

## Chapter 30

### TRADITIONAL DISINFECTION METHODS AND ACCEPTANCE BY CONSERVATORS OF GAMMA RADIATION TREATMENTS

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#### 30.1. INTRODUCTION

Many artefacts are preserved by cultural heritage institutions to prevent their deterioration. Chemical treatments were historically used as an effective method of preserving the physical integrity of objects comprised of organic materials, such as wood, fabrics, plant fibres and feathers. Pesticides, both traditional treatments and commercially available chemicals, began to be used by cultural institutions at the end of the nineteenth century [30.1].

The routine use of chemical treatments protected objects from multiple types of attack [30.2]. Many entomologists, taxidermists, collectors and curators shared their knowledge on these treatments, leading to a wider exchange of information on biological threats and expanding the use of chemical treatments worldwide [30.3].

The author developed an international survey to collect information on the use of chemical and non-chemical treatments used for cultural heritage collections. In order to widen participation by those not generally engaged in international surveys on conservation, the questions were made available in English, Spanish and Portuguese.

This chapter presents the results of the survey on traditional chemical methods of disinfecting objects and on the level of acceptance of more sustainable methods for the preservation of cultural heritage, such as gamma irradiation.

#### 30.2. METHODOLOGY

An on-line survey comprised 20 questions in four main sections. The first section collected general information about the participants, identifying the types of collection with which they worked their level of experience, employment status and country of residence. Museum professionals, archivists and librarians were

the target audience for the research. The second section focused on preventive conservation measures. The third section discussed previously used chemical treatments. The fourth section examined non-chemical alternatives, asking whether they were utilized and what methods were employed. The research used multiple choice questions complemented by some open fields. The survey was open between September and November 2022. The results were compiled using Microsoft Power BI software.

Answers to some questions were grouped according to geographical region: Africa, Asia and Oceania (which were grouped together owing to the low response rates from those regions), Canada, Europe, Latin America and the United States of America.

The questionnaire was widely distributed through professional mailing lists and conservation forums, such as the Global Conservation Forum and ConsDistList. Moreover, the survey was shared through social media (Facebook and Instagram), and a post was shared 87 times and reached 1177 accounts.

The survey was designed to reach as many participants as possible, but the reach of the audience could not be precisely measured, since the sharing of posts was organic. This prevented a precise calculation of the audience reach, and therefore it was not possible to calculate the sample percentage, margin of error or level of confidence of the survey. However, the 192 completed questionnaires provided important information.

This chapter also addresses the issue of professional acceptance of gamma radiation treatment by presenting the partial results of a research study conducted by S.G. de Brito [30.4], in which 105 Brazilian professionals participated.

### 30.3. RESULTS AND DISCUSSION

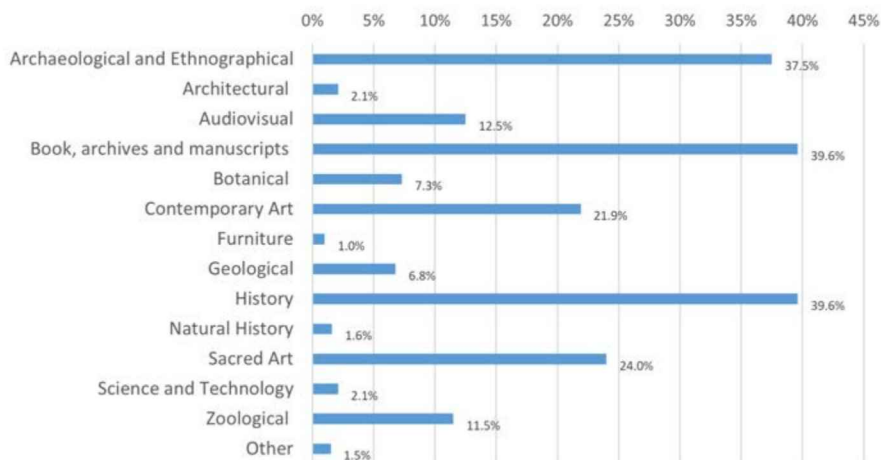
The first section of the questionnaire identified the participants' professional profiles. A total of 192 professionals from 30 countries and territories took part in the survey.<sup>1</sup> The majority of the participants were from Latin America, followed by Europe, the United States of America and Canada, with only a small number from countries in Africa, Asia and Oceania.

