
Freezing Technique as a Non-Chemical Preservation and Conservation Method: A Study from NLIK

Sadhana Goswami

Research Scholar,
Department of Library & Information Science,
University of Science & Technology, Meghalaya
Email: sgoswamilib@gmail.com

Zabeen Ahmed

Professor,
Department of Library & Information Science,
University of Science & Technology, Meghalaya
Email: zabeen2015@gmail.com

Abstract

The preservation of manuscripts and rare materials is an important responsibility of libraries and archival institutions because these materials represent valuable historical, cultural, literary, religious, linguistic and intellectual heritage. Paper manuscripts and rare books are particularly vulnerable to biological deterioration caused by insects, mould and microorganisms. Freezing is a non-chemical preservation technique used to control biological activity and is particularly useful for selected materials affected by infestation or moisture-related deterioration. The present study examines the application of freezing as a non-chemical preservation method at the National Library of India, Kolkata (NLIK) and the outcomes. The study finds that freezing provides NLIK with an important alternative to chemical treatment for selected rare materials. However, its effective application requires careful material assessment, controlled conditions, appropriate packaging, trained personnel and follow-up inspection. Overall, freezing forms a valuable component of NLIK's integrated preservation and conservation programme.

Keywords

Freezing technique; Non-chemical Method;
Manuscripts; Rare material; Preservation; NLIK.

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1. Introduction

Manuscripts and rare books are valuable sources of historical, cultural, literary, religious, linguistic and intellectual heritage. As many of these materials are unique or available in limited numbers, their proper preservation is essential for ensuring long-term access to original resources. The National Library of India, Kolkata (NLIK), particularly its Rare Book Division (RBD), houses a diverse collection of manuscripts, rare books and other historically significant materials in various languages, scripts, formats and physical forms. These materials are vulnerable to deterioration caused by biological agents such as insects, mould, and other microorganisms, as well as environmental factors such as excessive moisture and high relative humidity. Chemical treatments have traditionally been used to control biological deterioration; however, concerns about chemical residues, toxicity, occupational safety, and potential effects on historic materials have encouraged the use of non-chemical preservation methods. Freezing is one such method that uses low temperature to control biological activity and can be applied to selected materials affected by insect infestation, mould or water-related deterioration (Setyawati, 2023; Sharma, 2022). It may also provide valuable time for the recovery and treatment of affected collections. However, freezing is not suitable for all types of materials and requires careful assessment before treatment. In this context, the present study examines the use of freezing as a non-chemical preservation technique at NLIK and considers its role in protecting and maintaining the physical condition of manuscripts and rare materials.

2. Methodology

The study adopted a survey-based approach supported by a review of relevant literature on the preservation and conservation of manuscripts and rare materials. Personal visits were made to the National Library of India, Kolkata (NLIK) to collect first-hand information. Primary data were gathered through personal interviews, direct observation, and examination of relevant institutional practices and records, providing practical information on the preservation and conservation of manuscripts and rare materials at NLIK.

3. Objectives of the Paper

- 3.1 To examine the use of the freezing technique as a non-chemical method for the preservation and

conservation of manuscripts and rare materials at the National Library of India, Kolkata (NLIK).

- 3.2 To examine the procedures, conditions and facilities involved in the application of freezing treatment for controlling biological deterioration of selected rare materials at NLIK.
- 3.3 To assess the significance, benefits and limitations of freezing as a component of NLIK's overall preservation and conservation practices for manuscripts and rare materials.

4. Identification and Classification of Manuscripts and Rare Materials at NLIK

As per the National Library of India, Kolkata (NLIK), unpublished handwritten documents preserved in the Rare Book Division, such as palm-leaf manuscripts, bark manuscripts, letters and diaries, are considered manuscripts. In contrast, published and printed materials, including books, periodicals, magazines, newspapers, monographs, religious texts, paintings, illustrations and Tibetan xylographs, are treated as rare materials. Books published or printed before 1860 are generally considered rare materials and are preserved in the Rare Book Division (RBD). One of the important criteria for inclusion in the Rare Book Division is the availability of Indian publications and printed works produced before 1860 (Fatima, 2021; Goswami & Ahmed, 2024). However, there is no fixed time limit for applying preservation measures to these materials. NLIK adopts and modifies its preservation practices and procedures as required according to the condition, nature and preservation needs of its manuscripts and rare materials.

