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Metal Packaging and Food Quality

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Over the years with man's quest for newer technology and packaging maeterial for a variety of food products has gained prime importacne. The conventional methods of harvesting, processing and handling are gradully replaced by modern systems with improvised and sophisticated techniques. The natural fruits, vegetables and all the perishable food products must be stored and sold without spoilage. Amongst various packaging materials, metal plays an important role to meet the necessary conditions to protect food products from spoilage. In the present paper, role and importance of tin metal is evaluated with respect to safety, stability and consumers acceptance. The usage of tin metal and its interaction with the food products causing changes in the nutritional value of food is discussed. The results indicate that tin does not impart toxicity to canned fruits and vegetables.

Key words: Metal, packaging, food, quality.

INTRODUCTION

In today's world, proper packaging can add value to the food product and provides better market. India is the largest producer of fruits and vegetables of different kinds depending upon seasons. However, only 1.5% of the gross production is marketed as a processed product. The processed fruits and vegetables are considered as a luxury item for the domestic consumers probably due to the high cost involved in packaging. However, 70% of the processed products are exported to different countries.

A recent study[1] reveals that the average Indian spends nearly 50% of his personal income on food compared to his American counterpart, who spends only 10% [1] The production of fruits and vegetable products has increased from 469,000 to 960,000 tonnes during the period 1993–1997. Fruits like mango, banana, guava and apple account for 80% of the fruit production.[2] However, low consumption of processed fruits and vegetables in the local market is probably due to easy availability of fresh products. The development of new technologies for packaging and the materials used in packaging has provided extra stability and safety to the processed products.

Tin-coated cans are popular as a packaging material[3]. Tinplate is a versatile, rigid and impervious material. It consists of thin sheets of low carbon steel coated on both sides with a thin layer of metallic tin. It is anti-corrosive in nature and

lighter in weight. The tin can is the best container in terms of cost and protection. It also provides longer shelf life as compared with other packaging materials.

The present study was planned to understand storage behaviour with reference to trace minerals and tin content in the various processed fruits and vegetables. It is expected that tin-coated cans and tinplates may have different permeability against UV-radiation, moisture and oxygen content. These parameters will affect leaching of tin into the product. It was reported[3] that tin cans have best barrier properties but also dissolve tin ions, which may have adverse effect on the aesthetic properties of the food product. Various food samples packed in the tin-plated cans of different sizes and shapes were selected and analyzed for their tin content.

EXPERIMENTAL

Sample collection: Most of the commercial samples like fruit slices (ripe mango, pineapple, peaches, pears), fruit pulp, tomato juice/puree and green vegetables like carrot, peas and mushrooms are commobly available in tin-coated containers. Samples of different brands for few selected fruits and vegetables were collected from the local market. Each sample was analyzed by ash method for tin content using atomic absorption spectrophotometer AAS (Model: Chemito AA 203).

Sample preparation: 20 g of homogenized sample was weighed accurately and heated at 525°C in the furnace till yellowish white ash. Subsequently, the entire ash was treated with 40 cm^3 of aqua-regia and digested on a water bath for 30 min. The digested solution was diluted to 50 cm^3 in volumetric flask.

The diluted solution was aspirated in the AAS with hollow cathode lamp of tin and the corresponding reading was recorded. The standard curve was obtained by aspiration of standard solution (1000 ppm) of tin supplied by M/s Merck Ltd. Each experiment was performed five times and average values are reported in Table-1. The reproducibility and acccuracy of determination was supported by statistical calculation.

RESULTS AND DISCUSSION

Large varieties of food products, which are canned, involve many different techniques. It becomes the official source for the contamination of tin in the final product. People from the new generation consider canned food as a convenient food but use canned vegetables only in any unforeseen situation like non-availability of seasonal fruits and vegetables. Canning can compete with all other packaging material because of high production speed and low production cost. The popularity of metal cans in food processing is due to their heremetical sealing, high speed packaging operation, easy stacking, handling and transportation, better shelf-life and capability of adapting to thermal processing of food.

