THE FATE OF POLYCHLORINATED DIBENZO-*P*-DIOXINS, DIBENZOFURANS AND COPLANAR PCBS IN SILAGE CORN

Ryuichi UEGAKI[1], Shunji KUROKAWA[2], Yoshinori YOSHIMURA[2], Yimin Cai[2], Yasuhito Fujita[2], Heesoo EUN[1], Nobuyasu SEIKE[1], Masahiko KUWAHARA[1], Masako UEJI[1]

1 : National Institute for Agro-Environmental Sciences, Kannondai 3-1-3, Tsukuba, Ibaraki 305-8604, JAPAN, Phone : +81-298-38-8329
2 : National Institute of Livestock and Grassland Science, Senbonmatsu 768, Nishinasuno, Tochigi 329-2747, JAPAN, Phone : +81-287-37-7802

Introduction

There is concern with regard to contamination with polychlorinated dibenzo-*p*-dioxin (PCDDs), polychlorinated-dibenzofuran (PCDFs) and coplanar PCB (Co-PCBs) (these chemical groups are called dioxins in this paper) in foods from farm animals. It was reported that 90% of the total intake of dioxins is originate from foods, of which 30 % are related to food products from farm animals[1)]. In order to reduce the intake of the chemicals contaminating human food, we must minimize the original contamination in animal feed.

Corn is one of the major feeds for farm animals, but we have poor knowledge of contamination with dioxins of corn grown in open fields. Corn (silage corn) is fed to animals as silage made by anaerobic fermentation process of whole corn. But, it is not known whether the concentration of the chemicals in silage evolves during the fermentation process. It has been reported that the chemicals contaminate corn is via the atmosphere[2)]. But there have been no report on the fate of dioxins in corn grown on soils contaminated with dioxins. Our study was undertaken in order to know the fate of dioxins in corn during the growth and the fermentation process for silage processing.

Materials and Methods

Experiment 1: A variety of silage corn, Nasuhomare, was grown in an experimental field in northern area of Kanto, Japan, in 1999, and harvested at five different stages; juvenile stage (14th, June), heading stage (21st, July), yellow ripe stage (26th, Aug.), and then 1 month latter of yellow ripe stage(24th, Sept.), respectively. The whole parts of the plants were chopped and mixed thoroughly, and they were taken for analysis of dioxins. The samples harvested at yellow ripe stage were used for silage, too.

Experiment 2 : Corn at yellow ripe stage was used for silage making. Silage was prepared using a small scale system of silage fermentation. Approximately 100-g portions of forage material chopped to about 10-mm lengths, were packed into plastic film bags (Asahikasei, Hiryu® KN type, Tokyo, Japan) that were sealed using a vacuum sealer. These bag silos were kept at 25℃, and they were open at 0, 4 and 30 days of fermentation for analysis of dioxins concentrations.

Experiment 3: A variety of silage corn, Dea, was grown in a greenhouse on two soils contaminated with different concentrations of dioxins. They were given fertilizer and water in proper amounts. They were harvested at yellow ripe stage, or 102 days after sowing, and were chopped to leaf blade and ear for analysis of dioxins.

Dioxins analysis: The analysis of concentration of dioxins (PCDD/Fs + Co-PCB) were commissioned to measure by Japan Food Research Laboratory (JFRL), Tokyo, Japan, for examination 1 and 2, respectively. In examination 3, dioxins (PCDD/Fs) analysis was done as follows: Plant samples (100g) were crushed with dry ice, then hexane/acetone(=150 ml/150 ml) were added and filtrated with glass filter. The filtrate was treated with sulfuric acid, then the organic layer was evaporated, purified and separated, respectively. Purification and separation were carried out using silica gel and activated carbon column chromatography. All samples were analyzed by HRGC/HRMS (HP6890 / VG Autospec ULTIMA) equipped with SP2331 (Supelco) or DB-5 (J&W Scientific).

