THE USE OF WASTE PLASTICS FOR PLASTINATION OF ORGANIC MATERIALS AND IN CIVIL CONSTRUCTION MATERIALS

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ABSTRACT

Plastic teacups and thermocol play a major role in environmental pollution, hence proper recycling or disposal of these materials becomes most important. The Department of Anatomy has invented a new method of recycling these plastic teacups and thermocol, for the first time in the world, which can be used for the preservation of organs, especially of endangered species, cadavers, in veterinary, medical and other biological sciences. The organs are being traditionally preserved in formalin solution. This method has many disadvantages as formalin is an irritant to eyes, nose and throat and is also carcinogenic. The present method has many advantages – first being the recycling of environmental pollutants such as plastic teacups and thermocol, thus reducing the environmental pollution; the second advantage is, by reusing them as preservative, the organs and cadavers can be preserved in dry condition for teaching, research and museum purposes; and the third advantage is, leftover solution can be used to prepare bricks and to fill potholes. The western world is also preserving the biological specimens by using epoxy-resins and silicon, which is a very costly process and not affordable in developing countries. In order to overcome this, the present economical method of preservation is very useful.

Keywords: environmental pollution, plastic teacups, thermocol, biological specimen, preservation, bricks.

1 INTRODUCTION

Environmental pollutants play a major role in the public health. These pollutants are of different types such as air, water, industrial waste, gases and solid wastes. Amongst dry waste, plastic and thermocol play a major role. Bangalore city, Karnataka, India, alone produces nearly 1,700 to 5,000 metric tonnes of solid waste daily [1]–[5]. The Government is implementing many projects to recycle these waste products, but unable to do so completely. In the mean time we developed a novel technique to recycle the plastic teacups and thermocol by using an organic solvent to prepare a resinous solution which could be used for the dry preservation of biological specimens (plastination) and preparation of bricks. Traditionally biological specimens are preserved in formalin [6]–[9], which has health hazards, irritant to eye, carcinogenic, infective to lung and many more.

1.1 Toxicity of plastination chemicals

The chemicals used in the plastination technique are toxic ranging from mild to severe. Some can be toxic either in the liquid or gaseous form. Care should be taken while being exposed to these chemicals. In 2001 Holladay et al. [10] did a study and review on the chemicals such as silicone, epoxy, and polyester that is used in the plastination process. Plastination requires the handling of chemical agents not encountered by anatomic preparators. The silicone products commonly used contain poly-alkylsiloxane. A variety of adverse effects including skin hypersensitivity have been associated with these. Epoxy resins are well-known mucous membrane, skin and eye irritants and are also associated with allergic skin response. The structure of hydroxyl-terminated polydimethylsiloxane with (Si-O) represents a basic silicone molecule.

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The following first aid measures are indicated in case of contact with the polymers:

- Eye contact – rinse with water. Contact doctor immediately.
- Skin contact – mechanically remove product.
- On swallowing – seek medical assistance.

These chemicals should always be handled using proper protection, like industrial grade gloves, eye and face protection. It is always safe to work in an area having proper ventilation. But the procedure to establish such plants in Developing countries is not affordable. Therefore, a simple, cheap, and economical technique has been devised in the Department of Anatomy, Sapthagiri Institute of Medical Sciences and Research Center, Bangalore, Karnataka, India to prepare the biological specimens, which are almost similar to Western world specimens.

The plastic teacups, and thermocol which are harmful to the nature are made useful by making them one of the key ingredients in the low cost plastination technique. For years even though the role of plastics in environmental pollution was known, the technique of completely eradicating them is not in process.

In this background, the present work was undertaken for preserving the organs and efficient waste management.

2 MATERIALS AND METHODS

The plastic teacups and thermocol were procured from all the garbage collecting centers, various agencies, hotels, restaurants, local coffee/tea shops of the city.

The human body parts were procured from the dissected bodies after the completion of dissection and fresh animal visceral organs and limbs were procured from slaughter houses. Since these specimens are procured from the cadavers or from slaughter houses, this does not require any ethical committee approval. The organs will be processed for indigenous method of plastination which involves the following steps.

2.1 Collection and preparation of the specimens

Blood clots, unwanted tissues and fat were removed from the organs. The gall bladder was removed from the liver at the time of collection. The meninges and blood vessels of brains were removed to the possible extent; and limbs were dissected. All these organs and limbs were washed in running water.

2.2 Plastination of specimens

This process involves fixation, dehydration, impregnation and curing.

2.2.1 Fixation

After the preparation of the specimens, the organs were transferred to 5% Formal saline in separate containers for a period of two weeks except brain. The quantity of the fixative will be approximately more than 20 times the volume of the organ. Brains were infused with 20% formalin for two days and later submerged in 5% formol saline for 2 months before plastination [11].