The production of canned food products undergoes various stages in sequence as described below:

Field crop-harvest — cooling — transport — cleaning and trimming — peeling — cutting and shredding — formulation — filling — brining and syruping —

exhaust — sealing — thermal treatment — cooling — store and label — transportation — retail store — purchase — food preparation — consumer's plate.

Various canning processes also influence the abnormal content of trace metal inclusion in the selected food products. The most important factors like headspace, consistency of the product, gelling agents within can, ratio of solid to liquid, design of equipment for retorting, size of the can, initial microbial load in the product and rate of cooling can may influence the leaching of tin from coating. It is therefore desirable to take utmost care throughout the canning process.

The content of tin in the processed fruits and vegetables is summarized in Table-1.

TABLE-1
TIN CONTENT OF DIFFERENT FRUITS AND VEGETABLES PACKED IN A CAN

Products	Tin content in mg							Std. dev.	% C.V.
	X_1	X_2	X_3	X_4	X_5	ΣX_n	Mean		
Pineapple	121.5	146.3	112.4	154.2	126.2	660.6	132.12	17.50	13.25
Mango	108.7	105.9	112.1	142.8	110.7	580.2	116.04	15.14	13.05
Peaches	176.3	139.8	153.7	129.0	154.6	753.4	150.68	19.01	12.62
Pears	164.1	143.2	164.3	175.1	155.5	802.2	160.44	11.88	7.41
Tomato juice	133.9	170.1	145.4	132.7	133.8	715.9	143.18	15.92	11.12
Tomato puree	154.9	154.3	142.0	136.8	125.8	713.8	142.76	12.29	8.61
Mushrooms	89.5	79.5	99.5	77.7	80.4	426.6	85.32	9.15	10.72
Green peas	112.1	111.1	147.9	136.1	152.9	660.1	132.02	19.62	14.86
Carrots	143.9	164.2	154.8	127.9	145.8	736.6	147.32	13.53	9.18

Canned Fruits: It can be seen from the Table-1 that canned pineapple and mango have mean of 132. 12 and 116.04 mg of tin per 100 g of canned product. After controlled ripening of the fruit, it is mechanically peeled and cut into slices. These slices are transferred into cans containing hot syrup, juice and water. Pears and peaches are highly acidic in nature, which may accelerate the dissolution of tin from inner coating of the container. It can be seen that pears packed in tin-coated can had maximum amount of tin (160.44 mg/kg). Other fruits under investigation also show similar high content. This may be probably due to poor lacquered coating and acidic corrosion reaction of fruit syrup on the metal container. The presence of sugar might have accelerated the corrosion reaction to leach out tin into the product. The enzymes from ripe mango and pineapple may show catalytic effect on coating. In either case the amount of tin in the product is likely to be abnormally high, though it is less than the maximum permissible limits reported by PFA Act 1954[4]. Mahadeviah has reported[5] similar values for few selected fruit jams in tinplated cans.

Canned vegetables: The vegetables are removed from pods by mobile viners in the field. The separated green peas, carrots and mushrooms are transferred with minimum delay for canning after washing and blanching. Cans are filled with peas, carrots and mushrooms with hot, slightly sweetened and salted brine solution. The cans are closed and generally retorted. Tin content in these products

averages to 132.02, 147.32 and 85.32mg/kg respectively. Srivatsa *et al.*[6] have reported no leaching of metal in the product if mushrooms are stored at low temperautre in the aluminum container. However, the amount of tin found in the processed peas, carrots and mushrooms may be attributed to the presence of sugar and salt in the liquid portion which catalyzes the leaching process of tin in the food products.

