STUDY ON THE DISTRIBUTION OF SELENIUM AND OTHER ELEMENTS IN CORN SAMPLES BY NAA AND BIOCHEMICAL TECHNIQUE

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ABSTRACT

Biochemical technique was used to separate three kinds of proteins (albumin, globulin and gliadin) in corn samples from high selenium areas and normal areas in Erxi autonomous region of Hubei Province, China. The contents of Se and other elements in these proteins were determined by neutron activation analysis (NAA). The results show that Se is enriched in corn proteins at high selenium area, while Cu, Al, Mn, V and Cl are also enriched in varying degrees.

Keywords: Selenium Corn protein Separation Biological function

Ⅰ. INTRODUCTION

Trace element Se is an essential element for human beings. Yang[1] and Mao[2] have proved that Se is greatly related to the Keshan Disease and Se poisoning diseases in China. Se poisoning diseases are mainly caused by high selenium cereal which man or domestic animal eat. But the easily absorbed parts of the cereal are cereal proteins[3,4]. Hence the elemental distribution in the cereal proteins is very significant to understand the selenium toxicity for human body. The method of separating cereal proteins has been reported by Bushuk[5] and Qu[6], but Bushuk only studied their composition, biological function and Qu only analysed the contents of REE in them. The reports about other elements in cereal proteins are rare. In this work we have measured the contents of Se, Cu, V, Mn, Al and Cl in corn proteins extracted by biological technique from corn at high selenium and normal areas in Erxi autonomous region of Hubei Province with NAA, thereby deciphering element distributions in them.

Ⅱ. EXPERIMENTAL

1. Separation procedure

The biochemical separation scheme of corn protein is shown in Fig.1.

2. Extraction of corn proteins

The proteins of corn have been separated into three groups: albumin, globulin and

gliadin. The extraction procedure employed in this work was similar to the classical protein separating procedure of Obsborne[7]. Albumin was extracted twice by 20 ml

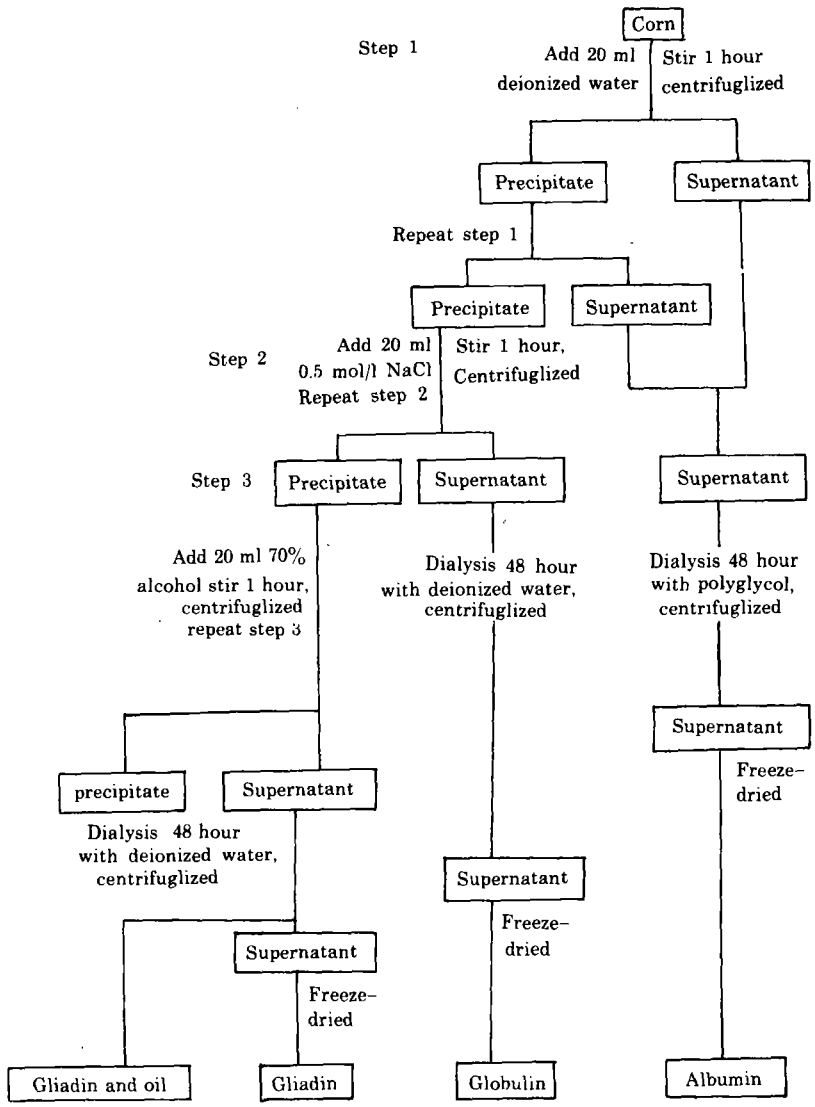

Fig.1 The biochemical separation scheme of corn protein

deionized water in a beaker at 4°C with a magnetic stirrer for 2 h. Mild stirring was adopted to avoid the formation of artifacts that might occur by high- shear stirring[8]. Each suspension was centrifuged for 10 min at 5000 rpm, and the supernatant was stored. The two supernatants were combined. This extract was dialyzed with polyethylene glycol against cold distilled water for 48 h and centrifuged to separate out the precipitated proteins, while water- soluble albumin remained in the

supernatant. The remaining residue after extraction by deionized water was then extracted similarly with two portions total 40 ml) of 0.5mol/l sodium chloride solution. After that, the residue was extracted with 40 ml distilled water for 10 min to remove residual salt. The three supernatants were mixed. The water- soluble globulins can be obtained after the extract was dialyzed against cold distilled water for 48 h and centrifuged to separate out the precipitated salt- soluble proteins. The resulting residue was further extracted with two portions (total 40 ml) of 70% ethanol solution. The water- soluble gladians can be gotten. The three soluble fractions and final residue were freeze- dried and stored in a refrigerator.

