Journal of **Kim Il Sung** University (Natural Science)
Vol. 3 No. 1
Juche103(2014)

Distribution and the Excretion Properties of Radioactive ^{137}Cs and ^{90}Sr in Mouse(*Mus nusculus*) by the Oral Chitosan Adsorbent

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Abstract The adsorbents mixed chitosan and natural materials as the eliminants of radioactive materials absorbed into the body have been developed.

^{137}Cs and ^{90}Sr absorbed into the body of the white mouse could be remarkably excreted by the oral adsorbents of chitosan and the distribution of the radioactive materials in body has been found.

Key words chitosan, strontium, cesium, separation

Introduction

It is especially important to give studies to ward off damage by radiations and radioactive isotopes because radioactive isotopes in different fields of the national economy have been widely using recently, and in particularly.

The radioactive ^{137}Cs may distributes homogeneously to the tissues and organs of human body since it is similar to chemical behavior of sodium and potassium after its intake, and the radioactive ^{90}Sr may occur the inner irradiation for a long time, depositing to bone.

Materials that make a most effective excretion of the radioactive ^{137}Cs in human body are known to ferric hexacyanoferrate(Ⅲ) ($Fe_4[Fe(CN)_6]_3$), activated charcoal etc. and excretive materials of the radioactive ^{90}Sr have been using complex formative reagents, such as citric acid and mono-sodium glutamate, tartaric acid, ascorbic acid, 4, 7, 10, 13, 16-hexaoxacyclooctadecane (18-crown-6), 2,3-dimercaptosuccinic acid, succinic acid, malic acid, ethylene-diaminetetraacetic acid, ethylenglycol-bis-(13-amino-ethyl- ether)-N, N' tetraacetic acid, cyclohexane-diaminetetraacetic acid and diethylentriaminepenta acetic acidsodium arginate, diuretics and activated charcoal etc[2, 5].

Recently chitin and chitosan are taken note as eliminant, radiological protectant and adsorbent of heavy metals and radioactive materials[1－9].

Oral adsorbents combined chitosan with inorganic adsorbents as eliminants of the radioactive ^{137}Cs and ^{90}Sr absorbed in body have not been used so far.

In this paper the distribution and the excretion properties of radioactive ^{137}Cs and ^{90}Sr in mouse by the oral adsorbent combined chitosan with bentonite have been discussed.

Experimental Method

The white mice(*Mus nusculus*) weighed (20±2)g as experimental animals to investigate the excretion properties of radioactive materials have used.

There were 6 white mice in each control group and each experimental group and experiment in each group proceeded with 3 times.

Quantities of the daily feed and water for the white mice in all groups have been fixed.

Quantities of the daily excrement in a mouse(0.16±0.06g) are little difference in the control groups and the experimental groups.

The floor of all mice cages was made of the lattice to collect their urine and feces and the excrement was collected on filter papers under the wire cages.

$^{137}CsNO_3$ and $^{90}Sr(NO_3)_2$ solution, $\sim 5 \cdot 10^4$ pulse·min^{-1}·mL^{-1} in specific radioactivity, were used as the radioactive materals.

The volumn of an injection for a white mouse was 0.2 mL.

The oral chitosan adsorbent was made from dissolving chitosan with 75～80 percent of its deacetalation degree and 60～120 thousand of its molecular weight in 1mol/L CH_3COOH solution and mixing bentonite in it.

After in the control groups 0.2mL of the radioactive solution has been got an oral injection the inside of white mices' stomach and constant time went on, radioactivity of each tissues and excrement was measured.

Meanwhile after in the experimental groups 0.5mL of the adsorbent solution has been got an oral injection inside of their stomach for a day or a few days and subsequently 0.2mL of the radioactive solution has been got a oral injection, radioactivity of each tissues and excrement was measured at constant intervals.

Dry excrement was made fine powder, 1g of it was put on the plate, and then radioactivity of excrement was measured by the counting equipment with the counting tube "СБТ-13".

Back-radioactivity was measured, getting dry the filter paper deposited the radioactive solution of volumn of an injection or the 1g of excrement mixed with it.

The radioactive distribution in each tissues of white mouse was determined by the measurement of its radioactivity after radioactive solution has been got a oral injection and then the tissues have been seperated, incinerated and ground after 24 hours.

The measurement time was selected as 0.01 of relative error.

Result and Discussion

The rate of remaining and excrement of the radioactive substance in white mouse as a function of the time elasped were shown in table 1.

As shown in table 1, after the radioactive ^{137}Cs was got a oral injection, it was excreted rapidly for a day and then was decreased in proportion to the time elapsed.

Table 1. The remaining rate of ^{137}Cs as a function of the time elapsed (%)

Time elapsed/d	1	2	3	4	5
Experimental group	94.8±2.1	87.7±1.5	84.4±1.7	78.2±1.1	75.1±0.9
20% of bentonite	96.9±2.4	82.3±1.8	76.1±0.8	72.4±0.6	68.5±0.4
20% of chitosan	76.2±2.2	72.7±1.8	67.9±0.9	64.2±0.6	58.3±0.4
20% of bentonite +20% of chitosan	74.3±1.4	67.5±1.1	61.8±0.9	57.7±0.8	53.9±0.2

In case of a oral injection of the adsorbent mixed chitosan with bentonite, the excrement rate of ^{137}Cs was higher more than 20 percent as compared with the control groups and mean 5～10 percent as compared with the independent use of bentonite or chitosan.