Canned tomatoes: The product will be derived form fresh and fully ripe tomatoes, free from insect and fungal attack or any other blemish affecting the quality of the fruits. The canning industries produce canned tomato juice, soup, sauce, paste and puree. Good harvested fruits are transferred to canneries for further processing. The processing involves various steps in sequence, like hot-break, equipment for chopping and healing, preventing undesirable enzyme activity. Large vacuum evaporators can remove the water. The concentrate is converted to tomato puree after blending with salt, sugar and spices. Finally, these products are filled in the can, closed and heat processed in rotary retort. Tin may have passage into canned tomato products through the various stages given above.

The typical taste and aesthetic appearance of the product in tin-plated cans may be affected. However, plain tin cans are preferred for packaging of food products at pH 4.0–5.0. The reaction of fruits and vegetables with the tinplated container may lead to bulging of the can known as hydrogen swell. Also, corrosion reaction is accelerated by constituents of the products and ingredients used in processing[7]. Coating the container with suitable lacquer can minimize the rate of corrosion reaction. Container coating protects the metal from content, prevents contamination of the product by metal ions, facilitates production, acts as a barrier to external corrosion, as a base for decoration, and prevents tin and iron sulfide staining, tin dissolution, acid attack and hydrogen ion evolution and staining of natural colorant. Various coatings of synthetic resins like epoxy phenolic lacquers, vinyl lacquers and phenolic lacquers can meet these requirements. The results of analysis of food products shown in nutrient profile relate the nutrient in the food to the RDA for various age group persons.

Literature survey reveals that maximum daily intake is provisionally set to 2 mg/kg body weight[8]. The excessive tin content in food may cause acute gastric irritation and hence it is advisable not to store fruit-based beverages in open tin-plated cans.

The health of the consumer of canned foodstuff is degraded in presence of foreign matter. It occurs if the package is not sufficiently impermeable. The foodstuff deteriorates because of insufficient protection from temperature changes and physical stress. Metal cans cannot provide such protection. The food product may deteriorate due to its interaction with packaging especially when acidic foodstuffs attack the lacquered can or when a metal like tin migrates and dissolves in the product.

From this study it is evident that amount of tin ions varies considerably in various processed fruits and vegetables. These variations are due to either variation in the recipe, as a result of contamination due to processings or as a result of interaction with packaging material. However, in selected canned fruits and vegetables the content of tin remains below the permissible limit even after

1-year storage under different annual climatic conditions. Besides the toxic effect of tin metal, it may affect the flavour and appearance of the final product. It is therefore essential that as far as possible fresh fruits and vegetables may be consumed. However, need-best quality well-lacquered tin cans with smaller size and good headspace can be used to ensure the safety and stability fruits and vegetables.

Conclusion

- Different varieties of canned fruits have tin content below optimum level.
- In spite of various official sources of contamination, canned fruits are free from tin toxicity.
- Metal packaging with tin containers requires appropriate lacquering to prevent leaching of tin.
- Smaller size of container is preferred for packing fresh fruits.
- Metal packaging has several advantages over other packaging materials.

REFERENCES

1. O.P. Beerh, J.K. Manan, S.K. Berry and G.J. Joshi, *Indian Food Packer,* **12** (Jan-Feb 1990).
2. *Packaging India*, **32,** 17 (2000).
3. Modern Food Packaging, 1st Edn., Indian Institute of Packaging, p. 312 (1998)
4. PFA Bare Act 1954, 2nd Edn., Akalnik Publication, p. 254 (1999).
5. M. Mahadevaiah, *Indian Food Packer*, **43** (Mar-Apr 1998).
6. A.N. Srivasta, A. Ramakrishana, V.K. Gopinathan, S. Nataraju and R.K. Leela, *J. Food Sci. Technol.*, **30,** 429 (1993).
7. A. Powari, M. Mahadevaiah and R.V. Gowramma, *Indian Food Packer,* **33** (July-Aug. 1997).
8. Tin Plate in Packaging, 1st Edn., Indian Insttitute of Packaging, p. 500 (1996).

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