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Common Storage Materials Adopted for Non-perishable Food Items and Dangers of Toxin Seepage

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ABSTRACT Present study was undertaken to ascertain the common food storage materials adopted and effect of the metallic containers on the seepage of toxic contents in the stored food items. The study was conducted in two phases. In first phase, survey was conducted on randomly selected 80 homemakers to find out the commonly stored non-perishable food items and the type of containers used for their storing. In the second phase laboratory experiments were conducted to study the effect of metallic containers on toxic contents in food stored. The maximum period of storage of food items was taken as 60 days. For the purpose of laboratory experiments five food items (*suji*, milk powder, *garam masala*, *gur*, *desi ghee*) and stainless steel containers were selected. It was observed that all selected food items that is, *suji*, milk powder, *garam masala* and *desi ghee* were having chromium contents more than the permissible limits. Maximum increase in chromium content was found in milk powder stored in stainless steel and minimum increase was found in *garam masala* when stored in stainless steel.

INTRODUCTION

In recent years human beings as awakened and alert consumers have placed increased emphasis on food safety, reason being the emergence of new types of serious illnesses. Today's conscious consumer expects that food should not contribute to any food borne disease or chronic disease such as cancer, heart disease, diabetes etc. Food safety means any edible item which is fit for human consumption should not have any harmful affect on the human beings (Potter and Hotchkiss 2006). The quality of food depends not only on its original state but also on the extent of the changes during processing and storage. The influences of different variables, such as temperature, time, light, water activity etc. on the stability of the product have been reported in many studies. The aim of such studies has been to establish the best storage and preservation conditions for extending shelf life of the food product especially the non-perishable food products, while preserving nutritional and sensory characteristics (Vijayalakshmi and Murugesan 2001).

Niazi (2001) reported that heavy metals act as a catalyst which increases the production of free radicals, which can lead to cancer, heart, liver and kidney diseases, so prolonged exposure to food stuff should be avoided. Anon (2003) concluded from his research that we should use only high quality non-porous stainless steel for maximum safety and avoid coated vessels as these have chemicals and metals can also deposit in the food.

For thermally processed food, market presented variety of containers other than the traditional ones. All common packaging material: board, glass and plastics as well as metal are now represented and the most recent entry as food storage containers is of plastics. Other major packaging formats for ambient, stable moist/liquid products are the board/foil laminated tetra-pack and comb bloc containers mostly for the fruit juices and for dairy products. Market also has the glass as well as plastic containers (Goddard 1994) for food storage.

All investments to produce large quantity of food go waste, if we cannot ensure the safety of foods from hazards. Good appearance (color, shape, size etc), texture and flavour are of no use unless the food is free from deleterious substances. Most of the safety factors unlike other quality factors cannot be assessed from outside. There are serious problems and increasing threats to food safety in developing countries (Sandhu et al. 2009).

According to Jood and Khetarpal (2002), non-perishable foods have very low moisture content. They are mature food grains, cereals, pulses, nuts and are not easily susceptible to spoilage by microorganisms and enzymes. It is a general observation that Indian housewives are in the habit of procuring non-perishable food items in plenty and store it for months/years together. Even farm households

store their farm produce in bulk for their future use, without realizing the toxic contents and its ill effects on the human beings. To educate them on safe food storage practices, it is important to have some authentic data.

Therefore, there is a need to know the effect of metallic containers on non-perishable food items. Hence, the present study was planned with following specific objectives:

- To study the food storage materials for non-perishable items adopted by the selected families.
- To analyse the seepage of toxic content in food items stored in the selected containers.

METHODS AND MATERIALS

The present study was conducted in two localities of Ludhiana city in the year 2009. An interview schedule was prepared, pretested and finalized for data collection. The data were collected by personally interviewing the eighty (forty each from selected two localities) homemakers through the specially structured interview schedule. Homemakers were asked about the type of containers used for storage of different selected food items and the preference for type of material selected for storage of non-perishable food items. On the basis of the household survey, the most common non-perishable food items stored and the type of containers used for storing these food items, were selected for laboratory experiments. For the purpose of laboratory experiments five food items of different food groups (*suji*, milk powder, *garam masala, gur, desi ghee*) and stainless steel containers were selected to see the seepage of chromium in the stored food.