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<sup>1</sup> Location and number of participants:

Argentina (15), Austria (1), Plurinational State of Bolivia (1), Brazil (60), Canada (3), Chile (9), Colombia (10), Costa Rica (2), Cuba (1), Ecuador (1), Egypt (4), El Salvador (1), Germany (27), Guatemala (2), India (2), Indonesia (1), Luxembourg (2), Mexico (9), New Zealand (1), Peru (18), Philippines (1), Portugal (2), Puerto Rico (1), Spain (1), Switzerland (1), United Kingdom of Great Britain and Northern Ireland (3), United Republic of Tanzania (1), United States of America (7), Uruguay (4) and Zimbabwe (1).

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*FIG. 30.1. Categories of collections on which the participants worked.*

A total of 169 participants (88%) indicated that they had at least five years of experience in cultural heritage conservation; 126 participants (65.6%) reported working full time in an institution, which included museums, libraries and archives.

Participants reported working with archival and bibliographic materials (39.6%), historical collections (39.6%) and archaeological and ethnographic objects (37.5%) (Fig. 30.1); participants were allowed to give more than one answer to this question. This indicates that the material covered is quite comprehensive, since historical, archaeological and ethnographic objects are composed of various organic materials, including wood, textiles, plant fibres, feathers and leather.

On the topic of preventive conservation, 99.5% of participants indicated that their institution currently carries out preventive conservation for their collection, including climate monitoring, integrated pest management policies and periodic inspections.

There were different responses when asked about the types of biological threat that had recently been recorded in their collections. Multiple answers could be provided to this question. According to the responses, it could be concluded that Latin American professionals reported frequent problems with mould (37%), moths (32.3%), woodboring insects (28.6%) and termites (28.1%). For the United States of America and Canada, woodboring insects (4.2%), moths (3.6%), mould (2.6%) and silverfish (2.6%) were the main biological threats. In Europe, woodboring insects (15.6%), moths and silverfish (13% each) and mould (10.9%) predominated.

Participants from countries in Africa reported occurrences of silverfish (2.6%) and woodboring insects (2.1%). In Asia and Oceania, participants mentioned termites and silverfish with equal frequency (2.1%), followed by mould (1.6%). Figure 30.2 contains a comparative table for all participants by geographical region.

On the topic of chemical treatments, 38.5% of participants reported having used chemical substances to eliminate pests from objects.

According to the results of the geographical analysis (Fig. 30.3), the use of naphthalene is highest in Latin America (10.4%), followed by cypermethrin (8.9%) and thymol (7.8%). Participants in the United States of America and Canada primarily used thymol (0.5%), dichlorvos (0.5%) and heavy metals, such as lead, arsenic and mercury (0.5%). Participants in Europe reported using permethrin (3.1%), thymol (1.6%) and naphthalene (1.0%). Participants in Asia noted the use of paradichlorobenzene (0.5%), while participants in Africa noted the use of other non-listed chemical substances (0.5%).

A total of 20.8% of participants who answered affirmatively regarding the use of chemicals stated that these substances were chosen because of their fast treatment and effectiveness and their knowledge of the product (Fig. 30.4). For other participants, these chemical methods are used owing to their low cost, low complexity and status as traditional treatments. According to two participants (in Brazil and the United States of America), the use of chemical substances was based on predefined guidelines. Some restoration projects must adhere to pre-established

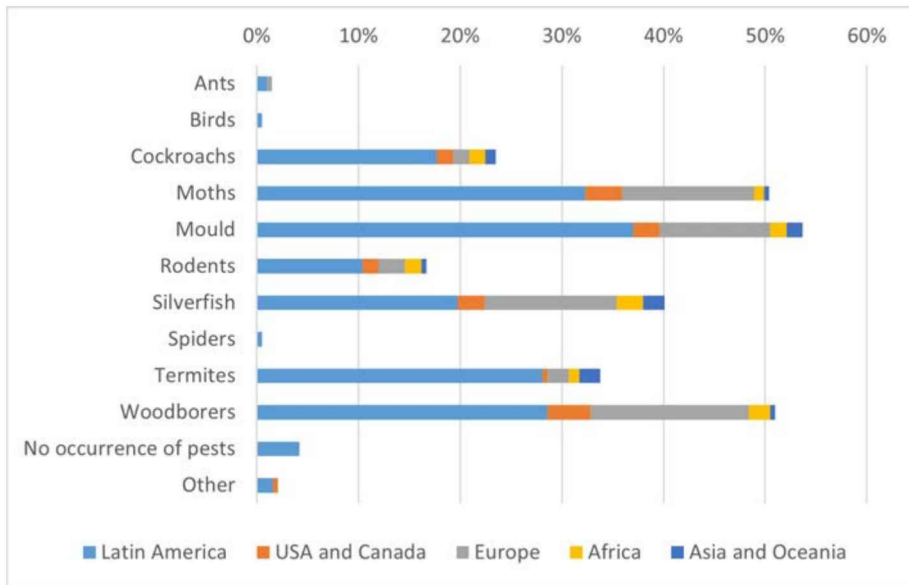


FIG. 30.2. Geographical comparisons of pest occurrences in recent years.

