Chapter **8**

PACKAGING ASPECTS OF DRINKING WATER

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Water is most important human need next only to air. It is required for the assimilation of nutrients from our food. Water is used in the body as building material in making of cells and tissues. It is used as solvent to carry nutrients to the cells and to detoxify the system by removing waste products of metabolism out of cells. In digestive process, water aids in mastification and softening of foods, facilitates movement of food in the gastrointestinal tract and absorption of digested products from the intestine. Water acts as lubricant in joints and between internal organs and as a temperature regulator by removing heat from the body. Water is also an important source of minerals. Daily requirement of water is suggested as 1 ml per calorie of food. Thus 5-6 glasses of fluids should be consumed daily as water or in the form of beverage. The requirement for water is increasing due to increase in population. Thus water being the most important need, it should be made available in uncontaminated form for human consumption. A safe and dependable supply of drinking water has become critical for the health of all human beings. The availability of safe and reliable source of water is thus an essential requirement for the establishment of all eco-systems and human beings. Because of the excessiveness/deficiency in certain mineral content of water flowing on different water beds on earth and also due to the pollution, the water from natural sources must be treated before they are consumed.

Specifications for Drinking Water

Both the PFA Act and BIS state that the water must be completely free of bacteria such as salmonella, E. coli, Faecal streptococci, V.Cholera and other bacteria, which are likely to cause disease and also free from harmful heavy metals such as lead, mercury, arsenic, aluminium, barium, etc., which may affect health. All water found in natural sources does contain minerals such as magnesium, calcium, sodium and other salts and which present in right mix add taste and have nutritional value. In US, the FDA rules stipulate that to qualify as mineral water, it has to contain a minimum of 250 mg per litre (mg/l) of such Total Dissolved Solids as these are classified. In India, the PFA Act and BIS mention only the maximum as 1,500 mg/l and do not

specify a minimum. The drinking water should conform to the specifications with respect to appearance, individual mineral content, pesticide residues and microbial contamination. Therefore, water supplied for drinking needs to be treated.

Treatment of Water Before Packaging

Before ready for consumption, water should undergo treatment to make it drinkable. The treatment steps involve collection of water from sources like well, river, springs, glacial melts, etc. This water is aerated to remove volatile organics, methane, hydrogen sulfide. Further, the aerated water is filtered with the aid of activated carbon / sand, etc., to remove solids, odour, coarse materials, iron, sulfur, etc. Then it is demineralised using water softeners / deionizers / distiller / cation, anion or mixed bed filters to remove minerals, pathogens and so on. Then minerals are added in required proportions to improve the taste, mineral and chemical composition. This water is again purified by ozonation at a level of 0.4 –0.6 ppm, uv radiation to kill bacteria, parasites and viruses. It is also carbonated to lower pH to kill bacteria and finally this purified product is made ready for distribution.

Storage and Transportation of Drinking Water

Normally, the source of water will be at a lower level. It has to be pumped to a higher level and transported through huge metal pipes for public distribution system. Metal / plastic pipes are being used to transport water for domestic purposes. At various storages, water is generally stored in huge cement tanks / sumps and overhead tanks for public distribution systems, industrial and domestic purposes and restaurants. Now a days epoxy coated tanks, polyester and HDPE tanks are becoming popular. In kitchen also, water is stored in metal / plastic pots, cans, bottles, jugs, etc. The container meant for packing drinking / mineral water should not impart any of its toxic components that affect the safety and quality of the packed water. Therefore, the container should be sterile, hygienic, colourless, transparent, taint proof and pilfer proof. Metal containers and enameled containers which are rusty due to chipping are unfit for storage of drinking water as per PFA Rules 1955. As per the latest version of EC Directive (98 / 83 / EC)(4), the odour and taste of water stored in the container shall be acceptable to consumers and no abnormal change should be perceived. The odour and flavour requirements shall also apply to hoses and laminate / composite pipes assessed in accordance with BS 6920-2.2.2. The above standard also prescribes the method to evaluate the stored water for the appearance (colour), extracted metals from the contact material, odour, etc.

