the two elements of the guarantee on the need to strengthen seedling management.

4.3 Choosing Proper Varieties of Vegetables

According to the ability of rich selenium, specifically choose proper varieties of vegetables, like choosing the bulb, cabbage, green leafy vegetables and so on.

4.4 Selecting Proper Types of Soil

Because of different soil influences effect of rich selenium of vegetables, thus, selecting soil by adjusting measures to local conditions is an essential step to guarantee effect of rich selenium of vegetables.

CONCLUSION

Judging from systematized science, this article analyzes the systematic structure of rich selenium of vegetables, explores hierarchy of elements in the system, clearly shows systematic structure of rich selenium vegetables and offers theoretical reference for production of selenium-rich vegetables.

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