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Study regarding the tin and iron migration from metallic cans into foodstuff during storage

Amelia Buculei, Gheorghe Gutt, Amariei Sonia, Dabija Adriana, Gabriela Constantinescu

Ştefan cel Mare University of Suceava, Food Engineering Faculty, 13th University Street, 720229, Suceava - Romania

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Abstract

Interaction between packaging and food consists of the transfer of substances from the environment as well as from the packaging into the food and vice versa. Chemical reactions inside the packaging or food are also possible. Experimental studies were conducted on the migration of Fe, Sn, in canned foodstuffs. In order to study the interaction of metal packaging at the same time to check the stability of protective varnish applied to the boxes, canned produced were analyzed periodically during storage, from the point of view of sensorial, physical - chemical and microbiological properties and of migration of heavy metals.Three-piece-cans had been protected with different coatings and techniques. After filling with different raw materials, cans were stored in ambient temperature (ca 20 °C) during 2 years. There was stated increasing dependence of storage time on concentration of Fe and Sn in cans. There are great differences among migration of Fe, Sn and migration trends of the other heavy metals reported in the literature. These phenomena are disadvantageous for quality of canned foodstuff.

Keywords: heavy metals, cans, food, migration

1. Introduction

Food packaging can retard product deterioration, retain the beneficial effects of processing, extend shelf-life, and maintain or increase the quality and safety of food. Undoing so, packaging provides protection from 3 major classes of external influences: chemical, biological, and physical.[1]

Lately, food packaging has gained a widespread importance in food safety due to the possibility of migration of chemicals from food contact materials. The term 'migration' usually describes a diffusion process, which may be strongly influenced by an interaction of the packaging material with the food [2]. Although much work has been undertaken to help to reduce lab testing required through simplifying analytical procedures or use of mathematical modeling, within different EU projects during last years, further work was proposed before finally agreed models could be put forward for its adoption [2].

The current approach for the authorization and control of substances used in food contact materials is cautious in estimating the potential exposure of the consumer to these substances. Approaches, which take better account of the actual exposure of the consumer to food contact materials in risk assessment, are under discussion.

To estimate dietary exposure to a substance migrating from a food packaging material, information is needed on the types of food packaged, the nature of the packaging material, migration data, packaging usage factors and food consumption Migration testing using food simulants is the normal procedure for checking compliance of a food packaging material against specific migration limits (SMLs).

* Corresponding author: *e-mail:* ameliab@fia.usv.ro

However, as Feigenbaum et al. (2002) [15] point out, this is not practical for several reasons. Industries that put packaged foods or materials intended for food contact on the market do not know the identities of the potential migrants; sometimes, those who manufacture and sell these raw materials do not know the processing conditions or the final application; and even if the identities of the migrants were known it may be difficult to analyze them. Therefore, the use of mathematical modeling to predict migration, which can reduce the amount of tests to be undertaken, has been recently introduced into legislation [2].

In the packaging internally lacquered, the interaction product/packing occurs mainly through these discontinuities. The main consequence of this discontinuity is the iron, which can be dissolved in the food. The reactions involved can modify the flavor characteristic of the product conferring to it metallic flavor [3].

The combination of sensory, nutritional and hygienic characteristics will provide the quality of a food product [4]. For the case of the beverage cans made from tinplate, the control of the migration of iron acquires an even greater importance; because extremely small levels of iron migrated to the drink (0.5 ppm) can already compromise the flavor of the drink [5]. The lacquer coating is the most widely used method for reducing tinplate can corrosion [6]. A need for rapid development of new internal coatings on tinplate cans arise in the food and beverage industry, mainly as a response to proposed volatile organic compound regulations. Nowadays, the coatings industry is interested in water-based coatings, because they release very little organic solvent into the atmosphere [7].

Trace metal levels of various vegetable samples have been widely reported in the literature [8,9,10].