Plastic Packaging Materials for Packing Water

Due to the non-availability of safe water, packaged mineral / drinking water other than mineral water as specified by its components is becoming popular. Mineral water includes all kinds of mineral water or natural mineral water by whatever name it is called and sold. Natural mineral water is water clearly distinguished from ordinary drinking water as it is characterized by its content of certain mineral salts and their relative

Fig. 8.1. PET bottles of various brands of mineral water

proportions and the presence of trace elements or of other constituents (PFA Rules 1955). Packaged drinking water shall be potable water or treated potable water other than natural mineral water, that is hermetically sealed in bottles or other packages and is intended for human consumption. Earlier, bottled water was available in only glass bottles which are quite inert but fragile and heavy. Presently, due to the logistic advantages like light weight, good barrier properties, strength properties, availability in different shapes, colours, sizes, etc, and cost effectiveness, different types of plastic containers such as polyethylene, polypropylene, poly vinyl chloride, polyethylene terephthalate and polycarbonate in different forms such as pouches, cans, pots, drums, bottles, etc are being used for storage and distribution of drinking water. PVC tubes are becoming popular for transportation of drinking water. Today, roughly 1.5 million tons of plastics are used world-wide to pack water.

All the plastic containers used for packing potable / drinking water shall conform to IS 15410-2003. Water shall be packed in clean, sterile, colourless, transparent and tamperproof bottles/ containers made of polyethylene (PE) conforming to IS:10146 or polyvinyl chloride (PVC) conforming to IS:10151 or polyalkylene terephthalate (PET and PBT) conforming to IS:12252 or polypropylene conforming to IS:10910 or food grade polycarbonate or sterile glass bottles suitable for preventing possible adulteration or contamination of the water. All packaging materials of plastic origin shall pass the overall migration and colour migration limits as laid down in the relevant national and international standards for products for respective packaging materials

Fig. 8.2. PET containers for drinking water

Studies at CFTRI on the Evaluation of Plastics for their Safe Use in Contact with Drinking Water

In CFTRI, plastic materials like PE, PP, PVC, PET and PC materials in various forms used for contact with drinking/potable water and beverages have been evaluated for their safe use in contact with drinking water by global migration tests with distilled water as food simulant at 40º C /10 days as per IS 9845-1998. All the materials tested had overall migration values far below the safety limit of 10 mg/dm^2 and 60 ppm as specified by BIS. The results of these evaluated plastics are shown in Table 8.1. This safety limit has been arrived based on toxicological studies. When migration data was analysed using Duncan's new multiple range test to find the difference amongst different plastics, no significant difference was observed between the five categories of plastic materials tested ($P < 0.05$) indicating that all the tested plastic materials manufactured in the country pass the migration test for contact with water.

Fig. 8.3. Polyethylene materials for contact with drinking water

LDPE/LLDPE is widely used for packing of potable water in 200 ml pouches for serving during travelling. Pouches made up of LDPE laminated with PET are used for packing water for army. Because of its heat sealability, PE will invariably be the food contact layer. Cling films and PE coated papers are being used to pack fresh fruits and vegetables that contain high amount of water. This water may act as a carrier of migrants to the food. White pigmented multilayer PE films being used for milk packaging needs to be tested for safety in food packaging. Because of its softness, the usage of PE as bottle is very rare. But this property renders it highly suitable for saline/glucose bottles given as drips for patients. LDPE/LLDPE are also used as lids for bottles. Because of poor impact strength, HDPE film is not recommended for liquids. However they were tested for suitability of food products which contain free water. The maximum application of HDPE in liquid packaging is as closure for bottles (drinking water or pharmaceutical syrups). Except blue closures all had very low migration values. However the values for the blue closures were also well within the safety limits. Other application of (HM)HDPE is as water pipes and as drums to store potable water. HDPE imparts waxy odour to water but running water in pipes or storing water and replacing them by fresh water 3-4 times reduces the taint

Table 8.1. Global migration values from plastic packaging materials into distilled water at 40 °C / 10 days