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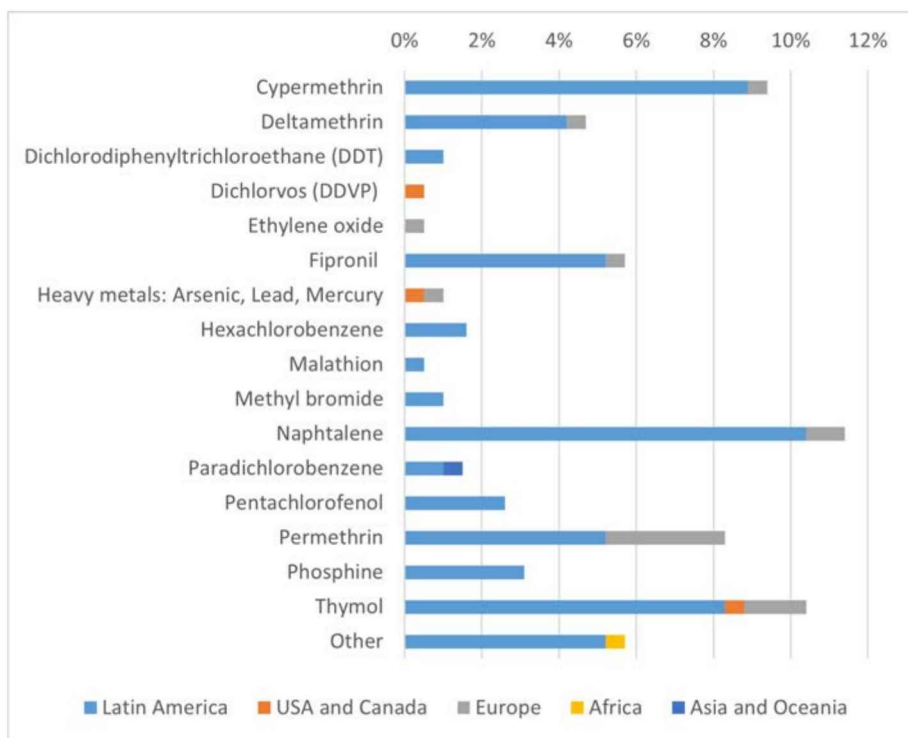


FIG. 30.3. Comparison of the chemicals used by participants based on their geographical location.

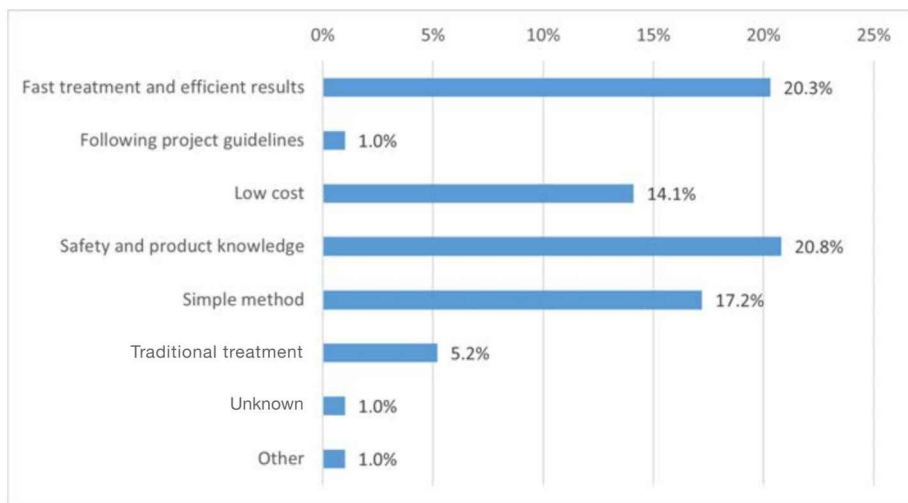


FIG. 30.4. Justification for the current use of chemical substances.

guidelines issued by governmental heritage preservation agencies. In some cases, the people responsible for defining these guidelines may not be aware of more sustainable conservation practices and recommend the use of chemical substances. When such directives are already in place, conservators should attempt to negotiate. However, if there is no space for negotiation, they are left with no option but to follow the prescribed procedures.