5. Significance of Preservation and Conservation Practices

Preservation and conservation are essential for maintaining the physical condition and long-term accessibility of manuscripts and rare materials. Preservation aims to prevent or slow deterioration, while conservation focuses on stabilizing and protecting materials from existing or potential damage (Barbhuiya, 2021). Among the various approaches, freezing is a useful non-chemical technique for selected materials affected by biological deterioration, such as insects, mould and moisture-related problems. By using controlled low temperatures, it can help reduce biological activity without introducing chemical substances. However, proper material assessment, packaging, controlled

treatment conditions, trained personnel, cleaning and follow-up inspection are necessary. Thus, freezing can serve as an important component of an integrated preservation and conservation programme.

6. Factors Responsible for the Deterioration of Manuscripts and Rare Materials

Manuscripts and rare materials may deteriorate due to various physical, biological, chemical, environmental and human factors. Ageing gradually causes brittleness, discoloration and loss of strength, while biological agents such as insects, mould, microorganisms and rodents can cause significant damage. Chemical factors, including acidity and pollutants, may weaken or discolour materials. Environmental conditions such as unsuitable temperature, humidity, moisture, light, dust and water can accelerate deterioration. Natural and human-made disasters, including fire and floods, may cause severe damage. In addition, human factors, such as improper handling, careless use, inadequate storage and inappropriate repair practices, can further contribute to the deterioration of valuable collections (Ejiroghene, 2020; Fatima, 2021; Goswami & Ahmed, 2024).

7. Collection Profile of the Rare Book Division at the NLIK

The Rare Book Division (RBD) of the National Library of India, Kolkata (NLIK) preserves and provides access to manuscripts (MSS), rare materials for readers and research scholars within its designated reading room. Since these collections are of considerable historical and research value, materials housed in the RBD are not permitted to be removed from the division. The division therefore operates its own reader service and maintains continuous supervision to prevent the loss, mutilation or physical damage of materials during use. The NLIK holds an estimated 13,256 volumes of historically significant manuscripts and rare materials in various forms, including books, monographs, periodicals, newspapers, correspondence, diaries and Tibetan xylographs (Table 1 and Figure 1) (Fatima, 2021; Goswami & Ahmed, 2024). The detailed holdings of the Rare Book Division are presented below.

Table 1: Collection Profile of the Rare Book Division at the NLIK

language manuscripts, English and Bengali manuscripts form the largest category with 29.23%

SL. No.	Rare Materials (Printed Material)		Manuscripts (MSS)									
1	Books, Monographs, periodicals & Newspapers	Tibetan Xylographs	Special Language MSS				Special Persons Collection					
			English & Bengali	Arabic	Persian	Sanskrit	Jadunath Sarkar	Hidayat Hussain	Imambara	Zakaria		
2	5717	878	3875	467	485	827	206	15	140	45	351	250
Perc enta ge	43.13	6.62	29.23	3.52	3.66	6.24	1.55	0.11	1.06	0.34	2.65	1.89
Total	6595		5654				406				351	250
			6661									
GRAND TOTAL							13256					

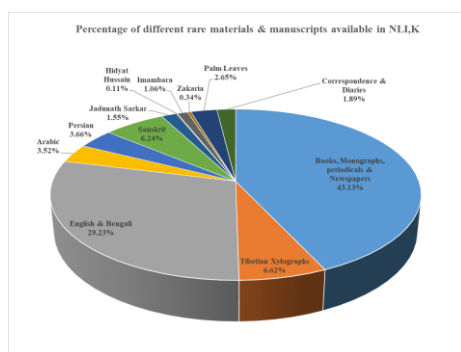


Figure-1: Percentage of different manuscripts and rare materials available in NLI, Kolkata

