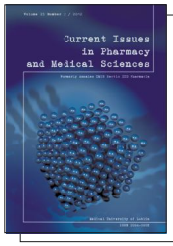

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# The risk assessment of mercury poisoning after consuming teas and cereal products

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**ABSTRACT**

The objective of the study was the determination of the level of concentration of total mercury in various cereal products and teas commonly available to the consumer. In the course of the research, 161 samples of products were analysed, among which only one sample – a single-component fruit tea – contained mercury at the concentration of 0.03100 mg/kg. All other samples of food products were characterised by mercury levels that, according to the current state of knowledge, do not pose a threat to human health.

**Keywords:** mercury, teas, cereal products

## INTRODUCTION

Mercury is a toxic metal commonly found in the human environment, which is related primarily with the utilisation of the element in certain branches of industry. After penetration into human organism, mercury is accumulated in the kidneys, brain and hair. It can cause serious poisoning and permanent damage to our organism, frequently leading to death [9]. In 2010, the Joint Committee of FAO/WHO for Food Additives (JECFA) established the Provisional Tolerable Weekly Intake (PTWI) for inorganic mercury at the level of 4 μg/kg of body weight, including a maximum of 1.6 μg/kg of body weight for methylmercury [2]. Although mercury appears in the environment at decreasing concentration, it still remains a notable threat to humans. Therefore, it is important to conduct monitoring of the level of mercury in various food products which are one of the primary sources of mercury introduced into the organism via the gastrointestinal pathway.

Earlier research by these authors addressed the problem of human population contamination with mercury in the aspect of nutrition habits and life style [5]. As a continuation of that research cycle, the authors addressed the aspect of monitoring of total mercury in herbal products available on the market [4]. Moreover, taking note of the relation between mercury accumulation in the organism and cigarette smoking, a study was performed on the content of mercury in cigarettes and in cigarette smoke [6]. Another group of studies comprised the monitoring of levels of mercury in the kidneys of birds of prey from various regions of Poland [3].

The objective of the research presented herein was the estimation of the content of total mercury in teas and in processed cereal products commonly available to the consumers. The subject matter of the research is of particular importance in the area of food safety and at the same time, it has an effect on the awareness of the population through information that can be addressed directly to the consumers.

## MATERIALS AND METHODS

The research material comprised samples of teas and processed cereal products (a total of 161 samples) available on the retail market. Prior to the analyses, the samples tested were homogenised and ground as required.

Mercury content in such prepared samples was determined using non-flame atomic spectrometry absorption technique (mercury analyzer AMA 254, Altec, Czech Republic). During the analysis in the AMA 254, samples were pre-dried in the internal oven of the analyzer and burned in oxygen (99.999% purity). The decomposition products were further carried to an amalgamator for a selective mercury trap. After stabilization of temperature (120C) within the amalgamator, the content of trapped mercury was measured. Thus, mercury was released from the amalgamator by a short heat-up and the mercury cloud was transferred by $O_2$ carrier gas to a double measuring cuvette. Hence the same quantity of mercury was measured twice using different sensitivy, resulting in a dynamic range of 0.05-600 ng Hg in a single measurement. The detection limit was $10^{-5}$ mg/kg. The original factory calibration was still valid for the calibration of the instrument. The values were controlled regularly by

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Table 1. Assessment of the accuracy and precision of the method by using two standard reference materials: INCT-MPH-2 and INCT-TL-1, (Institute of Nuclear Chemistry and Technology, Warszawa, Poland).

| INCT-MPH-2 (mg/kg), n=10 | | INCT-TL-1 (mg/kg), n=10 | |
|---|---|---|---|
| certified value | determined value | certified value | determined value |
| 0.01760±0.00160 | 0.01670±0.00050 | 0.00492±0.00074 | 0.00527±0.00043 |