More than one answer was allowed to this question on the use of chemical substances.

Participants reported side effects as a result of chemical exposure, either personal experience or that of colleagues (Fig. 30.5). The most common reaction mentioned among participants was headaches (25.5%), followed by irritation of the respiratory tract (16.7%) and eye irritation (16.7%).

Responses regarding the historical treatment records were almost evenly divided (Fig. 30.6). Only 34.9% of responses indicated that there were any historical treatment records, and 32.3% stated that they were not available. As noted in literature reviews, it is often difficult to locate accurate records of past pesticide treatments in institutions such as museums [30.5–30.7].

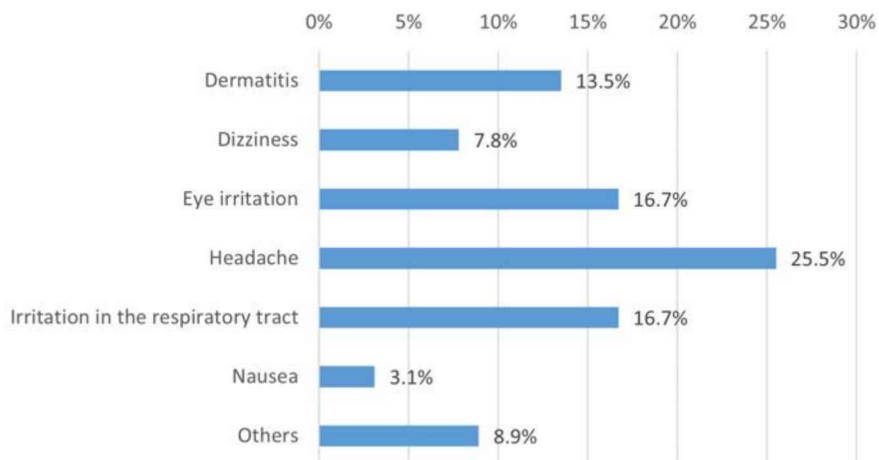
The geographical grouping provides valuable insights regarding past chemical treatments (Fig. 30.9). The use of naphthalene was more prevalent in Latin American countries (28.1%). In the study, thymol was cited by 14.6% of participants, followed by cypermethrin (12%) and deltamethrin (7.3%). Only 6.3% of respondents mentioned dichloro-diphenyl-trichloroethane (DDT) as an example of an old treatment. According to the survey, 14.6% of participants were unaware of the products that were used in historical treatments. A significant continuity can be seen in these countries, as the products used most frequently in the past (naphthalene, thymol and synthetic pyrethroids) are also those most frequently applied recently.

Heavy metals (3.6%) and DDT, dichlorvos and paradichlorobenzene (2.1%, respectively) were the most frequently mentioned treatments in Canada and the United States of America. In Europe, chlorinated pesticides were the most commonly reported past treatments. Lindane was used in 11.5% of all registered treatments, followed by DDT at 10.4%. Permethrin ranks third at 9.4% ,and heavy metals were listed in fourth place at 8.9%.

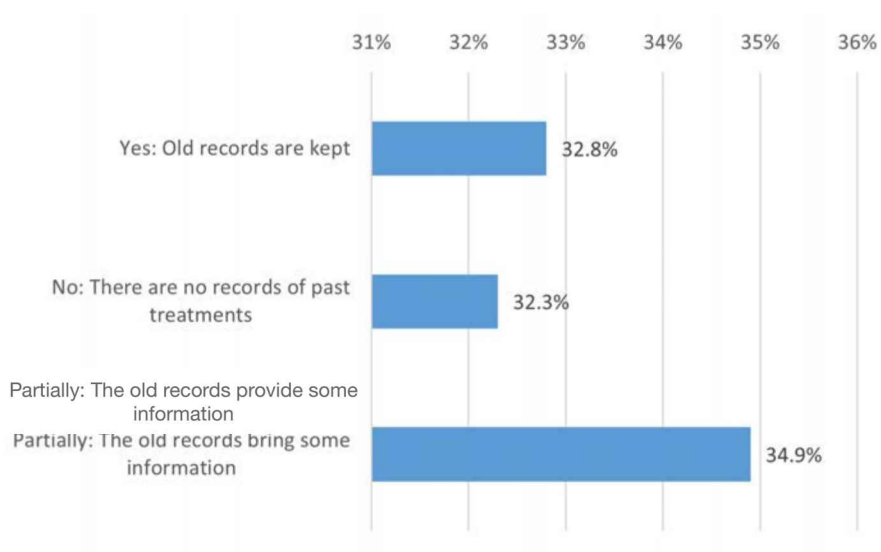
DDT also ranked first in Asia, at 1.0%, followed by paradichlorobenzene (1.0%) and other substances. African participants appear to have fewer records about old treatments. However, they indicate the presence of DDT, paradichlorobenzene, heavy metals and other pesticides.