Table 1 and Figure 1 present the percentage distribution of different categories of manuscripts and rare materials preserved in the Rare Book Division of the National Library of India, Kolkata. The total collection comprises 13,256 items, including 6,595 rare printed materials and 6,661 manuscripts. Among the rare printed materials, Books, Monographs, Periodicals and Newspapers constitute the largest category, accounting for 43.13% (5,717 items) of the total holdings, while Tibetan Xylographs account for 6.62% (878 items). The manuscript collection is further divided into special language manuscripts, special-person collections, palm-leaf manuscripts, and correspondence and diaries. Within the special

(3,875 items), followed by Sanskrit manuscripts at

6.24% (827 items), Persian manuscripts at 3.66% (485 items) and Arabic manuscripts at 3.52% (467 items). The special-person collections include the Jadunath Sarkar Collection (1.55%), Imambara Collection (1.06%), Zakaria Collection (0.34%) and Hidayat Hussain Collection (0.11%). In addition, Palm-leaf manuscripts constitute 2.65% (351 items), while Correspondence and Diaries account for 1.89% (250 items). Overall, the distribution demonstrates the considerable diversity of the RBD collection in terms of format, language and provenance, with printed rare materials and English-Bengali manuscripts forming the major components of the holdings.

8. Preservation and Conservation Techniques Adopted by the NLIK:

The National Library of India, Kolkata (NLIK) uses following systematic preservation and conservation techniques (Table 2) to protect its manuscripts and rare materials from deterioration and damage:

Table 2: Main Preservation Techniques applied for Manuscripts and Rare Materials in the NLIK

Sl. No.	Techniques		Equipment	Work of equipment
1.	Digitization	Devices for the digitization of manuscripts and rare materials	Hybrid Camera (for scanning) (company: Zeutschel model name: OK 300)	This scanner includes delicate mechanical and electronic components. This hybrid camera scans NLIK's manuscripts and rare materials.
		Software used for Digitization	DSpace, an open-access software (Developer: The Massachusetts Institute of Technology (MIT) Libraries and Hewlett-Packard (HP) Labs)	NLIK digitises its manuscripts and rare materials using DSpace software. DSpace is a free and open-source repository software package that allows you to construct digital repositories for scholarly and published work. It organises, saves, and provides quick access to digital content in a variety of forms, including PDF, Word, JPEG, MPEG, and TIF.
		Storing media of digitized manuscripts and rare materials	In the Cloud server (provided by the National Virtual Library of India)	NLIK saves all digitised manuscripts and rare items on a cloud server supplied by the National Virtual Library of India (NVLI), which is accessible on demand to an infinite number of users.
			Hard disk	The fundamental purpose of a hard disk is to store files. NLIK keeps all digitised manuscripts and rare materials on their personal hard drive for convenient reading.
		Reading the digitized manuscripts and rare materials	Through website (Uploaded in the Ministry of Culture, Government of India)	NLIK uploaded the digitized manuscripts and rare materials on the website of the Ministry of Culture, Government of India. Readers can read the uploaded manuscripts and rare materials at https://indiaculture.gov.in . Going through the website Of the NLIK.
		Reading the digitized manuscripts and rare materials (in-house)	Computer (Designated place for reading all scanned documents through the Hard disk)	NLIK provides a designated place with computers for reading all scanned documents through the Hard Disk.
2.	Microfilming (The hardware of a micrographic system includes equipment for processing, filming, duplication, quality control, viewing, and storage. A microfilm reader is the absolute minimum of office equipment necessary for the use of microfilm records.)		Hybrid Camera (for scanning) (company: Zeutschel model name: OK 300)	NLIK uses a hybrid camera to scan its manuscripts and rare materials. Hybrid technology combines analogue and digital technologies to enable long-term archiving up to A0 dimensions (841mm x 1189mm).
			Microfilm camera model name: Fuji Microfilm Camera S2	In the NLIK, a microfilm analogue camera (also known as a microfilmer or "imager") is used to photograph documents, resulting in a compact, permanent record of the original on roll-film.
			Camera Model name: +- Jmtec & Model name: Carlzeiss Jena	Microfilm cameras (also known as a microfilmer or "imager") are used in the NLIK to photograph documents, providing a compact, permanent record of the original in the form of roll-film.
			Developing machine	NLIK operates the developing machine manually during the dark room process. Microfilm processors manually rinse,