Table 2. Concentration of total mercury in teas and cereal products

| No. | Product | Mean SD (mg/kg) | | |
|---|---|---|---|---|
| teas | | | | |
| 1 | *Single-component fruit tea* | 1) 0.00075±0.00015[1a] | 2) 0.00060±0.00015[9a] | 3) <LD[10a] |
| | | 4) <LD[10a] | 5) 0.00040±0.00010[10a] | 6) 0.00290±0.00150[12a] |
| | | 7) <LD[10a] | 8) <LD[10a] | 9) <LD[10a] |
| | | 10) 0.00020±0.00010[10a] | 11) 0.00210±0.00004[12a] | 12) 0.03100±0.00290[12a] |
| | | 13) 0.00290±0.00010[12a] | 14) <LD[10] | 15) 0.00310±0.00060[12a] |
| 2 | *Binary-component fruit tea* | 16) 0.00040±0.00010[9a] | 17) 0.00105±0.00016[2a] | 18) 0.00290±0.00065[2a] |
| | | 19) 0.00050±0.00010[9a] | 20) 0.00080±0.00020[9a] | 21) 0.00070±0.00015[9a] |
| 3 | *Ternary-component fruit tea* | 22) 0.00150±0.00020[9a] | 23) 0.00130±0.00004[9a] | 24) 0.00160±0.00005[9a] |
| 4 | *Quaternary-component fruit tea* | 25) 0.00160±0.00030[9a] | 26) 0.00302±0.00067[3a] | 27) 0.00225±0.00037[2a] |
| | | 28) 0.00175±0.00018[3a] | 29) 0.00127±0.00043[1a] | 30) 0.00285±0.00019[6a] |
| 5 | *Five-component fruit tea* | 31) 0.00040±0.00010[7a] | 32) 0.00200±0.00041[2a] | 33) 0.00150±0.00020[9a] |
| | | 34) 0.00069±0.00026[1a] | 35) 0.00020±0.00003[9a] | 36) 0.00050±0.00010[9a] |
| | | 37) 0.00050±0.00010[9a] | – | – |
| 6 | *Six-, seven-, eight-, nine-component fruit tea* | 38) 0.00287±0.000183[3a] | 39) 0.00050±0.00010[9a] | 40) 0.00236±0.00014[3a] |
| | | 41) 0.00030±0.00010[7a] | 42) 0.00198±0.00011[6a] | |
| | | 43) 0.00151±0.00013[1a] | 44) 0.00246±0.00024[2a] | 45) 0.001477±0.00021[1a] |
| 7 | *Help slimming tea* | 46) 0.00333±0.00076[1a] | 47) 0.00463±0.00070[2a] | 48) 0.00568±0.00084[3a] |
| | | 49) 0.00225±0.00014[9a] | 50) 0.00105±0.00027[9a] | 51) 0.00369±0.00070[3a] |
| | | 52) 0.00247±0.00044[1a] | 53) 0.00626±0.00095[2a] | 54) 0.00519±0.00127[3a] |
| | | 55) 0.00179±0.00018[9] | – | – |
| 8 | *Green tea* | 56) 0.00653±0.00058[3a] | 57) 0.00220±0.00020[9a] | 58) 0.00480±0.00040[9a] |
| | | 59) 0.00220±0.00060[9a] | 60) 0.00254±0.00009[13a] | 61) 0.00462±0.00018[13a] |
| | | 62) 0.00700±0.00030[9a] | – | – |
| 9 | *Black tea* | 63) 0.00126±0.00019[4a] | 64) 0.00207±0.00020[4] | 65) 0.00250±0.00023[4a] |
| | | 66) 0.00104±0.00013[5a] | 67) 0.00094±0.00015[5a] | 68) 0.00270±0.00005[5a] |
| | | 69) 0.00495±0.00019[8a] | 70) 0.00267±0.00016[11a] | 71) 0.00216±0.00033[11a] |
| | | 72) 0.00298±0.00016[11a] | 73) 0.00336±0.00025[6a] | 74) 0.00935±0.00040[6a] |