The answers provided are in accordance with literature reviews. Naturalists and collectors used recipes that included arsenic, mercury and lead to control infestations during the nineteenth century [30.8]. The recipes were published in natural history museum reports and publications. In the second half of the

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*FIG. 30.5. Side effects experienced as a result of the use of chemical substances.*



*FIG. 30.6. Documentation of past pest control treatments.*

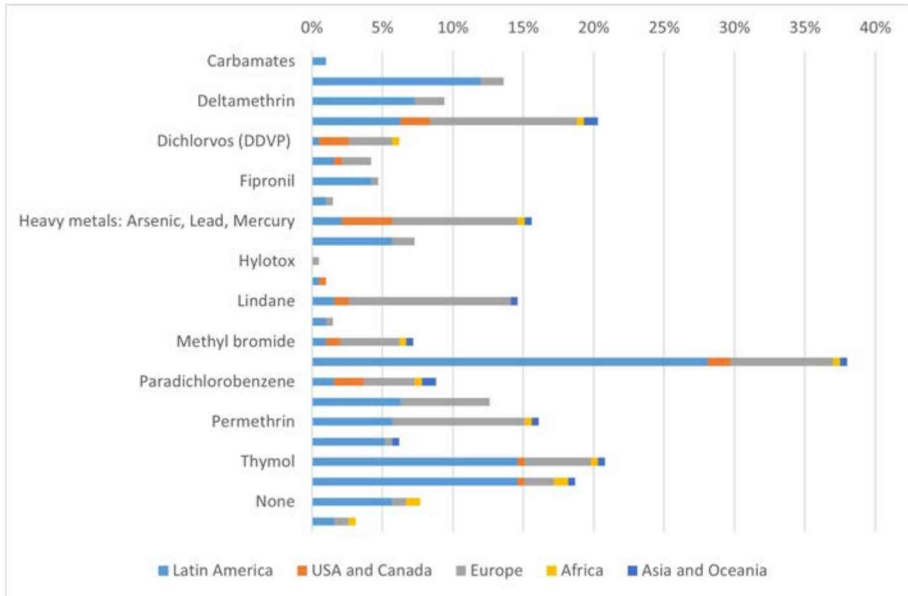


FIG. 30.7. Geographically based past treatment records.

twentieth century, and with the advancement of the chemical industry, new solutions began to be applied and exchanged [30.2].

In the post-war period, organochlorine pesticides were widely used in Europe. Participants from Austria, Germany, Luxembourg and Switzerland reported that lindane and DDT were the preferred treatments. The use of chlorinated products has also been documented in the Americas, Asia and Africa. It is possible that European colonial countries adopted the practice of using chlorinated insecticides to preserve documents and other materials in tropical climates [30.9].

Participants reported using sustainable techniques for treating collections. In the survey, 39.1% of participants reported the use of inert atmospheres as a method of pest control, particularly participants in Canada, Europe and the United States of America. Participants also mentioned freezing, heating, gamma irradiation and the use of essential oils and local plants.