			repair, develop, and dry films as they pass through the machine.
		Printing/ Enlarge Machine	Microfilm printing is the xerographic process in which images from microfilm are transferred to paper. Now it is not in use for printing.
		Auto Developer machine Model: Kodak Prostar Archive Processor	It's easy to add the convenience, fast turnaround, and security of in-house microfilm processing with a Kodak Prostar Microfilm Processor.
		Microfilm Printer Model: FUJI microfilm printer	Microfilm printer is used for duplicating of microfilm rolls from negative to positive, negative to negative, positive to negative, and positive roll. The microfilm printer duplicates microfilm rolls from negative to positive, negative to negative, positive to negative, and positive rolls. Microfilm duplication is the process of creating microfilm copies from a microfilm master. The master film is typically the camera's original film. Unlike original microphotography, which is an optical process, an intermediate master can be created from the camera's original film and used as a printing master for future reproduction. Contact printing procedures such as silver gelatine, diazo, or vesicular film are used to duplicate microfilms. Duplicating numerous types of film for different microforms often involves the use of separate duplicators. Card-to-roll duplicators are machines that can duplicate and reformat.
		Microfilm reader Company: Indus	Prior to seeing microfilm images, they must be expanded and projected. The two most prevalent types of readers used to magnify and study microfilm are desk readers and free-standing devices. The availability of supplemental lenses and accessories for studying different microforms varies based on the model and user needs.
		Microfilm scanner Company: Kodak	NLIK operates a digital microfilm scanner and printer. It scans micro images directly from microfilm and displays them on the PC's monitor. Digital images can be processed and saved on a variety of media, including CDs and flash memory, before being printed with a printer. Images can be faxed or emailed to other computer users.
		Printer cum reprographic machine	NLIK uses a printer cum reprographic machine, which combines the functionality of a printer with the ability to copy or reproduce images and documents, often referred to as a multifunction printer or multifunction printer.
3.	Freezing	Freezing Chamber	The Freezing method is used to quickly kill different forms of fungus and insects and their eggs that grow and damage the manuscripts and rare materials. The NLIK uses the freezing method to preserve its manuscripts and rare materials because it does not involve chemical materials. This method is considered safer than other techniques of chemical preservation.
4.	Fumigation	Fumigation Chamber	Fumigation chambers, which use airtight enclosures and various fumigants, are a common practice in libraries to remove pests and mold from books and other materials. The National Library likely uses them as part of its preservation efforts.
		Vacuum Fumigation Chamber	Vacuum fumigation chambers are used in NLIK to treat manuscripts and rare materials infested with insects or

			pests, using an airtight chamber and a fumigant gas, often ethylene oxide, to eliminate them, followed by airing and cleaning.
5.	Deacidification	Aqueous and non-aqueous deacidification	In the NLIK conservation, both aqueous and non-aqueous deacidification methods are used to combat paper degradation, with aqueous methods involving water-based solutions and non-aqueous methods using organic solvents.
6.	Binding	Leather, cloth, and paper are used as covering materials, thread, gauze, and tapes are used for Sewing purpose. Paste, glue, and gum are used as adhesives.	In NLIK, binding is a crucial preservation method aimed at extending the lifespan of books and periodicals by reinforcing the text block and spine, ensuring durability and accessibility for library patrons.
7.	Mending	Wet Cloth, long cloth or Malmal, cutter, paper, paste, wax or glassine paper.	In NLIK, mending is used to extend the lifespan of the collections, including proper cleaning, repairing of spines, and reattaching pages.
8.	Lamination	Japanese Tissue Paper, Cotton, Acetate Foil Cloth, and Acetone	Here, lamination refers to a conservation process where a thin layer of Japanese Tissue paper and Acetate Foil Cloth is applied to documents or materials to protect them from wear, tear, and damage. Cotton is used with Acetone to fix the Japanese Tissue Paper in the desired rare materials for future use.
9.	Pest Control	Pesticides, Insect Repellents (Naphthalene, Thymol crystals, Citronella oil, Phenyl, and etc.)	To control pests in the NLIK, an integrated approach focusing on prevention, monitoring, and targeted treatments is crucial, minimizing chemical use and focusing on maintaining good housekeeping and storage conditions.