| | | 75) 0.00145±0.00026[4a] | 76) 0.00277±0.00064[8a] | 77) 0.00267±0.00016[11a] |
| 10 | *Pu-erh tea* | 78) 0.00240±0.00050[9a] | 79) 0.00240±0.00030[9a] | 80) <LD[10a] |
| cereal products | | | | |
| 11 | *Pasta* | 81) 0.00062±0.00002[5b] | 82) 0.00059±0.00001[5b] | 83) <LD[11b] |
| | | 84) 0.00049±0.00010[11b] | 85) 0.00028±0.00005[11b] | 86) <LQ[11b] |
| | | 87) <LD[11b] | 88) 0.00011±0.00002[11b] | – |
| | | 89) 0.00064±0.00019[1b] | 90) 0.00063±0.00010[1b] | 91) 0.00109±0.00042[2b] |
| | | 92) 0.00023±0.00005[11b] | 93) <LD[11b] | 94) 0.00049±0.00002[1b] |
| | | 95) 0.00023±0.00005[11b] | 96) 0.00073±0.00012[8b] | 97) 0.00089±0.00015[9b] |
| | | 98) 0.00169±0.00011[10b] | 99) 0.00004±0.00001[11b] | – |
| 12 | *Breakfast cereals* | 100) 0.00023±0.00002[3b] | 101) 0.00032±0.00000[4b] | 102) 0.00047±0.00002[4b] |
| | | 103) 0.00024±0.00008[3b] | 104) 0.00037±0.00011[4b] | 105) 0.00075±0.00005[11b] |
| | | 106) 0.00042±0.00009[3b] | 107) 0.00013±0.00002[11b] | 108) 0.00027±0.00005[11b] |
| | | 109) <LD[11b] | 110) <LD[11b] | 111) <LD[11b] |
| | | 112) 0.00065±0.00000[4b] | 113) <LD[11b] | 114) 0.00032±0.00005[11b] |
| | | 115) 0.00079±0.00011[3b] | 116) 0.00055±0.00002[4b] | 117) <LD[11b] |
| | | 118) 0.00038±0.00005[11b] | 119) 0.00018±0.00005[11b] | 120) 0.00015±0.00002[11b] |
| | | 121) 0.00015±0.00002[11b] | 122) <LQ[11b] | - |
| 13 | *Wheat flours* | 123) 0.00083±0.00000[6b] | 124) <LD[11b] | 125) 0.00018±0.00002[11b] |
| | | 126) 0.00019±0.00002[11b] | 127) 0.00077±0.00000[6b] | 128) 0.00096±0.00024[7b] |
| | | 129) <LD[11b] | 130) 0.00020±0.00005[11b] | 131) 0.00037±0.00000[7b] |
| | | 132) <LQ[11b] | 133) <LQ[11b] | 134) 0.00025±0.00005[11b] |
| | | 135) 0.00119±0.00018[7b] | 136) 0.00018±0.00005[11b] | 137) 0.00019±0.00004[11b] |
| | | 138) 0.00017±0.00004[11b] | 139) 0.00029±0.00004[11b] | 140) 0.00025±0.00004[11b] |
| | | 141) 0.00058±0.000011[6b] | 142) <LD[11b] | 143) <LQ[11b] |
| 14 | *Barley groats* | 144) <LD[11b] | 145) <LD[11b] | 146) <LD[11b] |
| | | 147) 0.00035±0.00005[11b] | 148) 0.00033±0.00005[11b] | 149) 0.00038±0.00008[11b] |
| | | 150) <LD[11b] | 151) 0.00056±0.00010[11b] | 152) <LD[13b] |
| 15 | *Semolina* | 153) <LD[11b] | 154) 0.00030±0.00005[11b] | 155) <LD[13b] |
| 16 | *Rice* | 156) 0.00046±0.00010[11b] | 157) 0.00033±0.00008[12b] | 158) 0.00040±0.00005[13b] |
| 17 | *Buckwheat* | 159) 0.00044±0.00010[11b] | 160) <LD [12b] | 161) 0.00025±0.00006[13b] |

