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Conference paper

TOXIC SUBSTANCES IN THE FOOD CHAIN - RISK ASSESSMENT

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Abstract

It seems to be impossible to keep toxic substances out of the food chain. Interaction of natural environmental toxins and other chemicals or residues in food may result in harmful synergistic effects. In order to protect human health against the deleterious effects of different toxic substances it is imperative that tolerance levels be established. Tolerance levels can only be established on the basis of comprehensive risk assessment studies.

Keywords: cadmium, fumonisins, ochratoxin A, food chain

Introduction

Scientific results support the presumption that animal- and human health problems in majority of cases can be due to environmental pollution. According to some estimations the human health state is determined in 25% by the environment. Among environmental factors food is a source of essential nutrients sustaining life and in some aspects ensuring life quality. Some constituents of food however may decrease nutritional value, some of them like heavy metals and mycotoxins - may be even harmful. So the food chain may contain natural environmental pollutants. Interaction of environmental toxins and other chemicals or residues in food may result in harmful synergistic effects. Assessment of whether a food is safe, should be based on its inherent toxicity and on what kind of a hazard is created.

Cadmium movement in the food chain

In a series of experiments we examined the kinetics of cadmium in the food chain in one region of Hungary. The aim of the study was to get more

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information about the kinetics and cumulating of Cd in the soils, plants, animal and human organisms and organs.

Methods applied

Cd level of grains grown on different soils, in the blood serum of cows before and after calving, in colostrum and milk, in pigmented hairs, in different organs of cows and in blood and milk of women was measured. Details of the analyses are published by Kovács et al. (1998).

Results

Blood serum of cows fed corn grains grown on acid soils contained 23 nmoVl Cd, measured 10-14 days before calving. The Cd content of the colostrum was 30-32 nmol/I and remained 16 nmol/I during lactation. Close significant correlation was found between the Cd content of the soils and the Cd level of pigmented hairs of the animals kept in this region.

Cd concentration of the blood, the milk and hair samples were also in close correlation, the minimum lowest levels were measured subsequently after calving. According to the data of the National Institute for Food Control, the highest amount of Cd (450-560 μg/kg in case of cows) was detected in the kidneys of the slaughtered animals, less Cd was in the liver, muscles contained the least amount. According to the preliminary examinations, Cd was detectable in the blood and colostrum of woman in amount of 18-20 and 24-30 nmol/I, respectively.

Conclusions

Cd is detectable in every elements of the food chain, even in the colostrum of women, the first nutriment of newborns. Data show that Cd accumulates in the kidney of the animals. The Cd content of pigmented hair of animals may indicate the degree of Cd contamination of soils. Vegetables, cereal products and foods of animal origin (meat, liver, kidneys) were considered as the most important factors of Cd accumulation in human.

Detection of ochratoxin a in human blood and colostrum

Ochratoxin A (OA) is one of the commonest naturally occurring mycotoxins in Hungary, synthesised by numerous species of the genera Aspergillus and Penicillium. Its high prevalence and incidence can be

attributed partly to the higher resistance of the strains to environmental conditions (relative humidity, temperature). OA has nephrotoxic and hepatotoxic effects. The long known human disease designated "Balkan endemic nephropathy" has been assumed to be caused by OA. Because of the high prevalence of OA in Hungary, the OA levels in human blood and colostrum were determined.

Methods applied

Blood samples and mother's colostrum samples were collected by a randomised method, in different parts of Hungary. The OA content of the blood samples was determined by the method described by Sandor et al. (1991). The determination of OA in mother's colostrum was carried out by the method described by Gareis et al. (1988), the HPLC method applied in this study is described in detail by Kovács et al (1995).

Results

As had been expected OA could be detected in a relatively high proportion (52%) of the human blood samples tested. 34% of the samples showed OA level below 1 ng/ml, 16% between 1 and 5 ng/ml. In one sample the concentration of OA was above 10 ng/ml. Ninety-two mother's colostrum samples were collected from parturient mothers within 24 hours after delivery, and 38 of these were found to be positive. The average toxin concentration was 1.4 ng/ml.

