CN9501700

THE LONG-TERM TREND OF CARBON-14 LEVEL IN JAPAN

Yoshikazu Inoue and Tetsuo Iwakura
National Institute of Radiological Sciences,
9-1, Anagawa 4-Chome, Inage-ku, Chiba-shi 263 JAPAN

ABSTRACT

The long-term trend of the specific activity of ^{14}C in terms of dpm/gC from 1942 to 1991 in the natural environment in Japan was obtained as baseline data by analyzing plant components so as to evaluate the collective effective dose. It was deduced that the specific activity of ^{14}C in plants reflected well that of atmospheric $^{14}CO_2$. Uniform distribution of the specific activity in plant among species as well as the production places was confirmed. The Suess effect was observed clearly for a period of 10 years from the late 1960's. The ^{14}C level was at about 13.7 dpm/gC due to cosmic ray production in 1940's, and reached a peak of about 24.5 dpm/gC in 1963 due to nuclear weapons testing and decreased to 15.6 dpm/gC in 1991. Fermented alcohol proved to be a convenient indicator for measuring the annual mean specific activity of ^{14}C in the atmosphere.

INTRODUCTION

Our continued survey program [1,2] for obtaining the long-term trend of the specific activity of ^{14}C in the natural environment in Japan started in 1960 in order to evaluate the collective effective dose due to ^{14}C originating from natural production, nuclear weapons testing and nuclear power generation. In this report, the variation of ^{14}C specific activity due to plant species and production places in Japan will be discussed, and the long-term trend of ^{14}C specific activity in plant will be compared with that of atmospheric $^{14}CO_2$ predicted by the model reported in the NCRP report No.81.[3]

MATERIALS AND METHOD

In the past survey program[1,2], plants components and their derivatives such as thymol, menthol, and alcohol fermented from sweet potato were selected and analyzed. Production places of raw materials were shown in Fig.1. Details of sample preparation and counting method for these materials were described previously[4].

After 1983 only wine samples were collected. The production places of wine grapes were distributed in several prefectures in

Japan as shown in Fig.1. Alcohol contained in wine was separated by azeotropic distillation with toluene and the content of alcohol was determined by measuring specific gravity. The alcohol sample of 10ml, whose alcohol content was generally higher than 95%, was weighed and mixed with 10ml of toluene scintillator in a low potassium glass vial and was counted for a few hundred minutes each by low background type liquid scintillation counters. The blank samples were prepared using 10 ml of alcohol synthesized from petroleum.

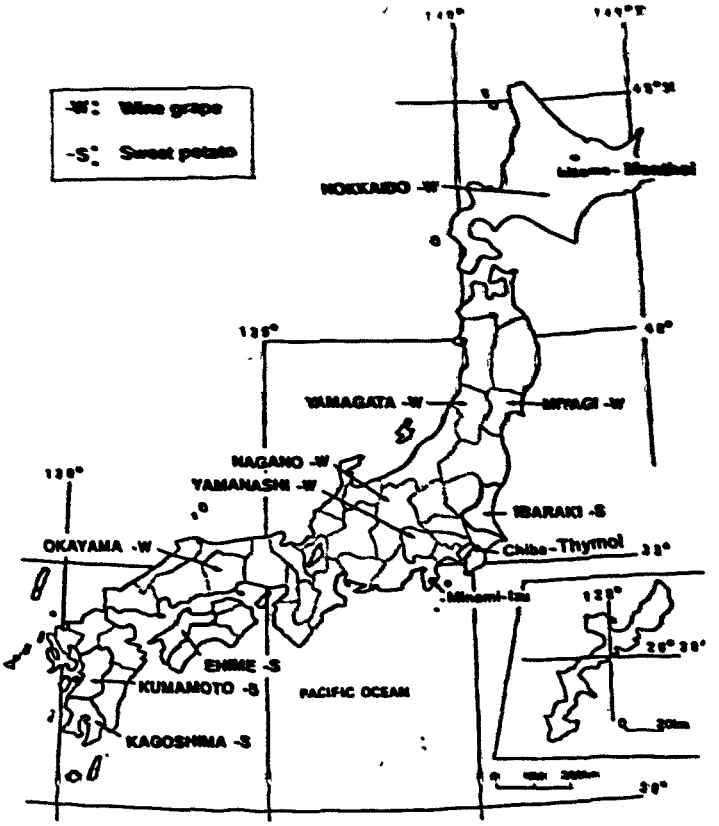

Fig.1 Sampling places of plant deribatives in Japan

RESULTS AND DISCUSSION

1. Comparison of the specific activity of ^{14}C in some plant derivatives with that in the atmosphere.

As shown in Fig.2, the long-term trend of ^{14}C specific activity in plants in Japan agreed well with that of atmospheric $^{14}CO_2$ predicted by the model[3] especially until the mid 1960's. This fact

suggests that the specific activity of ^{14}C in plants reflects that of atmospheric $^{14}CO_2$ substantially, and therefore the plant components can be a good indicator both for the specific activity of ^{14}C in inhaled air and ingested plant foods.