LD – limit of detection (0,00001 mg/kg)
LQ – limit of quantification (0,00015 mg/kg)
1), 2), 3) – codes of products
1, 2, 3...a, b – codes of producers

calibration standard mercury solutions – NIST-traceable Hg standard solution (Accu Trace Single Element Standard; AccuStandard Inc., New Haven, CT, USA) [3]. The Mixed Polish Herbs (INCT-MPH-2, Institute of Nuclear Chemistry and Technology, Warszawa, Poland) and the Tea Leaves (INCT-TL-1, Institute of Nuclear Chemistry and Technology, Warszawa, Poland) were used as reference materials [4].

## RESULTS AND DISCUSSION

Table 1 presents a comparison of the achieved results of the content of mercury of the reference materials studied with reference values. Whereas, data on the content of mercury in the teas and cereal products under study are compiled in Table 2.

The results obtained in the study presented here indicate that all samples of tested teas, with the exception of a single instance, do not exceed the mercury content level of 0.02 mg/kg, which should be considered as satisfactory. The highest concentration of mercury was recorded in one sample of a single-component fruit tea (0.03100 mg/kg). In the case of green teas, the highest concentration of mercury was 0.00700 mg/kg, while for black teas the maximum concentration was 0.00935 mg/kg. Wojciechowska-Mazurek et al. [10] report that the mean levels of mercury contamination of leaf teas, tea bags, granulated teas and fruit teas were 0.008 mg/kg, 0.007 mg/kg, 0.009 mg/kg and 0.003 mg/kg, respectively, which was generally confirmed in this study.

Significantly lower concentrations of mercury were noted in the cereal products studied than in the teas. The wheat flours under analysis, contained mercury up to a maximum level of 0.00119 mg/kg, while the tested kinds of pasta up to 0.00169 mg/kg and cereal breakfast flakes up to 0.00079 mg/kg. The analysed grits and rice also had mercury concentrations below 0.001 mg/kg. Studies conducted by Wyka et al. [11] showed that in the samples of cereals from the Legnica-Głogów region (under the effect of copper smelting plants) studied by those authors the levels of mercury oscillated within the range of 0.0001 - 0.0008 mg/kg, i.e. below those recorded in this research. Whereas, Hęś and Nadolna [1] determined mercury levels below 0.005 mg/kg in instant grits for infants. Miśniakiewicz [7] showed that the samples of bread dough mercury content in the range from 0.00050 mg/kg to 0.00191 mg/kg.

In view of the lack of specific requirements concerning the content of mercury in teas and cereal products in the current legislation (Commission Regulation (EC) *No. 1881/2006* of 19 December 2006 with subsequent revisions), the upper permissible limits of contamination with that metal can be adopted on the basis of the recommendations concerning herbicide and pesticide residues specified in Commission Regulation (EC) No. 396/2005 with revisions [8], i.e. 0.02 mg/kg for teas and 0.01 mg/kg for cereals.

The current knowledge does not permit any definitive statement whether the standards adopted are correct, especially as data on the genetic effects of mercury poisoning may become apparent in future generations. However, summarising the results of the research presented here, we can conclude that the teas and cereal products available on the market should not constitute a threat to human health in terms of their mercury content. Moreover, the study indicates that the products studied, originating in an overwhelming majority from local production, do not provide any disturbing hints that would constitute indirect information on potential pollution of natural or agricultural areas with that toxic element.

## CONCLUSIONS

The following conclusions result from the conducted research:

1. It was demonstrated that among the 81 samples of teas (fruit teas, digestion-regulating teas, green teas, black teas and Pu-erh type teas) only one sample had mercury content at a level above 0.02 mg/kg.
2. The cereal products under analysis had mercury levels below 0.01 mg/kg.
3. The results obtained indicate an absence of threat of mercury poisoning due to the consumption of cereal products and teas.

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