It is known that adequate iron in a diet is very important for decreasing the incidence of anemia. Iron deficiency occurs when the demand for iron is high, e.g., in growth, high menstrual loss, and pregnancy, and the intake is quantitatively inadequate or contains elements that render the iron unavailable for absorption [11]. Poor bioavailability is considered to be an important factor leading to iron deficiency in many countries. Iron content was ranged from 27.5 µg/g, in canned delicatessen to 79.6 µg/g in canned mushroom samples. Iron levels in vegetables have been reported in the range of 9.3–76.0 µg/g [9], 4.5–9.7 µg/g [12], and 40.1–261.6 µg/g [10]. The maximum iron level permitted for canned food according to Turkish Food Codex is 15µg/g [13]. Iron levels in analyzed canned samples were found to be higher than legal limits. It is predicted that high iron level is sourced from processing of raw materials.[14]

2. Materials and methods

In order to study the interactions between the package and the contents of can in practical terms during the period of storage it was tested four types of canned products manufactured with different lakes. In order to compare the skills of several systems for varnishing was used the same type of tin. Thus, it has sought the variation of migration of metals (iron and tin) of the packaging in food during storage, various canned peas, tomato paste, canned meat and liver pate, aimed at extending the term of protection systems conservability.

AAS determination of heavy metals migration

Microwave digestion.One gram of sample was digested with 6 ml of concentrated HNO_3 (65%) (Suprapure, Merck) and 2 ml of concentrated H_2O_2 (30%) (Suprapure, Merck) in microwave digestion system. After that was diluted to 10 ml with double deionised water (Milli-Q Millipore 18.2 MΩ/cm resistivity). A blank digest was carried out in the same way (digestion conditions for microwave system were applied as 2 min for 250 W, 2 min for 0 W, 6 min for 250 W, 5 min for 400 W, 8 min for 550 W, vent: 8 min, respectively).

Trace metals determination: A Perkin–Elmer Analyst 400 atomic absorption spectrometer, with found correction absorbance (D_2 lamp), for all metals analysis was used, except tin, which was analysed using an ICP-AES spectrophotometer. The operating parameters for working elements were set as recommended by the manufacturer. The operating parameters for working elements were set as recommended by the manufacturer; iron and tin in canned food during 36 months storage were determined by HGA graphite furnace using argon as inert gas. The elements were determined by using air-acetylene flame. Milestone Ethos D microwave closed system (maximum pressure 1450 psi, maximum temperature 300^0C) was used.

3. Results and Discussion

Varnish- 1 – universal varnish;
Varnish - 2 – epoxifenolic varnish

In figure 1 it is observed that during the period of storage for 0-1080 days appears insignificantly Fe content in both types of cans, and the following period is currently a significant increase of Fe.

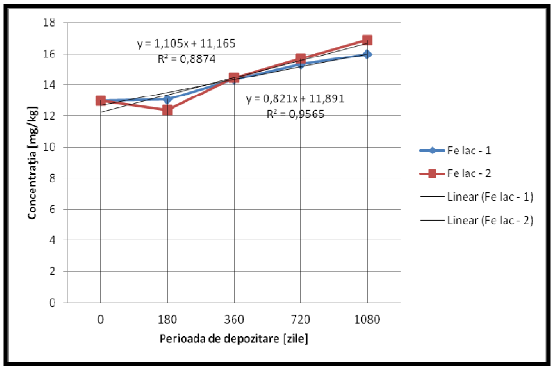

Figure 1. Variation of iron content of peas cans at storage

In figure 2 it is observed that during the period of storage of 720-1080 Sn content migration of the product packed in the box covered with varnish I shall have much faster than changing the Sn of the product currently packed in the box covered with varnish II.