In the geographical comparison (Fig. 30.8), it can be seen that Latin American participants preferred to use anoxia (16.7%), freezing (12.5%) and traditional materials and techniques, such as the use of spices, local plants and essential oils (10.9%). Gamma irradiation was mentioned by 9.4% of participants for pest control in that region, with the largest number of responses from Brazilian participants. A total of 29.7% of participants indicated that no non-chemical

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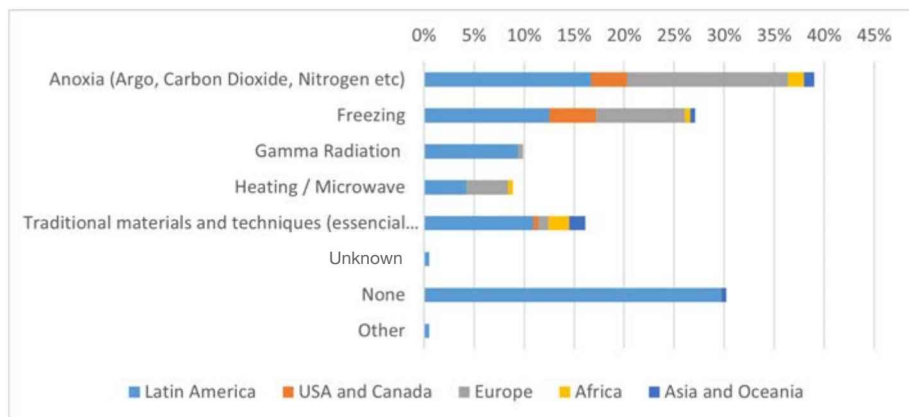


FIG. 30.8. Comparison of non-chemical techniques currently being used by participants in different regions.

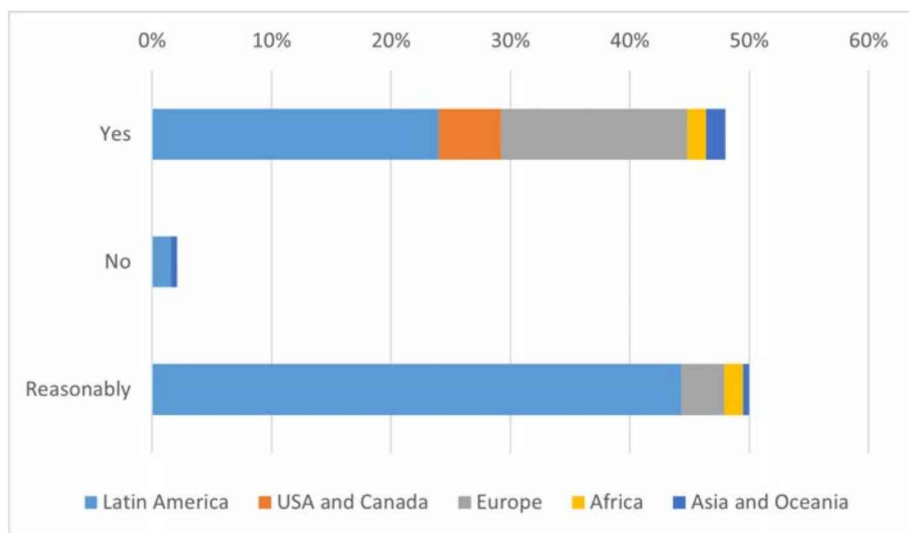


FIG. 30.9. Comparison of the level of confidence in non-chemical treatments across different geographical regions.

techniques are used in their institution; it is therefore possible that these participants continue to use chemical substances.

The most commonly used technique in Canada and the United States of America is freezing (4.7%), followed by anoxia (3.6%). Anoxia ranked first (16.1%) in Europe, followed by freezing (8.9%). Traditional materials are used more systematically in Africa (2.1%) and Asia and Oceania (1.6%).

There was a reasonable level of trust in non-chemical techniques among 50% of participants, while 47.9% said they had full confidence in these techniques, and 2.1% said they did not trust alternative treatments. Latin American participants had the lowest level of confidence in these techniques as compared with participants from other geographical regions (Fig. 30.9).

Regarding the level of trust in non-chemical techniques, there is a geographical trend that needs to be addressed. Latin American countries are the most likely to use chemical methods to control pests and rely the least on non-chemical methods. In Canada, Europe and the United States of America, this issue appears to have been overcome, since there were no negative responses about the level of confidence in alternative techniques, and the level of reasonable confidence was low compared with positive responses.

There are some possible explanations for this. There are few training courses on conservation in Latin American countries, and this lack of formal training may reflect the absence of information about the consequences of chemical treatments applied to collections in the region.

Non-chemical alternative techniques may also be unavailable because of financial constraints. Most institutions cannot afford anoxia, freezing or other solutions to treat objects. Therefore, commercial chemical substances are more accessible.

A language barrier may also hinder the dissemination of this information, since most of the bibliographic material published on the subject is in English, thus excluding professionals who only speak Spanish or Portuguese.