As shown in Fig. 1, in the control group got independently an oral injection of radioactive ^{90}Sr, 80% of the injected quantities was excreted for 3 days and the rest was decreased slowly. After 7 days, the injected radioactive material was remained about 5 percent extent.

Meanwhile, in the groups got a injection of the oral chitosan adsorbent, 90% of the radioactive material was excreted for 2 days and 3% of it was remained after 7 days.

Also, after the adsorbent solution has been got an injection a day for 5 days continuously, in case of the injection of the radioactive material the higher excrement appeared.

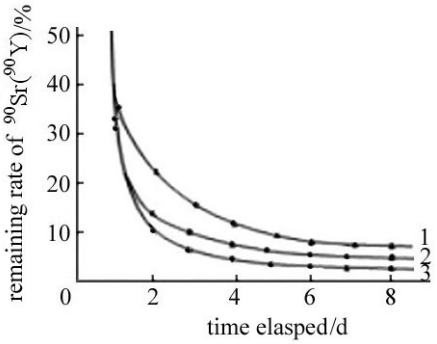

Fig. 1. The remaining rate of ^{90}Sr as a function of the time elasped
1－Control group, 2, 3－ In case of pre-injection of adsorbent solution a day and 5 days

At that time the radioactive material was excreted more than 90% for 2 days and about 1% extent of it was remained after 7 days. It is shown that the low-molecular chitosan may take effect on the elimination of the radioactive ^{90}Sr in the enteron and in particular the pre-intake of chitosan may decrease markedly the remaining rate of the radioactive material in body.

After the oral chitosan adsorbent has been got an oral injection a day for 5 days, the excrement rate of the radioactive ^{90}Sr in the urine(Fig. 2) and the feces(Fig. 3) was very high just after the radioactive material was got an oral injection. The value (U/F), the ratios the excrement rate in feces to the excrement rate in urine, is 0.7 in the control groups but is 0.16~0.21 in the experimental groups after 2 days. It is shown that the oral chitosan adsorbent accelerates the excrement of the radioactive material so it adsorbs the radioactive ^{90}Sr and makes the low absorption in the enteron.

And the higher concentration of chitosan is, the higher excrement of the radioactive material is.

The fact that the oral chitosan adsorbent makes the low aborption of the radioactive ^{90}Sr in the enteron may also appear in the distribution of radioactivity in body(Table 2).

As shown in table 2, most of the radioactive ^{90}Sr deposit on the bone in the control group. But in the experimental group it deposits 3～5 times lower than one in the control group.

The radioactive material has been got an oral injection in white mice and then the distribution of the radioactive ^{137}Cs in each tissues after 1 days were listed in table 3.

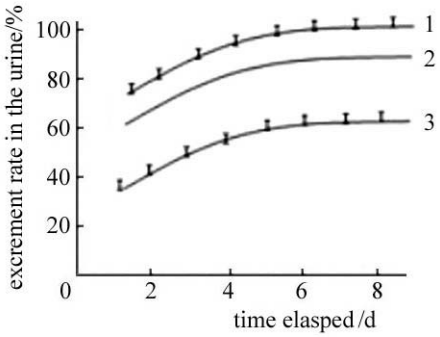

Fig. 2. The excrement rate of ^{90}Sr in the urine as a function of the time elapsed

1－control group, 2－20% of solution, 3－40% of solution

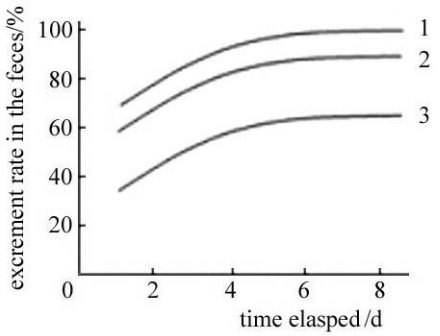

Fig. 3. The excrement rate of ^{90}Sr in the feces as a function of the time elapsed

1－40% of solution group, 2－20% of solution, 3－control

Table 2. The radioactivity of ^{90}Sr in each tissues of white mouse after 24 hours(pulse·min^{-1}·g^{-1})

Organs	Heart, spleen, kidney	Lung	Liver	Stomach	Colon	Small intestine	Coccyx	Backbone	Blood
Control group	－	671	151	463	4 163	505	5 630	15 477	848
20% of chitosan+ 20% of bentonite	－	534	51	268	3 972	333	1 509	3 357	344

As shown in table 3, the radioactive ^{137}Cs is distributed homogeneously in body. And in case of the injection of adsorbent, the radioactivity in small and large intestine is double higher than one in the control group.

Table 3. The radioactivity of ^{137}Cs in each tissues of white mouse after 24 hours(pulse·min^{-1}·g^{-1})

Organs	Heart, spleen	Lung	Liver	Stomach	Large and small intestine	Kidney	Backbone	Blood	Thyroid gland
Control group	－	246	165	277	437	200	167	630	214
20% of chitosan	－	274	165	255	837	242	158	259	－
20% of chitosan+ 20% of bentonite	－	207	171	167	725	329	127	308	－

Conclusion

We have discussed that an injection of the oral chitosan adsorbent with the radioactive material in white mice might decrease much lower than 20% of the remaining rate of the radioactive material in body as compared with the control groups and the higher concentration of chitosan is, the lower it.

We have discussed that the radioactive ^{90}Sr in body was distributed mainly in its bone and the radioactive ^{137}Cs was distributed homogeneously in all organs.

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