Packaging materials	mg/dm^2	ppm
LDPE,LLDPE films, 25–60 µm (10 samples)	0.28-0.72	2.70-7.20
PE coated paper (2 samples)	0.36, 0.71	3.20, 7.10
Multilayered expanded PE sheets	0.58	0.02
90 micron PET / poly film (4 samples)	0.18-0.65	1.80-6.50
LDPE bottles	0.65	3.70
White LLDPE closures for bottle	0.66	0.15
HDPE film, 25-50 µm (5 samples)	0.25-0.33	2.50-3.30
HDPE liners	0.62	6.20
HDPE closures for bottles (10 samples)	0.39-1.93	0.02-0.35
HDPE containers of 200 ml capacity	0.26	2.60
HMHDPE drum with lid	2.23	4.18
HDPE pipe	0.61	6.61
HDPE yarn	2.21	22.10
PP film, 37.5-50 µm (4 samples)	0.26-0.51	2.06-5.10
PP tumbler, bowls and cups (6 samples)	0.47-1.1	4.77- 15.3
PET bottle, 125 ml–1 litre capacity (20 samples)	0.30-1.1	3.30-15.3
Isophthalic polyester resin (2 samples)	0.44-0.66	4.00-6.00
PET jars, 30 litre capacity (4 samples)	0.42-0.52	0.95-1.03
PVC film, 25-100 µm (15 samples)	0.18-0.39	1.10-3.90
PVC tube (8 samples)	0.80-0.92	5.30-7.30
Limit as per IS: specifications on different plastics: 10 mg/dm^2 and 60 ppm		

problem. PP is another important plastic used in food packaging. As film, it is the contact layer in retort pouches. But its usage is more as tumblers, bowls and caps for potable water / beverage contact.

PET bottles of 200 ml, 500 ml, 750 ml, 1 litre and 2 litre capacities, 1.5 litre and 2 litre PET cans are being used for packing mineral water. They are ideally suited for the purpose. They have good impact strength and they neither impart taint nor allow packed water to pickup foreign odour. Also, 750 ml, 500 ml and 200 ml PET bottles are being used for soft drinks. Because of its excellent clarity and flavour barrier property, PET is replacing glass bottles in packing pharmaceutical syrups. Bottles 125 ml and 200 ml capacity are meant for this. PET along with poly-carbonate jar are also being used for bulk storage of mineral water. Because of the above advantages, glass fibre reinforced and cross-linked PET tanks are used to

store water of 1,000 litre and above capacities.

With added plasticizer, PVC tubes are more flexible and can be handled easily. So they find their application as hose pipes. Even though the global migration values are below the critical limit, the water stored in PVC bottles had off odour. This could be perhaps due to the migration of heat stabilizer. Because of poor impact strength, PVC bottles did not last long in the market. Apart from migration tests, PVC needs to be tested for vinyl chloride monomer content which is a known carcinogen. The prescribed limit for VCM as per BIS specification is 1 ppm in the PVC material and 10 ppb in the food packed in it. PET bottles, due to their reduced cost and better performance properties, have almost replaced PVC as water bottles.

Labeling for Water Containers

As per PFA Rules 1955, every package of drinking water and mineral water shall carry the declaration "PACKAGED DRINKING WATER" and "NATURAL MINERAL WATER" respectively in capital letters having the size of each letters as prescribed in Rule 36. One time usable plastic bottles of packaged drinking water / mineral water shall be labeled as "CRUSH THE BOTTLE AFTER USE"

As per US-FDA also, definite particulars of the source of water, the percentage of salts and minerals present in it should be labeled on the bottle.

No claims concerning medicinal (preventative, alleviative or curative) effects shall be made in respect of the properties of the product covered by the standard. Claims of other beneficial effects related to the health of the consumer shall not made.

The name of the locality, hamlet or specified place may not form part of the trade name unless it refers to packaged water collected at the place designated by that trade name.

Conclusion

Water is the most important component in life and hence needs to be supplied to all human beings in uncontaminated form. Before it is consumed, it requires proper treatment, storage and packaging. Today drinking water is being packed in different types of plastic containers in various forms, sizes and shapes. But their safety needs to be evaluated for contact with drinking water. CFTRI has evaluated many such materials and found them conforming to the specifications.

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