2.2.2 Dehydration

This process was carried out using 100% acetone which is a dehydrating agent. After removing from the fixative, the fixed organs were washed thoroughly in running tap water, and placed on the horizontal plates to stabilize and maintain their shape. The specimens were

immersed for two weeks in each change of acetone at normal atmospheric pressure. Three changes of acetone were given. Percentage of dehydration at each change was assessed using acetonometer.

2.2.3 Impregnation

The organs which dehydrated under normal room temperature and normal atmospheric pressure were impregnated in a resin prepared by recycling plastic teacups and thermocol in an organic solvent at a concentration of 15% with equal quantities of teacups and thermocol with 500 gms of petroleum jelly for 10 liters of resin solution. The organs dehydrated were impregnated in indigenous plastination solution at normal atmospheric pressure. The organs which floated completely initially, sink into the plastination solution gradually indicating complete impregnation. The total time of impregnation will be 2–4 weeks. After impregnation, the excess resin was wiped from the organs and allowed them to dry. Once the organs were completely dry, they were cured using 5% touch wood twice at an interval of 2–3 days and dried in room temperature.

2.3 Histology

For histological evaluation, a small piece of tissue was collected from the plastinated specimens. This tissue was directly embedded in the paraffin; and blocks were prepared. Similarly, the tissue samples from fresh organs were collected, fixed in 5% formol saline, processed under routine method and paraffin blocks were prepared. The blocks from the plastinated tissues and normal tissues were cut at 5 μm thickness and stained by routine Hematoxylin and Eosin-Phloxine (H&E-Phloxine) method [12] and observed under trinocular microscope to justify the effect of plastination on the endangered and domestic animal tissue sections (Figs 1, 2). This study showed that plastinated specimens could also be used for histological study and the teacup and thermocol solution prepared from pollutants can act as a substitute for paraffin infiltration.

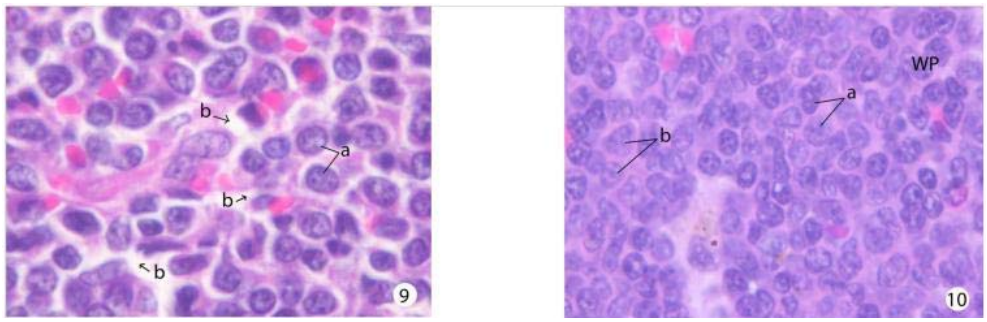

Figure 1: H&E-Phloxine X1000. (9) Photomicrograph of paraffin embedded spleen. Section of the spleen obtained from paraffin embedding technique showing (a) very good nuclear and cytoplasmic details; and (b) shrinkage induced separation of cell. (10) Photomicrograph of plastination embedded spleen. Section of the spleen obtained from plastination embedding technique showing (a) compact arrangement of lymphoid cells in white pulp, with (b) absence of clarity and sharpness in nuclear and cytoplasmic detail.

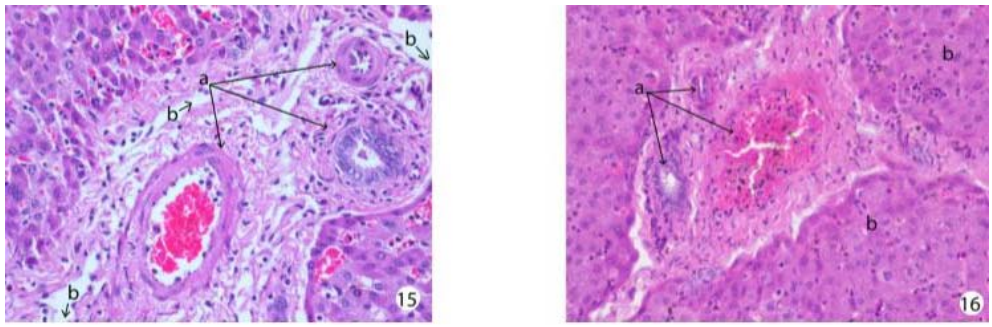

Figure 2: H&E-Phloxine X200. (15) Photomicrograph of paraffin embedded liver. Section of the liver obtained from paraffin embedding technique showing (a) portal triad, with (b) shrinkage induced separation of connective tissue fibers. (16) Photomicrograph of plastination embedded liver. Section of the liver obtained from plastination embedding technique showing (a) well maintained architecture of portal triad with minimum artifacts. However, note (b) poor cellular details and differential staining.