Conclusions

The results obtained indicate that human exposure to OA is a distinct possibility. This is a serious risk because of the teratogenic, mutagenic and carcinogenic properties of the toxin. Mycotoxins, which are also excreted in the mother's milk, pose a serious risk to the health of newborn infants, considering that susceptibility to the effects of toxins is inversely related to age.

Determination of tolerance limit value of fumonisin B1 in pigs

The metabolites of *Fusarium moniliforme*, the fumonisins (FB1, FB2, FB3 and FB4), constitute one of the five major toxin groups which play a role proving detrimental to human health. FB1 causes oesophageal cancer in humans, pulmonary oedema in pigs, and encephalomalacia in horses (Riley et

al., 1996). In Hungary almost 70% of mouldy maize inspected since 1993 has shown FB1 contamination (mean 2.6-8.65 mg/kg; maximum 9.8-75.1 mg/kg), the degree of this contamination increasing from year to year Fazekas et al., 1997). There is no generally accepted, uniform system of standards with respect to this toxin; thus the assessment, by means of determination of the tolerable limit values and the critical concentration, of the detrimental effect elicited in the human organism is unavoidable.

Methods applied

Three experiments were carried out with weaned piglets, in order to study the dose and time dependent effect of FB1. Fungal culture of Fusariun moniliforme was added to the diet so that the FB1 exposure was: 0, 10, 20 and 40 ppm for 4 weeks; 0, 1, 5 and 10 ppm for 8 weeks; 0, 1, 5, and 10 ppm for 5 months.

The piglets were subjected to computer tomography (CT) examination for the purpose of establishing diagnosis of newly developing or progressive changes to the lungs. Using the data referring the tissue density obtained so-termed HU indices, referring the water content of the lung were determined. Magnetic resonance (MR) examinations were performed in order to examine any changes occurring in the cerebral matter (e.g. oedema or encephalomalatia). Certain haematological (WBC, RBC, Htc, haemoglobin concentration), blood biochemical parameters (total protein, albumin, cholesterol, AST, ALT, GGT, ALKP) and serum free sphinganine and sphingosine concentrations were determined. At the end of the experiments the pigs were slaughtered, gross pathological and histopathological examinations were carried out. Methods applied are described in detail in Zomborszky-Kovács et al. (2000b).

Results

In none of the experiments and the periods examined had FB1 any significant effect on feed consumption, body weight gain and feed conversion of weaned pigs (for further data see Toth et al., 2000). No clinical signs due to toxic effect were observed. However, in computer tomography examinations performed, the development of mild and severe pulmonary oedema could be detected. On examination of the changes in the HU indices (referring to the water content of the lung tissue) significant difference between the healthy and pathological lungs could be statistically proven. In the images obtained from the magnetic resonance (MR) examinations performed at the same points in time as the CT examinations none of the animals showed significant change in

the cerebral tissue, indicating, that no changes occurred that could be detected using this technique. Of the biochemical parameters examined, the aspartate aminotransferase (AST) activities increased dependent upon the dose administered. This finding indicated pathological change in the liver. It has recently been shown that fumonisins are specific inhibitors of sphingolipid biosynthesis, reducing conversion of sphinganine (SA) to sphingosine (SO), with a consequent increase in the SA to SO ratio. The free SA to SO ratio in the blood serum is considered as the most sensitive biomarker of fumonisin toxicoses (Riley et al,1993). In our experiments SA to SO ratio examined increased in proportion to the dose of the toxin administered.

By dissection the number of the animals showing pathological changes, and the severity of the alterations were in accordance with the dose and time of exposure. In the case of pulmonary oedema infiltration and widening of the septa between the lobules were observed. The lungs were found to be slightly enlarged and stiff to the touch. Histopathological examination revealed mild intraalveolar and milder or more severe cases of subpleural and interlobular pulmonary oedema. The septa between the lobules of the lung were observed to be widened, the lymphatic vessels in this area were filled up with lymph, and there was serious infiltration between the constituent parts of the connective tissue.

Conclusions

No clinical signs were observed although mild and more severe pulmonary oedema had developed in the experimental animals. The CT examination and the mathematical and statistical analyses performed were adequate to diagnose pathological changes in the lung. This facility for diagnosis can be used in the examinations to follow, for the detection of microscopic changes which do not give rise to the development of clinical symptoms.