Although few participants from Africa, Asia and Oceania took part in the survey, it is interesting to highlight the use of sustainable pest control methods in those regions, including essential oils and native plants, which demonstrates that those participants, aware of the risks to health and cultural heritage, prefer non-chemical methods when treating objects.

In the last question of the survey, the participants were asked whether they knew about gamma irradiation as a method for disinfecting cultural items (Fig. 30.10). The majority of participants, 57.3%, indicated that they were not familiar with the technique, but many of them expressed an interest in receiving further information.

Through the participation of 105 Brazilian professionals from museums, archives and libraries, S.G. de Brito's research [30.4] explored the issue of

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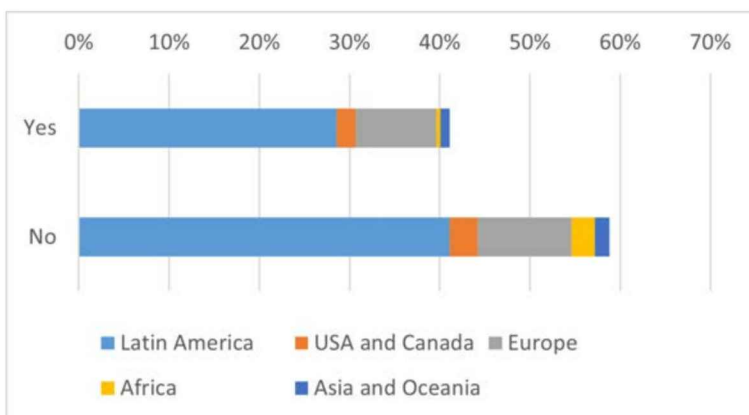


FIG. 30.10. Knowledge of gamma irradiation among participants.

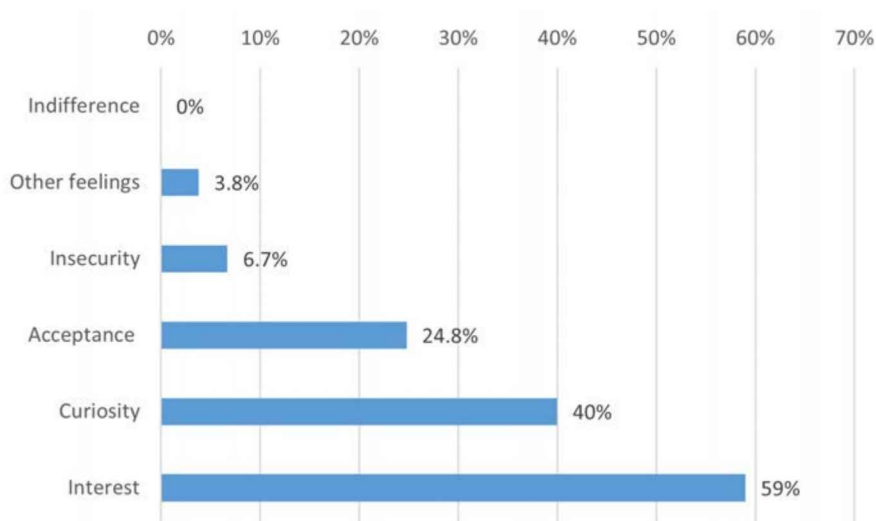


FIG. 30.11. Feelings evoked by the words 'gamma radiation'.

acceptance of gamma irradiation technology. The participants were asked about the feelings evoked by the words 'gamma radiation' (Fig. 30.11). The responses indicate that most participants have a positive attitude towards gamma irradiation. 'Interest' and 'curiosity' indicate a favourable perception of, and possible acceptance of, this technology, while 'insecurity' and 'other feelings' indicate little resistance [30.4] or concern about the technique.

S.G. de Brito also examined whether participants felt safe when handling materials that had previously been treated with gamma radiation. Participant perceptions of the safety of working with such materials were safe (39%), moderately safe (25.7%), very safe (22.9%), partially unsafe (6.7%) and completely unsafe (5.7%).

Furthermore, the survey examined whether participants would recommend ionizing radiation treatment to their colleagues. A total of 31.4% of participants would recommend the technique, 17.1% would fully recommend it, and 6.7% would recommend it with restrictions. A total of 44.8% of participants indicated that they were unable to give an opinion, and 'would not recommend' did not receive any responses.

According to the data, there is a clear difference of opinion, with a majority of respondents lacking knowledge to recommend or not recommend the technique. This suggests a need for an exchange of information about gamma radiation treatment among these professionals (Fig. 30.12).