A 15 gm sample of fresh as well as stored food items was taken in petri-dishes. Storage period decided was maximum 60 days for all selected non- perishable food items. Each sample was dried in hot air oven for 48 hours at 70^0C. After drying, samples were again weighed to know the moisture content in the food. Wet digestion of the dried samples was done to make a clear solution (Piper 1950). Nitric acid and perchloric acid of analytic reagent (AR) grade were mixed in the ratio of 5:1. Food samples (0.5 g) were digested with 25 ml of diacid mixture in conical flasks (250 ml) and kept overnight. These were heated at low temperature until about 1 ml of clear and colourless liquid was left, which was then transferred with deionized water into a 25 ml volumetric flask. Double beam Atomic Absorption Spectrophotometer, with automatic background correction was employed. The analysis was carried out using hollow cathode lamp of respective metallic element under standard instrumental operational conditions. For chromium detection air acetylene was used as a fuel. The experimental research was carried out in Punjab Agricultural University, Ludhiana.

RESULTS AND DISCUSSION

Material of the Containers Used to Store Cereals and Pulses: Through perusal of Table 1 it is clear that the stainless steel containers were the most preferred containers to store different cereals and pulses. Wheat was found to be the only cereal which was stored in aluminum container by maximum number of the respondents that is, 83.75 per cent followed by 16.25 per cent respondents who were found using stainless steel container. None of the respondents stored wheat in any other container. Different pulses were also stored either in stainless steel or in ordinary plastic. Tejinder (1985) reported that general practice of storing wheat, rice and maize was in iron bins in urban areas and jute bags and earthen pots were used in rural areas.

Regarding *suji,* 45.00 per cent respondents were found in practice of storing it in stainless steel, followed by ordinary plastic i.e. 30.00 per cent. The use of food grade plastic container and glass containers was found to be very less i.e. 11.25 per cent and 8.75 per cent respectively.

Material of the Containers Used to Store Spices: Table 2 highlights the information related to material of containers used to store spices. It shows that majority of the respondents used stainless steel to store spices followed by the ordinary plastic container, food grade plastic and glass. Very few responses were recorded for aluminum to store spices. Majority of the respondents (58.75%) used stainless steel, 36.25 per cent used ordinary plastic, 17.50 per cent used glass and 5.00 per cent used food grade/ branded plastic containers to store *garam masala*. None of the respondents used aluminum containers for storing

Table 1: Material of the containers used to store cereals and pulses n = 80

Food items	*Material*				
	Ordinary plastic	*Stainless steel*	*Aluminum*	*Glass*	*Food grade/ branded plastic*
Wheat	0 (0.00)	13(16.25)	67(83.75)	0 (0.00)	0 (0.00)
Wheat flour*	0 (0.00)	53(66.25)	44(55.00)	0 (0.00)	0 (0.00)
Rice*	25(31.25)	40(50.00)	18(22.50)	0 (0.00)	4 (5.00)
*Besan**	24(30.00)	42(52.50)	6 (7.50)	6 (7.50)	12(15.00)
*Maida**	3 (3.75)	45(56.25)	22(27.50)	12(15.00)	10(12.50)
*Suji**	24(30.00)	36(45.00)	11(13.75)	7 (8.75)	9(11.25)
Maize flour	13(16.25)	44(55.00)	11(13.75)	0 (0.00)	12(15.00)
Washed pulses	23(28.75)	42(52.50)	2 (2.50)	0 (0.00)	13(16.75)
Whole pulses	23(28.75)	42(52.50)	2 (2.50)	0 (0.00)	13(16.75)
Broken pulses	23(28.75)	42(52.50)	2 (2.50)	0 (0.00)	13(16.75)
Dalia	25(31.25)	35(43.75)	2 (2.50)	8(10.00)	10(12.50)
Breakfast cereals	23(28.75)	44(55.00)	1 (1.25)	0 (0.00)	12(15.00)
Sewian	5 (6.25)	50(62.50)	8(10.00)	11(13.75)	6 (7.50)
Poha	18(22.50)	30(37.50)	6 (7.50)	16(20.00)	10(12.50)

Figures in parentheses indicate percentages
* Multiple responses

garam masala. Regarding other frequently used spices, in Indian cooking, stainless steel were the most common containers followed by ordinary plastic containers. Use of aluminum was seen to be the least.

Material of the Containers Used to Store Sweeteners: The information regarding the material used to store sweeteners is shown in Table 3. Table shows that majority of the respondents used stainless steel to store sweeteners followed by food grade/ branded plastic containers, glass, aluminum and ordinary plastic containers. In case of *gur* also most of the respondents (62.50%) used stainless steel containers. The least used containers to store *gur/ shakkar* were found to be ordinary plastic that is, by 18.75 per cent of the selected families. In general, more than one type of containers were used for storing different selected sweeteners by the respondents.