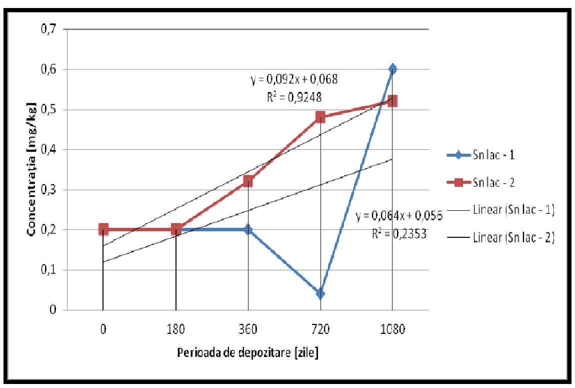

Figure 2. Variation of tin content of peas cans at storage

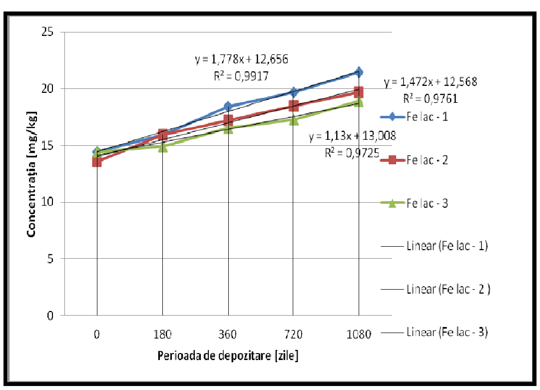

Figure 3. Variation of iron content in tomato cans at storage

The analyses carried out shows that migration of Fe content in the product presents a significant increase for the duration of storage of all types of used cans.

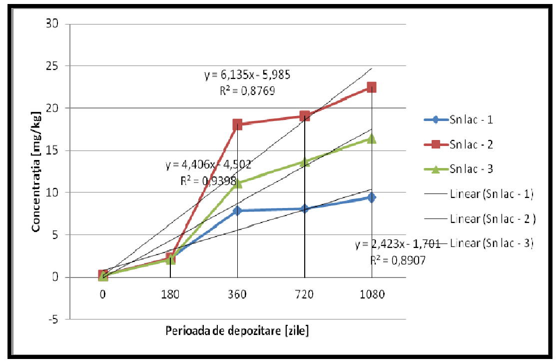

Figure 4. Variation of tin content in tomato cans at storage

The figure above shows that throughout the storage Tin content migration is more pronounced in the canned lacquer-coated epoxifenolic.

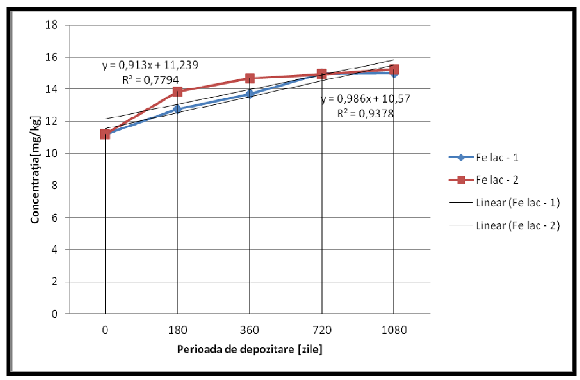

Figure 5. Variation of iron content in pork in own juice cans at storage

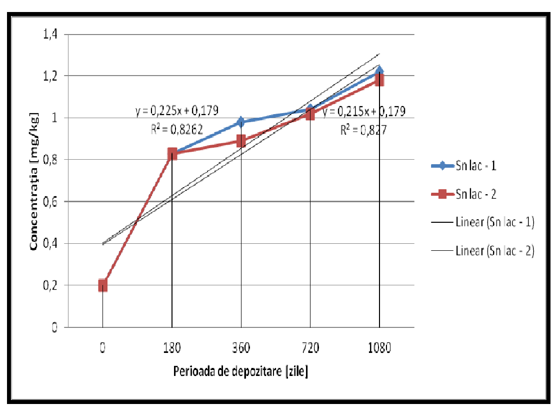

Figure 6. Variation of tin content in pork in own juice cans at storage

In figure 5, it could be observed a significant increase of the content of Fe in the first storage period (0-720 days) and in the second part of the migration of Fe content storage becomes constant and insignificant.