2.4 Civil construction material

The remaining plastination solution was used to prepare bricks, and the mixture was also used to fill the potholes. Cement, pebbles and granite powder was mixed in the ratio 1:2:2 respectively to prepare the mixture. To this powder, the plastination solution was added and mixed until it became more than a semisolid. This mixture was poured into a mould to make the brick and into the pothole and was left undisturbed for one or two days until it was dried.

3 RESULTS AND DISCUSSION

In this novel technique, the use of plastic teacups and thermocol which are considered to be hazardous to environment, have been used for the preservation of specimens.

The plastinated biological organs are environmentally friendly and can be used for education and research purpose (Fig. 3). Since these specimens are dry and easy to handle, they are student friendly in learning science. Similarly it will help in the preservation of extinct wild animal species.

Plastic and thermocol have been classified as thermoplastins and thermosettings. The thermoplastins, when heated become soft. They are soluble in organic solvents, examples being plastic teacups and thermocol, whereas thermosettings are not soluble in organic solvents, melt on heating, and become brittle. Ramakrishna et al. [13] used polyester resin (polyflex GR, 200-10) as impregnating material for the plastination of heart, kidney, uterus, uterine cotyledons, rumen, reticulum, omasum of buffalo calf and sorghum a cereal. The process was carried out under normal room temperature and normal atmospheric pressure. From the work it was found that, use of resin raised health concern by having pungent odour, irritating eyes and skin with burning sensations. Finally the procedure was discontinued.

In the western world the plastination work was started by von Hagens et al. [14] who used epoxy and S10 resin for plastination and S6 resin for curing.

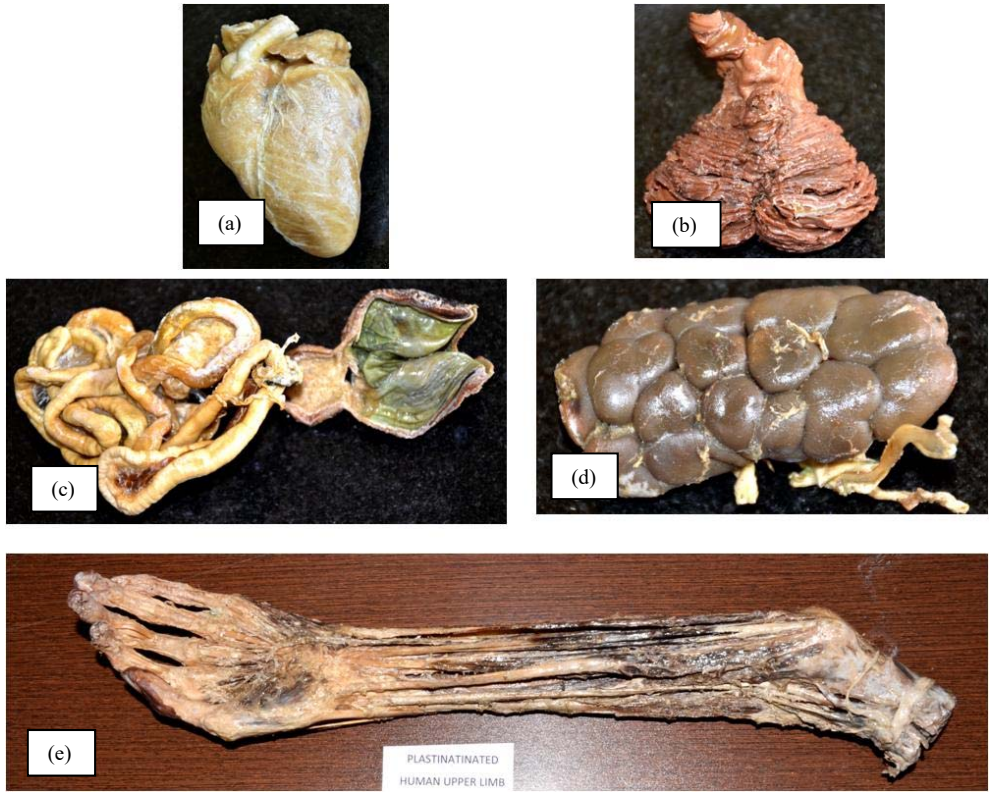

Figure 3: Whole organ plastinated specimens, which are prepared from the recycled pollutant materials (plastic teacups and thermocol). The organs from above downwards are: (a) Sheep heart; (b) Human cerebellum; (c) Chicken gizzard, proventriculus, and small intestine; (d) Buffalo kidney; and (E) Human forearm with hand.