Results and discussion

Experiment 1: Small amounts of concentrations of dioxins were detected in corn seeds. The concentrations of dioxins increased as the plants grown up (Fig. 1). Dioxin homologues distribution patterns detected from parts of corn were very similar during their stage. The values in concentration were expressed as pg/g wet weight, thus they were converted to those of dry weight in Fig. 2. It was shown that the concentration of dioxins has decreased from heading

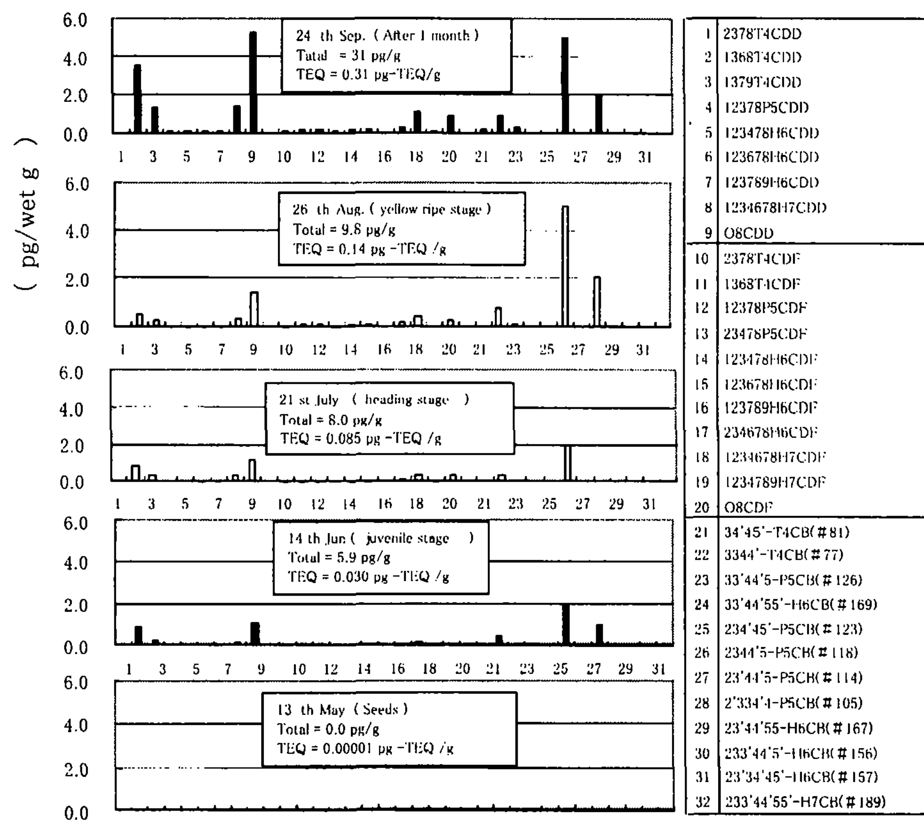

Fig. 1 The concentrations and homologue distribution patterns of dioxins detected in corn at different growth stage.

stage to yellow ripe stage. It was speculated that this tendency of the concentration of dioxins to decline at certain stages might be due to the balance of absorption and evaporation of the

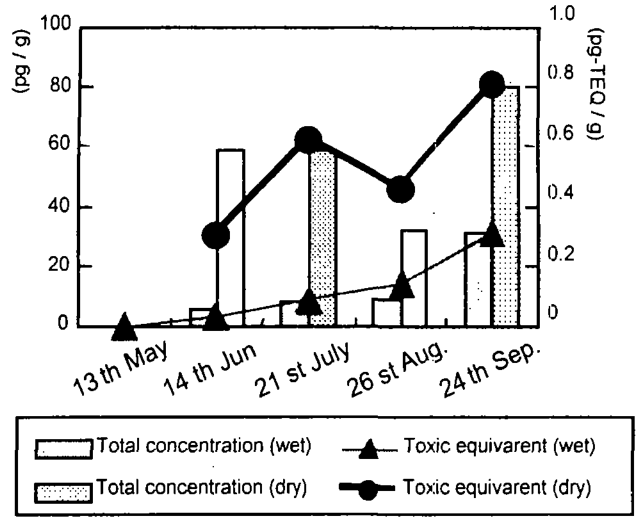

Fig. 2 Total concentrations of the dioxins and TEQ in diferent growth stage of ccrn.

chemicals in plants. Further studies are needed in order to explain this phenomenon.