Table 2 reflects the major Preservation and Conservation Techniques for Manuscripts and Rare Materials adopted by NLI, Kolkata, which includes nine preservation techniques that include Digitization, Microfilming, Freezing, Fumigation, Deacidification, Binding Mending, Lamination, Pest Control.

9. Freezing Technique as a Non-Chemical Preservation and Conservation Method

Freezing is a physical, non-chemical technique used to control biological deterioration in selected manuscripts and rare materials. Controlled low temperatures can help reduce biological activity, including active mould growth and certain insect infestations, without the direct use of chemical treatments. However, freezing does not completely eliminate all biological agents and is therefore not a sterilization method. Its effectiveness depends on the

material's condition, type of infestation, temperature, treatment duration and other treatment conditions. It may also help stabilize suitable water-damaged paper materials when immediate drying is not possible. Proper inspection, handling, cleaning and environmental control are essential after treatment. Thus, freezing is best considered a controlled treatment for suitable materials and an important component of an integrated preservation and conservation programme.

10. Freezing as a Non-Chemical Approach at NLIK

The National Library of India, Kolkata (NLIK), uses freezing as a non-chemical technique to control biological deterioration, particularly insect and pest infestations, in selected manuscripts and rare materials. The treatment involves exposing suitable materials to controlled low temperatures for a specified period, thereby reducing biological activity

without the direct use of pesticides or fumigants. NLIK has five freezing machines, providing dedicated facilities for this treatment. After freezing, the materials are carefully returned to suitable conditions, inspected, cleaned when required, and placed back in appropriate storage. Thus, freezing provides NLIK with a practical non-chemical option for protecting valuable manuscripts and rare materials from pest-related deterioration. Short description of the freezing process (Figure 2) at NLIK

- ❖ Inspection of materials: Manuscripts and rare materials are carefully examined to identify signs of insects, larvae, eggs, mould, dust, or other forms of deterioration.
- ❖ Selection of materials: Materials showing signs of insect infestation or requiring treatment are identified and selected for the freezing process.
- ❖ Documentation: The condition and identification details of the selected manuscripts and rare materials are recorded before treatment for future reference and comparison.
- ❖ Retrieval from storage: The selected materials are carefully removed from their storage shelves and handled properly to prevent damage to pages, bindings, and spines.
- ❖ Protective packing: The manuscripts and rare materials are placed in suitable airtight or vacuum bags and sealed properly. This protects the materials from moisture, dust, and external contamination during freezing and thawing.
- ❖ Preparation of the freezing chamber: The freezing chamber is prepared and allowed to reach a stable low temperature before the materials are placed inside.
- ❖ Freezing treatment: The packed manuscripts and rare materials are placed in the freezing chamber and maintained at a temperature below -20°C for approximately 24 hours. The low temperature helps to control and eliminate insects and their different life stages responsible for biological damage.
- ❖ Proper arrangement: The packed materials are arranged carefully inside the freezing chamber to ensure sufficient exposure to the low temperature and proper circulation of cold air.
- ❖ Gradual thawing: After approximately 24 hours of freezing treatment, the materials are removed from the chamber and allowed to thaw gradually while remaining sealed in their packaging. This helps reduce the risk of condensation and moisture-related damage.
- ❖ Removal from packaging: After the thawing process, the packaging is carefully opened and

the manuscripts and rare materials are removed from the bags for further examination and cleaning.

- ❖ Cleaning: After thawing, the manuscripts and rare materials are carefully examined and cleaned to remove dust, dead insects, insect remains, and other loose contaminants using appropriate cleaning equipment.
- ❖ Final inspection: A final examination is conducted to assess the condition of the treated materials and check for any remaining signs of infestation or damage.
- ❖ Return to storage: After treatment and inspection, the manuscripts and rare materials are returned to their designated storage areas under appropriate storage conditions.