The results obtained in the first experiment (10, 20, and 40 ppm FB1) prompted further experiments to be performed using even smaller doses in order to determine the No Observed Effect Level (NOEL) of the fumonisins. In the experiments with lower doses (1,5 and 10 ppm) at the 1 ppm level only one animal showed slight pulmonary oedema at the end of the 2nd month. However when using 1 ppm for long term period (5 months) there were 2 cases of oedema. As the SA/SO ratio in these animals did not differ significantly from the controls, we suggest that the limit value of tolerance for FB1 is bellow 1 ppm for pigs in case of long term exposure. These findings may provide useful data for the recommendation of permissible levels of mycotoxin contamination allowed in basic materials for animal feeds and in mixed diets.

Examination of perinatal toxicosis of fumonisin B_1 in pregnant sows and newborn piglets

There are no literature data available concerning possible harmful effect on pig foetuses of fumonisin B_1. It was also not known whether FB, is secreted in milk. The objective of the study was to establish whether FB, or any of its metabolites, can harm foetuses in utero when fed to sows in the advanced stage of pregnancy.

Methods applied

Three pregnant sows were fed a diet mixed with *Fusarium moniliforme* fungal culture from the 107th day of pregnancy so that the daily FB1 intake was 300 mg FB1 per sow. Two of the sows were given the toxin for a further 7 days after parturition, i.e. 14-16 days in total, while the third sow was given this dosage only until parturition, i.e. for a period of 7 days. Directly following parturition and before the first suckling two piglets from each sow were slaughtered. Subsequently, after 24 hours two more piglets which had had access to colostrum were taken from each sow, slaughtered and processed, followed by two more per sow on the 7th day after parturition. Blood samples of piglets were analysed for certain biochemical parameters (total protein, albumin, cholesterol, AST, ALT, GGT, ALKP) and serum free sphinganine and sphingosine concentration. FB1 concentration in sow's milk was determined. Analytical methods applied are described in Zomborszky-Kovács et al. (2000a).

Results

The results obtained appear to corroborate that FB1 toxin fed to sows in the advanced stages of pregnancy can harm foetuses while still in the uterus. Of the disorders characteristically caused by this toxin, pulmonary oedema of particular severity was observed in the piglets slaughtered immediately after parturition, before suckling could take place. Histopathological examination and increases in the activities of the plasma aspartate aminotransferase (AST), gamma glutamyl transferase (GGT) and alkaline phosphatase (ALKP) indicated pathological changes in the liver. The serum free SA/SO ratio varied in accordance with the degree of severity of the changes which occurred. These disorders could still be observed in piglets slaughtered 24 hours after parturition and on the 7th day. On the 7th day no change indicating pulmonary oedema was observed in the lungs of the piglets of the third sow, which was

fed a toxin-free diet after parturition. In milk samples taken from sows on the 1st and 2nd day following parturition, FB1 could be detected in quantities of 18-27.5 ppb. FB1 was not present in detectable quantities in the milk of that sow, to which no toxin was administered after parturition.

Conclusions

This study has confirmed that FB1, when fed to sows in the latter stage of pregnancy, exerted harmful effect on the foetuses in utero. The toxin was detectable in the sow's milk in quantities of ppb.

The effects of fumonisins on the reproductive processes of domestic livestock and on foetal development is not yet known. However further studies should primarily focus on the effects of the toxin ingested in low doses and causing no apparent clinical symptoms to the mother animal. The determination of the tolerable limit values for the foetus developing in the uterus is of particular importance.

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OTROVNE TVARI U PREHRANBENOM LANCU - PROCJENA RIZIKA

SAŽETAK

Čini se da je nemoguće zadržati otrovne tvari izvan prehrambenog lanca. Uzajamno djelovanje prirodnih otrova okoline i drugih kemikalija ili taloga u hrani može prouzročiti udružene štetne učinke. Da bi se zaštitilo ljudsko zdravlje od štetnog djelovanja raznih otrovnih tvari nužno je ustanoviti razine tolerantnosti. Razine tolerantnosti mogu se ustanoviti samo na temelju opsežnog proučavanja rizika procjene.

Ključne riječi: kadmij, fumonizini, okratoksin A, prehrambeni lanac

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