3. Irradiation and counting

The separated proteins were weighed and wrapped up in polyethylene membrane. Then samples were packed in a rabbit system and sent into a Miniature Neutron Source Reactor in Institute of Atomic Energy, China. Analytical condition of selenium by INAA is to irradiate 30s, cool 3s and measure 60s. Each sample was irradiated again for five min and measured after 2 min cooling in order to obtain the contents of Cu, Al, V, Mn and Cl by the absolute method. The thermal neutron flux is (4- 8)× $10^{11}n \cdot s^{-1} \cdot cm^{-2}$.Counting was carried out by a set of PC- controlled automatic counting device.

Ⅲ. RESULTS AND DISCUSSION

The analytical results of corns and their separated proteins are listed in Table 1. The selenium contents in corns from different soils are listed in Table 2.

In the normal area, the enrichment coefficients of Se, Cu, Cl and V in the corn globulin are 94, 16, 4 and 2, respectively. In the high selenium area, they are 9, 45, 2 and 2, respectively.

In the normal area, the enrichment coefficients of Al, Cu, Mn, Cl and V in the corn albumin are 3, 8, 2, 8 and 6, respectively. Se exhibits slight enrichment. In the high selenium area, the enrichment coefficients of Se, Cu, Mn, Cl and V in the corn albumins are 4.6, 10, 3, 7 and 2, respectively. Al has a somewhat enrichment.

In the normal area, the enrichment coefficient of Cl in the corn gliadins is 2. A slight enrichment of Se and a deficiency of Mn are observed. In the high selenium area, all of the enrichment coefficients of Al, Cl and V in the corn gliadins are 4.

Selenium is an essential element in human bodies. The results show that the selenium contents in the corn proteins from the high selenium areas are higher than those from the normal areas. There are a number of the Se- rich proteins in the Se- rich corns. The fact is that the corn can absorb inorganic selenium from the environment and transform it into selenium protein during corn growth.

The selenium content in corn relates to soil, fertilizer, storage place and drying process. The results in Table 2 show that selenium content in corn growing in soil

containing bone coal is 139 times as high as that in sandstone soil, 60 times as high as that in limestone soil. The higher the selenium content of soil is, the higher the selenium content of corn will be. The reserve of bone coal is very abundant in Erxi autonomous region of Hubei Province, China. As bone coal is used as the living fuel by the local residents, the poisoning diseases are found in the bone coal areas. Aridity makes water evaporated and at the same time bring about selenium volatile loss, furthermore selenium is separated out, then concentrated on the earth's surface;

Table 1

The elemental contents in corn proteins from high selenium and normal areas (μ g/g)

Sample No.	Element	In high selenium area		In normal area	
		Globulin (32.21 mg)*	Corn (95mg)* *	Globulin (37.76mg)*	Corn (129mg)
1	Se	103	11.5	4.05	0.043
	Al	41.2	22.8	39.7	32.1
	Cu	76.9	1.7	50.7	3.06
	Cl	744	459	1472	394
	Mn	3.22	4.78	3.57	7.59
	V	0.06	0.027	0.087	0.038
		Albumin* (35.05mg)		Albumin (14.12mg)*	Corn (115mg)
2	Se	52.6	11.5	- - -	0.739
	Al	34.9	22.8	82.0	27.3
	Cu	16.3	1.7	24.1	3.05
	Mn	14.4	4.78	9.50	4.39
	Cl	3183	459	2877	374
	V	0.078	0.027	0.210	0.033
		Gliadin* (28.43mg)		Gliadin (97mg)	Corn (120mg)
3	Se	17.9	11.9	0.48	0.39
	Al	83.0	22.0	23.2	29.7
	Cu	<18.0	2.45	<0.6	3.05
	Cl	1450	372	877	384
	Mn	4.49	5.14	3.18	5.99
	V	0.13	0.042	0.022	0.036

Note: * The weight of protein sample extracted from 10g corn * * Corn sample weight

Table 2

The selenium contents of corn in different soil (μ g/g)

Type of soil	Range	Average value	±SD
Bone coal soil	0.08- 12.75	4.17	3.40
Bituminous coal soil	0.09- 0.18	0.12	0.05
Anthracitic coal soil	0.09- 0.30	0.15	0.05
Limestone soil	0.05- 0.08	0.07	0.01
Sandstone soil	0.01- 0.04	0.03	0.01

Because of the increase of annual rainfall, the soil was eroded, which made selenium concentrated on the shallow land; Using fumigated soil as fertilizer also can lead to severe selenium pollution in the soil.

The Se- rich corn proteins can be employed to compensate for the selenium

deficiency of human beings and domestic animals in the low selenium areas. Schrauzer[10] thought that biological effects of selenium in natural organic compounds were 20 times higher than those of selenite. In the erythrocyte selenium mainly combines with GPx and Hb[3]. Hao[4] has proved that the Se- rich mushroom proteins have protection and stabilization functions to erythrocyte. The Se- rich mushroom proteins can also improve the activity of Se- GSHPx and promote the growth of cartilaginous cell. Because the Se- rich mushroom proteins and the Se- rich corn proteins are both the natural plant proteins, they are important substances to turn selenium plant proteins into the biological selenium nutrients.

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