In figure 6 it observed that the migration of Sn content preserved covered with lacquer, sulfur-resistant is more pronounced in the first storage period than the canned lacquer coated universal.

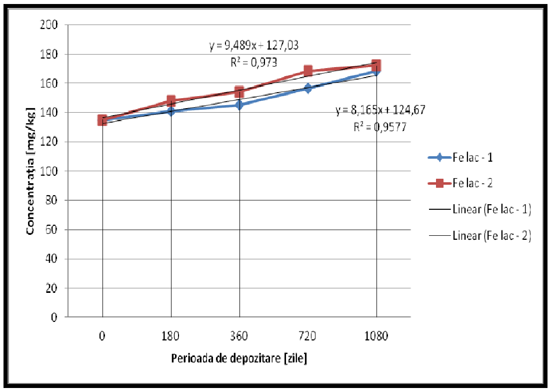

Figure7. Variation of iron content in liver pate cans at storage

In figure 7 it could be observe a constant increase in iron content of both products throughout the storage time.

In figure 8 are observed a significant increase in the levels of Tin in the second period preserved in storage-covered varnish sulfur-resistant to varnish preserved covered with universal.

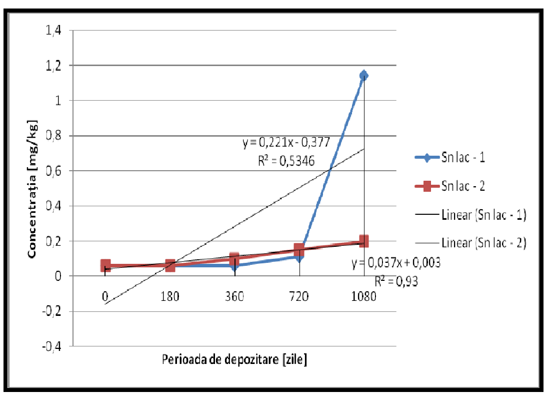

Figure 8. Variation of tin content in liver pate cans at storage

4. Conclusion

After 6 and 12 months of storage, the contents of heavy metals of rehydrated peas in tins packed with protective film, varnish II, I do not very significantly, the product fits within the scope of the Ministry of Health Order No. 975\/1998. The only change refers to the slight increase of iron content in the two types of varnishing. As regards the contents of tin was not only a slight increase observed, barely after 12 months of storage, the product is packed in boxes protected with yellow. After 24 month the content of metals increases significantly.

After 6 and 12 months of storage, heavy metal content of tomato pulp packed in tins that are protected with protective lacquer film White and yellow varies significantly. Changes are observed in all the three systems for varnishing in regards to the content of iron and tin, with progressive increases both after 6 months and after 12 months of storage.

• analysis of the appearance of the interior of the varnish, running a representative sample of open boxes, also has been properly and did not submit any changes during storage (in normal conditions at room temperature), in both variants of varnishing.

• in view of the fact that it was used to protect the inside of the boxes, so a specific meat products, sulfur-resistant -type \"White Lake\" and a \"universal-yellow Lake\", comparative analysis of the properties of the product is important.

• From the analyses carried out would result in a significant increase in heavy metal content of the product packed in cans of film, protected by varnish 1 and varnish 2.