Material of the Containers Used to Store Fats and Oils: Table 4 highlights the materials used to store fats and oils. Results showed that in case of *desi ghee* and mustard oil, the respondents were in practice of storing the same in all different types of containers. For storing refined oil, stainless steel bins was used by 80.00 per cent respondents followed by ordinary plastic (16.25 %). In case of olive oil, only 52 respondents among the selected sample purchased olive oil. Among these, 42.31 per cent respondents used to store it in glass and remaining 57.69 per cent stored it in its original packing. For *desi ghee*, 35.00 per cent respondents used food grade plastic, 28.75 per cent used glass, 27.50 per cent respondents used ordinary plas-

Table 2: Material of the containers used to store spices n = 80

Food items	*Material*				
	Ordinary plastic	*Stainless steel*	*Aluminum*	*Glass*	*Food grade/ branded plastic*
Jeera whole*	24(30.00)	22(27.50)	14(17.50)	18(22.50)	24(30.00)
Jeera powder*	18(22.50)	40(50.00)	2 (2.50)	22(27.50)	20(25.00)
Dhania whole*	24(30.00)	54(67.50)	2 (2.50)	0 (0.00)	0 (0.00)
Dhania powder*	18(22.50)	40(50.00)	2 (2.50)	22(27.50)	20(25.00)
Mustard seeds*	40(50.00)	32(40.00)	1 (1.25)	20(25.00)	8(10.00)
*Kasuri methi**	32(40.00)	51(63.75)	0 (0.00)	0 (0.00)	2 (2.50)
*Garam masala**	29(36.25)	47(58.75)	0 (0.00)	14(17.50)	4 (5.00)
Turmeric powder*	18(22.50)	42(52.50)	0 (0.00)	22(27.50)	20(25.00)
Mango powder*	18(22.50)	42(52.50)	0 (0.00)	22(27.50)	20(25.00)

Figures in parentheses indicate percentages
* Multiple responses

Table 3: Material of the containers used to store sweeteners n = 80

Food items	*Material*				
	Ordinary plastic	*Stainless steel*	*Aluminum*	*Glass*	*Food grade/ branded plastic*
Sugar*	12(15.00)	55(68.75)	20(25.00)	21(26.25)	29(36.25)
*Gur/shakkar**	15(18.75)	50(62.50)	20(25.00)	22(27.50)	30(37.50)
*Mishri**	22(27.50)	40(50.00)	20(25.00)	22(27.50)	24(30.00)
Sugar cubes*	14(17.50)	40(50.00)	20(25.00)	22(27.50)	24(30.00)

Figures in parentheses indicate percentages
* Multiple responses

Table 4: Material of the containers used to store fats and oils n = 80

Food items	*Material*				
	Ordinary plastic	*Stainless steel*	*Aluminum*	*Glass*	*Food grade/ branded plastic*
Refined oil*	13(16.25)	80(100.00)	0(0.00)	0 (0.00)	0 (0.00)
*Desi ghee**	22(27.50)	80(100.00)	5(6.25)	23(28.75)	28(35.00)
Mustard oil*	22(27.50)	80(100.00)	2(2.50)	22(27.50)	0 (0.00)
Olive oil	0 (0.00)	0 (0.00)	0(0.00)	22(42.31)**	0 (0.00)

Figures in parentheses indicate percentages
* Multiple responses ** Total response was 52

tic containers and only 6.25 per cent used aluminum bins to store it other than the stainless steel containers for which response was found to be 100 per cent.

Material of the Containers Used to Store Other Non-perishable Food Items: Table 5 depicts the information regarding the type of different material containers used to store different snacks, beverages, preserved food and milk powder. As far as snacks were concerned, maximum 60.00 per cent respondents used stainless steel for storage followed by ordinary plastic 37.50 per cent, food grade/branded plastic 35.00 per cent of the selected sample. Only 1.25 per cent respondents were found in practice of using aluminum container for its storage.

Beverages were found to be stored in glass, that is, its original packing in most of the cases by all the respondents. Though 57.50 per cent used food grade/branded plastics too. None of the family stored any beverages in stainless steel or in aluminum containers. These findings are in line with the results reported by Goddard (1994) who reported that fruit juices are stored in tetra pack or in glass jars.

Hundred per cent respondents stored different preserved foods in glass. The uses of food grade/branded plastic, ordinary plastic and stainless steel was 17.50 per cent, 15.00 per cent and 10.00 per cent respectively. None of the homemaker was found to store preserved food in aluminum containers.