Thus, the freezing technique adopted at NLIK provides a systematic non-chemical approach to controlling biological deterioration in manuscripts and rare materials. Proper inspection, documentation, packing, temperature control, treatment duration, gradual thawing, cleaning, and final inspection are important for ensuring the safe and effective preservation of the collections. The general sequence of inspection, retrieval, documentation, packing, freezing, thawing, cleaning, and return to storage is consistent with the process described in the supplied source.

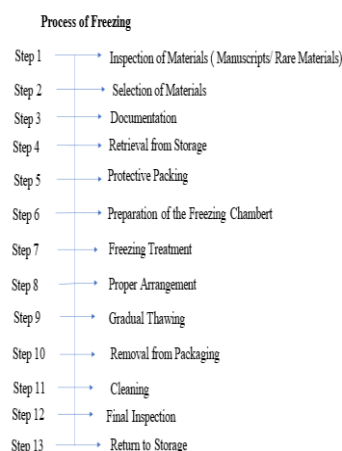


Figure 2: Freezing Process of the NLI, Kolkata

Figure 2 illustrates a systematic 13 steps of freezing process adopted for the preservation of manuscripts and rare materials. The process begins with the inspection and selection of suitable materials, followed by documentation and careful retrieval from storage. The selected materials are then appropriately packed

and the freezing chamber is prepared before treatment. During the treatment stage, the materials are systematically arranged in the chamber and subjected to controlled freezing, followed by gradual thawing to minimize the possibility of physical damage. After treatment, the protective packaging is carefully removed, and the materials are cleaned and thoroughly inspected to evaluate their condition. The final stage involves ensuring that the treated materials are suitable for further preservation and safe return to appropriate storage. Overall, the 13 steps procedure demonstrates a systematic and controlled approach to freezing treatment, helping to minimize handling risks, control biological deterioration and maintain the physical integrity of manuscripts and rare materials for long-term preservation.



Image 1: Freezing Chambers (Source: Self)



Image 2 & 3: Freezing Chambers (Source: Self)

11. Advantages of the Freezing Technique

Freezing offers several advantages as a non-chemical preservation method at NLIK. It helps control biological deterioration without directly applying fumigants or pesticides to collection materials. The low temperature can interrupt active mould growth and biological activity and can be useful for selected insect- or mould-affected materials. It may also help stabilize suitable water-damaged materials when immediate drying is not possible. The availability of five freezing machines at NLIK provides institutional capacity for carrying out this treatment. Thus, freezing offers a practical alternative or complement to chemical treatment within the preservation programme.

12. Limitations and Precautions

Although freezing is useful, it is not suitable for all manuscripts and rare materials. Materials containing sensitive media, mixed components or particular photographic and decorative elements may require alternative treatment. Freezing may stop active mould growth but does not necessarily destroy mould spores; therefore, cleaning and proper environmental control remain essential. Careful inspection, appropriate packaging and controlled temperature and treatment duration are necessary to minimize physical damage. The temperature below -20°C for approximately 24 hours represents the treatment procedure documented at NLIK and should not be considered universally applicable to all materials or biological agents. Proper assessment by trained conservation personnel is therefore essential.

13. Discussion

The study indicates that freezing is an important non-chemical preservation technique used at NLIK for selected manuscripts and rare materials affected by biological deterioration. The availability of five freezing machines and the documented treatment of below -20°C for approximately 24 hours demonstrate its practical application within the institution. However, freezing is a controlled treatment rather than a complete conservation solution, and its effectiveness depends on proper material selection, inspection, packaging, handling, cleaning and storage. The findings suggest that freezing can provide a useful alternative to chemical treatment, particularly for suitable mould-, insect- and moisture-affected materials, when integrated with preventive preservation, environmental control and regular monitoring.

14. Conclusion

Freezing is an important component of the preservation and conservation programme for selected rare materials at NLIK. It provides a non-chemical means of controlling biological activity while reducing dependence on chemical treatments. The institutional facilities and documented treatment procedure demonstrate NLIK's capacity to apply this technique. However, freezing cannot replace preventive preservation or professional conservation treatment. Its long-term effectiveness depends on careful material assessment, appropriate treatment conditions, proper handling and stable storage. Overall, freezing can be considered a useful and practical non-chemical preservation method for selected manuscripts and rare materials when applied systematically and under appropriate professional supervision.

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