Azian et al. [15] plastinated the brain and spinal cord under normal room temperature and assessed the quality with formalin fixed organs. They observed more shrinkage in plastinated organs. Similar shrinkage was seen by Mutturaj [16], who used plastination method using environmental pollutants such as plastic teacups and thermocol under normal room temperature and normal atmospheric pressure on various organs like kidney, liver, heart and brain. The method attempted was highly encouraging as far as the quality of the specimens was concerned, but hard to feel.

Smodlaka et al. [17] used North silicone polymer neat 285 or 295 for the impregnation process. Impregnation was carried out at room temperature. The resultant products were high quality specimens. The advantages of this method were, retention of the brightness of the organs, shortened impregnation time, less space for impregnation with ease of polymer drainage and manicuring. However, the quality of specimens produced, was less predictable according to them.

Ameko et al. [18] adopted plastination procedure under room temperature using locally available materials in Ghana. They studied that, the extent of shrinkage varied among the

various organs and among the various stages of plastination. For all the specimens, shrinkage occurred most at dehydration and least at fixation.

Suganthy and Deepak [19] studied the plastination using standard S-10 technique which yielded dry, odorless, durable plastination specimens which are used for prosection in the dissection hall and in the museum.

The resins used by the above authors have a very pungent smell, cause skin, eye irritation and burning. And also none of them used plastic teacups and thermocol to prepare resin.

There are two types of bricks; fired and non-fired bricks for house construction. The mud bricks are prepared with sand (silica), clay (alumina), lime, iron oxide, and magnesia baked in a furnace/kiln or air dried [20]. The concrete bricks or blocks are prepared with the cement, and crushed stone. In the present study there is no usage of sand and mud, and also the quantity of cement used is half the quantity used for the hollow bricks. At the same time the residual resin solution after the plastination process is used as a disposal for the preparation of cement bricks which is as strong as the other bricks. The same mixture used for filling the potholes has got longer life against mechanical pressure and rain than the usual method of using bitumen mixture (Fig. 4).

4 CONCLUSION

The plastinated specimens prepared were hard in texture and also there was shrinkage in the size of the specimens as compared to western technique. The technique is being improved to overcome these defects. The colour, morphology and the shape of the specimens were intact without any change.

Recycling of the plastic teacups and thermocol will contribute in controlling the environmental pollution to some extent. The reusage of left over resin after plastination for preparation of bricks helps in complete disposal of the plastics which is not observed in the literature.

Thus the above research will be most beneficial if it is implemented by the government or an industry, so that large amount of plastic and thermocol can be recycled and the following objectives could be achieved.

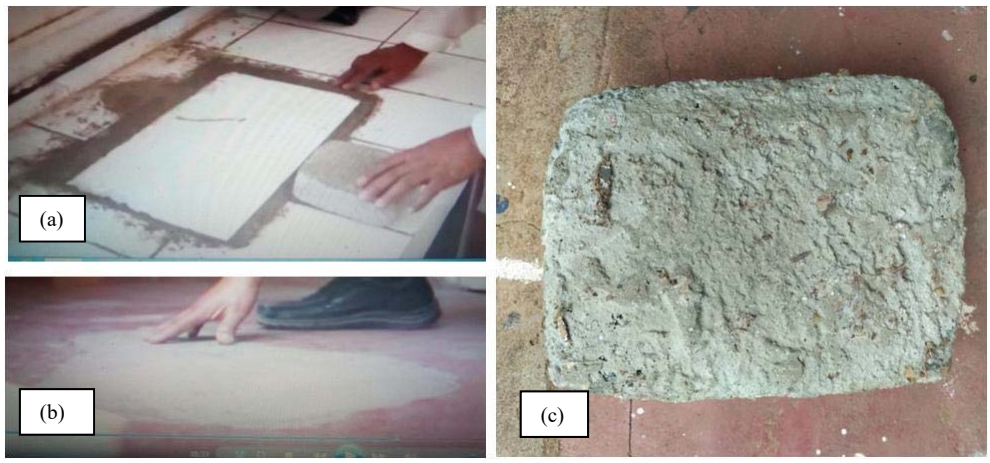

Figure 4: Uses of the mixture prepared with the remaining resin solution after plastinating the biological specimens. (a) Fixing of tile; (b) Pothole filled with the mixture; (c) Concrete brick.

- To mitigate the hazardous effects of hard to degrade plastics through their use as a specimen preservation material.
- In future, to develop a low-cost, non-toxic biological specimen preservation technique using environmental pollutants such as plastic bags, water bottles and pens.
- To reduce, and eventually eliminate the use of formalin with reduction in number of cadavers, a known carcinogen with several toxic effects, as a specimen preservation solution.
- To preserve the specimens of extinct species most effectively.
- To allow transport and long term-storage of preserved specimens at room temperature without the need for specialized containers, thereby eliminating cost associated with formalin purchase, exhaust hoods and containers.
- To prepare bricks and fill the potholes.

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