As far as milk powder was concerned it is very much clear from Table 5 that containers of different types of materials were used for storage milk powder by selected respondents. Maximum number of respondents, that is, 30.00

Table 5: Material of the containers used to store other non-perishable food items n = 80

Food items	*Material*				
	Ordinary plastic	*Stainless steel*	*Aluminum*	*Glass*	*Food grade/ branded plastic*
Snacks*	30(37.50)	48(60.00)	1 (1.25)	8 (10.00)	28(35.00)
Beverages*	19(23.75)	0 (0.00)	0 (0.00)	80(100.00)	46(57.50)
Preserved foods*	12(15.00)	8(10.00)	0 (0.00)	80(100.00)	14(17.50)
Milk powder*	18(22.50)	24(30.00)	14(17.50)	6 (7.50)	18(22.50)

Figures in parentheses indicate percentages
* Multiple responses

per cent used stainless steel, 22.50 per cent respondents used ordinary and food grade plastic containers. Aluminum containers were also used by 17.50 per cent respondents and glass was used only by 7.50 per cent respondents for storing milk powder.

Ranks Given to Selected Containers: It may be observed from Table 6 that the most preferred container was branded/food grade plastic container with mean score 5.0 followed by stainless steel with mean score 4.0. As the life of plastic is comparatively more and these containers are durable so people preferred these. Otherwise also food stored in it is visible from outside that's why sale of these containers were found to be more. Because of the sale, shopkeepers also preferred to keep such containers in their shops. Table 6 further highlights that the least preferred material for containers was aluminum with mean score 1.0.

Table 6: Ranks given to selected containers by the respondents

Storage containers	*Mean score*	*Rank*
Branded plastic containers	5.00	I
Ordinary plastic containers	2.00	IV
Stainless steel	4.00	II
Aluminum containers	1.00	V
Glass jar	3.00	III

Laboratory Experiments

Laboratory experiments were conducted on stainless steel containers and five selected food items (*suji*, milk powder, *garam masala*, *gur* and *ghee*). The selected containers were of approximately similar in size. The results pertaining to the toxicity analysis experiments are presented as below.

Moisture Content: Table 7 shows the average moisture content in different selected non-perishable food items. Maximum per cent decrease of moisture was found in *suji* in both fresh and stored samples that is, 8.67 per cent and 12.67 per cent respectively. Minimum per cent decrease was observed in *gur.*

Chromium Content in Food Samples: Table 8 shows the chromium content in selected food items (*suji*, milk powder, *garam masala*, *gur* and *desi ghee*) stored in steel containers. The storage period of all food samples was maximum 60 days (2 months). Results indicate the per cent increase of chromium content in all selected food items. Maximum per cent increase of chromium content was found in milk powder (749.10 %) and minimum increase was found in *garam masala* that is, 90.16 per cent. Results showed that in fresh sample and after the storage of 60 days the chromium content in *suji* was increased from 0.54 mg/ 100 gm to 2.45 mg/ 100gm, milk powder from 0.11 mg/ 100 gm to 0.95 mg/100gm, *garam masala* from 0.25 mg/ 100 gm to 0.48 mg/100gm, *gur/ shakkar* from 0.30 mg/ 100 gm to 0.65 mg/ 100gm and *desi ghee* from 0.36 mg/ 100 gm to 1.20 mg/100gm. These findings are in line with Bhutani et al. (2007) who also reported that in food cooked in stainless steel skillets, the chromium content further increased drastically. To compare these results whether they are within the permissible limits or not, the results were compared with the permissible limits given by International body named 'Alimentarius CODEX'.

Table 7: Average moisture content in selected food samples

Food items	*Fresh*		*After 60 days*	
	Average	*Percentage*	*Average*	*Percentage*
Suji	1.3	8.67	1.9	12.67
Milk powder	0.1	0.67	0.3	2
Garam masala	0.6	4	0.9	6
Gur	0	0	0.1	0.67

Table 8: Chromium content in selected food items stored in steel container per 100 gm

Food items	*Chromium (mg/100 gm)*		
	Fresh food samples	*After 60 days*	*% increase*
Suji	0.54	2.45	348.72
Milk powder	0.11	0.95	749.10
Garam masala	0.25	0.48	90.16
Gur	0.30	0.65	115.57
Ghee	0.36	1.20	235.84
Permissible limits	0.05-0.20 mg/day		

Except milk powder sample, all the samples of fresh food items selected were already having chromium more than the permissible limit. Regular consumption of such foods can lead to incurable diseases especially if the trace elements start depositing in the human body.

Prasad et al. (1995) reported that chromium can cause cancer, paralysis, gastroenteritis and heart failure in human being. The ingesting of the large amount of chromium can be harmful and it can act as cancer causing agent (Dhaliwal 2005).

CONCLUSION

It can be concluded that to store different non-perishable food items ordinary plastic, stainless steel, aluminum, glass and food grade/ branded plastic containers were commonly used by the respondents. It was also concluded that the seepage of chromium, a heavy metal, was quite high in the food stored in metallic containers. It is recommended that food items that are to be stored in small quantity especially spices, milk and milk product, sweeteners, pulses etc. must be stored in glass jars or in food grade plastics.

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