Experiment 2: The silages were good in quality at both 4 and 30 days storage. The concentration of dioxins and their homologue distribution pattern in silages stored for each period were not different as shown in Fig. 3. These results indicated that there was no influence of the fermentation during the storage on the concentration and homologue distribution pattern of dioxins.

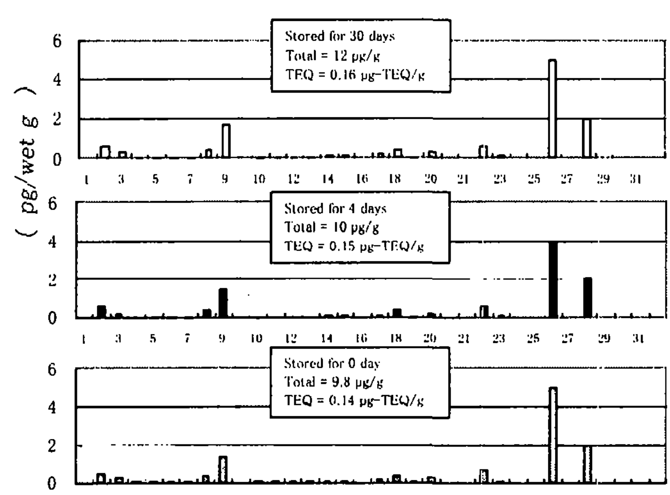

Fig. 3 The effect of fermentation during storage on concentrations and homologue distribution patterns of dioxins in silage. Numerals shown in figure are the same as shown in Fig.1.

Experiment 3: The concentrations of dioxins detected in leaf blade and ear of the plant were 2.3~2.4 pg-TEQ/g and 0.12~0.15 pg-TEQ/g, respectively as shown in Fig.4. There was no clear difference in concentrations and homologue distribution patterns of the chemicals detected in corns grown on soils contaminated with different concentrations and homologue distribution pattern of the chemicals. These results indicated that there are no relations in concentrations and homologue distribution patterns of the chemicals between corns grown on soils contaminated with different concentrations and homologue distribution patterns of dioxins.

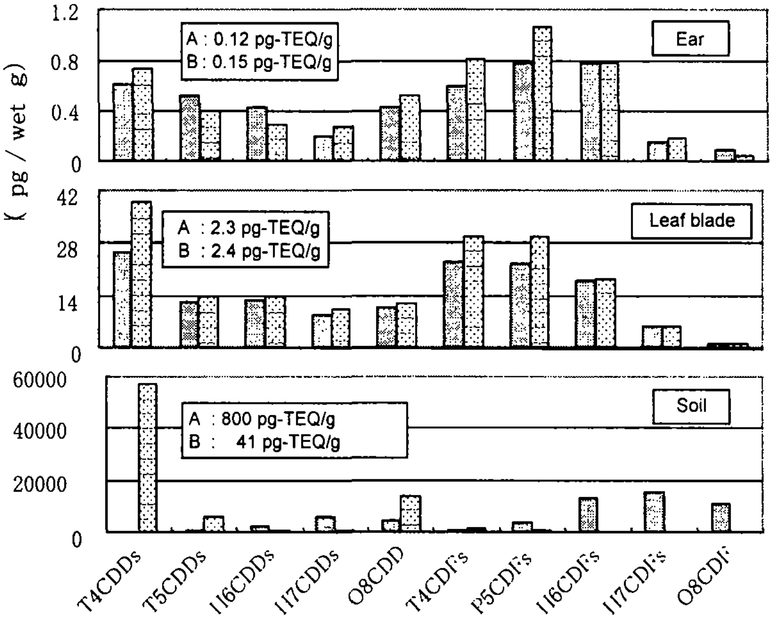

Fig. 4 The concentrations and homologue distribution patterns of dioxins in soils, leaf blade and ear in corns grown on soils contaminated with different concentration and homologue distribution patterns of dioxins.

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