References

1. Kenneth Marsh, Betty Bugusu, Food Packaging-Roles, Materials, and Environmental Issues, JFS R: Concise Reviews/Hypotheses in Food Science, *Journal of food science* R39, **2007**, *72*(3), R39-R55, doi: 10.1111/j.1750-3841.2007.00301.x
2. R. Sendo´n Garcı´a, A. Sanches Silvaa, I. Cooper, R. Franz and P. Paseiro Losada, Revision of analytical strategies to evaluate different migrants from food packaging materials, *Trends in Food Science & Technology*, **2006**, *17*(7), 354–366, http://dx.doi.org/10.1016/j.tifs.2006.01.005
3. P.E.M. Bernardo, J.L.C. Santos, N.G. Costa, Influence of the lacquer and end lining compound on the shelf life of the steel beverage can, *Progress in Organic Coatings*, **2005**, *54*(1), 34–42, http://dx.doi.org/10.1016/j.porgcoat.2005.04.002
4. A. Montanari, A. Pezzani, A. Cassar`a, A. Quaranta, R. Lupi, Quality of organic coatings for food cans: evaluation techniques and prospects of improvement, *Prog. Org. Coat.*, **1996**, *29*(1-4), 159-165,http://dx.doi.org/10.1016/S0300-9440(96)00625-X
5. J. Hollaender, Impedance Test Routines for Beverage Cans, *4th International Symposium on Electrochemical Impedance Spectroscopy*, **1998**, 194-197

6. R. Catal´a, J.M. Caba˜nes, J.M. Bastidas, An impedance study on the corrosion properties of lacquered tinplate cans in contact with tuna and mussels in pickled sauce, *Corros. Sci*. **1998**, *40*(9), 1455- 1467, http://dx.doi.org/10.1016/S0010-938X(98)00050-X
7. R.D. Armstrong, J.D. Wright, Impedance studies of poly ethylmethacrylate coatings formed upon tin-free steel, *Corros. Sci*., **1992**, *33*(10), 1529- 1539, http://dx.doi.org/10.1016/0010-938X(92)90031-W
8. Mustafa Tuzen, Mustafa Soylak, Evaluation of trace element contents in canned foods marketed from Turkey, *Food Chemistry*, **2007**, *102*(), 1089–1095, http://dx.doi.org/10.1016/j.foodchem.2006.06.048
9. Gebeloglu, N., Camcicetin, S., Ece, A., Sari, H., Mendil, D., & Tuzen, M., Determination of trace metals in soil, bean and tomato samples collected from agricultural areas near the motorway in Tokat, Turkey. *Asian Journal of Chemistry*, **2004**, *16*, 1500–1504.
10. Divrikli, U., Saracoglu, S., Soylak, M., & Elci, L., Determination of trace heavy metal contents of green vegetable samples from Kayseri-Turkey by flame atomic absorption spectrometry. *Fresenius Environmental Bulletin*, **2003**, *12*(9), 1123–1125.
11. Tuzen, M., & Soylak, M., Trace heavy metal levels in microwave digested honey samples from Middle Anatolia, Turkey. *Journal of Food and Drug Analysis*, **2005**, *13*, 343–347.
12. Tuzen, M., Determination of heavy metals in soil, mushroom and plant samples by atomic absorption spectrometry. *Microchemical Journal*, **2003**, *74*(3), 289–297,http://dx.doi.org/10.1016/S0026-265X(03)00035-3
13. Anonymous, Regulation of setting maximum levels for certain contaminants in foodstuffs. *Official Gazette*, **2002**, October 16, Iss: 24908.
14. Onabanjo, O. O., & Oguntona, C. R. B., Iron, zinc, copper and phytate content of standardized Nigerian dishes. *Journal of Food Composition and Analysis*, **2003**, *16*(6), 669–676, http://dx.doi.org/10.1016/S0889-1575(03)00063-2
15. A. Feigenbaum, D. Scholler, J. Bouquant, G. Brigot, D. Ferrier, R. Franz, L. Lillemark, A. M. Riquet, J. H. Petersen, B. Van Lierop & N. Yagoubi, Safety and quality of food contact materials. Part 1: Evaluation of analytical strategies to introduce migration testing into good manufacturing practice, *Food Additives and Contaminants*, **2002**, *19*(2), 184-201, doi:10.1080/02652030110053002