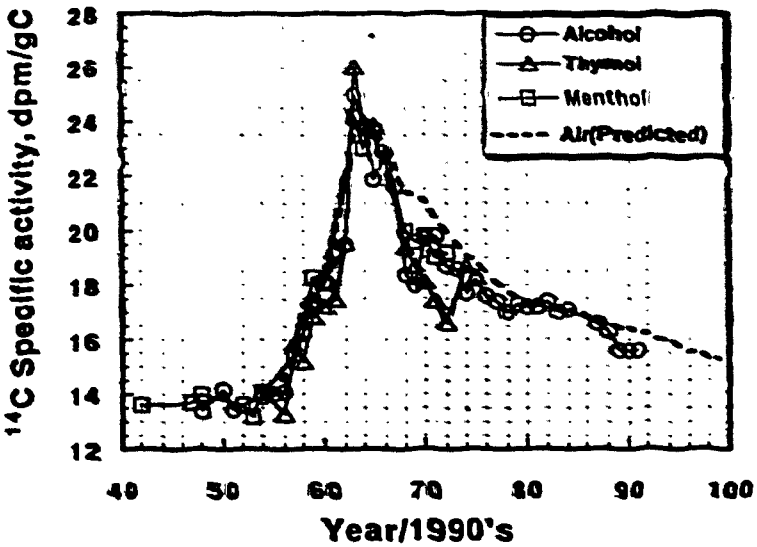

Fig.2 The ^{14}C specific activity with time in plant deribatives, and in the atmosphere predicted by the NCRP model.

2. Suess effect in Japan

As shown in Fig.2 the specific activity of ^{14}C in thymol produced in the industrializing district of Chiba city was clearly lower than those in alcohol and menthol from 1968 to 1972. The specific activity of ^{14}C in alcohol and menthol was also several to eighteen % lower than that of the atmospheric $^{14}CO_2$ for a period of about 10 years from the late 1960's. These temporal phenomena may be explained by the Suess effect which is a decrease in the ^{14}C specific activity caused by an increase of dead carbon dioxide in the atmosphere due to the large consumption of fossil fuels during the rapid industrialization of Japan in this period.

3. Distribution of ^{14}C in Japan

As shown in Fig. 2 the specific activity of thymol, menthol and alcohol produced in different places in Japan agreed very closely with each other from the late 1940's to the early 1960's. Sweet potatoes for fermented alcohol were produced in three different prefectures and grapes for wine were produced in three different districts in Japan. As shown in Fig. 3, the standard deviation of

specific activity calculated from two or three data in each year was less than 3% for most of the years from 1968 to 1991. The standard deviation of specific activity of three to four data obtained from wine samples produced within each prefecture was less than 1% every year from 1988 to 1991. These small difference in the specific activity in the production places suggests that $^{14}CO_2$ distributes uniformly in the atmosphere in Japan except in industrialized areas.

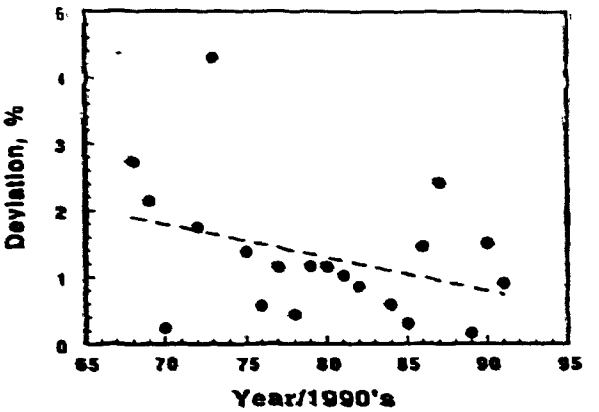

Fig.3 Deviation of ^{14}C specific activity in alcohol due to the production districts of raw materials.

4. Affect of nuclear weapon testing on the natural level of ^{14}C

The ^{14}C level of cosmic ray production was estimated at about 13.7 dpm/gC from the 1940's samples. As a result of nuclear weapons testing, the specific activity in plants reached a peak of about 24.5 dpm/gC in 1963. The specific activity of about 15.6 dpm/gC in recent years from 1988 to 1991 was still about 14 % higher than the natural production level.

REFERENCES

1) Radioactivity Survey Data in Japan, NIRS-RSD-44, National Institute of Radiological Sciences 1978.
2) Iwakura, T., Kasida, Y., Inoue, Y. et al., Behavior of environmental carbon-14 and tritium in Japan, Proc., Six Inter. Congr. Radiat. Res., 932-939, 1979.
3) Carbon-14 in the environment, NCRP Rep.81, National Council on Radiation Protection and Measurement, BETHESDA,MD., U.S.A.,1985.
4) Iwakura, T., Miyahara, S., Kasida, Y. and Yamada, O., Recent radiocarbon in plants, J. Radiat. Res., 7, 1966.