There is a lack of knowledge about the technique that is evident in the answers to the three questions, which is difficult to overcome in Brazil because the country is large and the profiles of its cultural institutions, and the training of their staff, vary considerably. Despite this, all the responses indicate that there is a trend towards acceptance of the technique. This can be achieved only through the dissemination of knowledge about gamma irradiation.

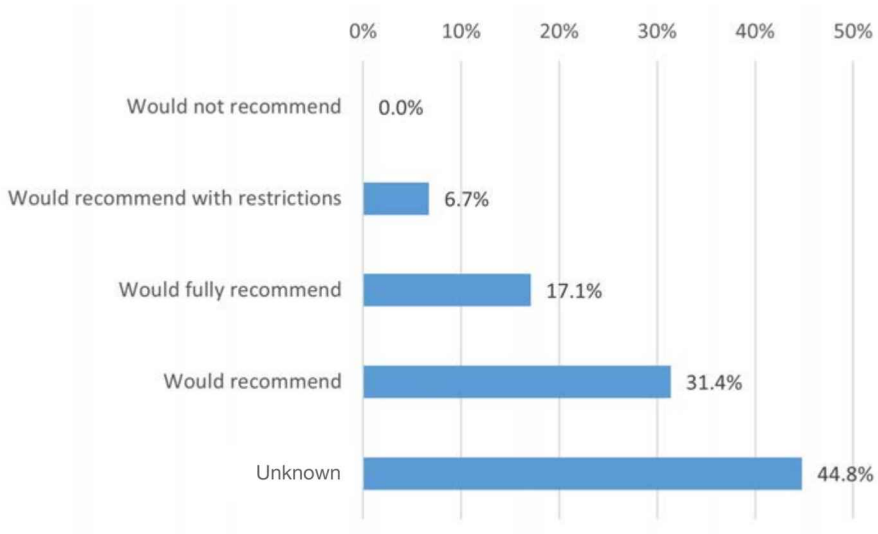


FIG. 30.12. Gamma radiation application recommendation to treat cultural heritage objects.

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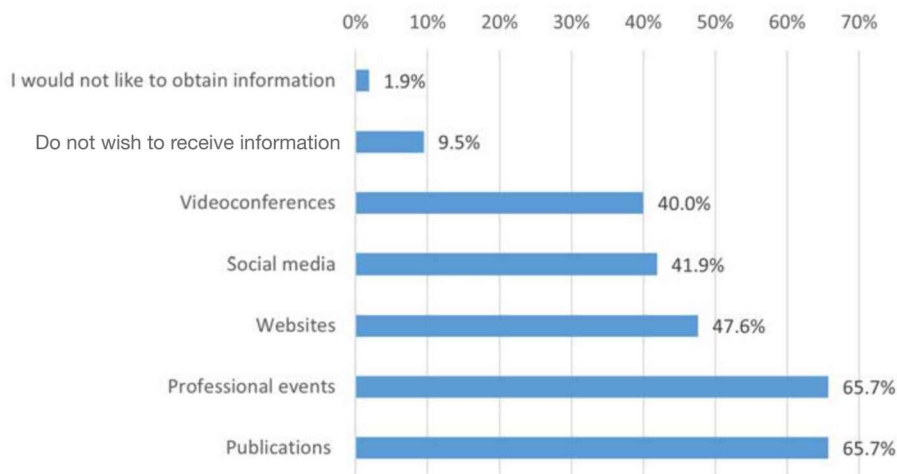


FIG. 30.13. Preferred method for obtaining information on radiation technology.

S.G. de Brito's research also addresses the preferred method for professionals to receive information about radiation technology applied to cultural heritage preservation (Fig. 30.13). According to the responses, scientific publications and professional events are the most preferred methods; 47.6% of participants preferred websites, 41.9% chose social media and 40% mentioned videoconferences. According to these data, almost all participants are interested in learning more about this technique, indicating that there is a considerable need for up-to-date and accessible information.

### 30.4. CONCLUSIONS

Over the past few decades, there has been substantial progress in the conservation of cultural heritage. Changes have been made as a result of new international regulations and national legislation in countries restricting the availability and use of biocidal products. In addition to raising awareness about the harmful effects of chemicals, sustainability initiatives related to cultural heritage have also resulted in significant changes in behaviour [30.10].

A concern for sustainability and a desire to mitigate workplace risk led conservators to adopt non-chemical treatments in the 1990s. Most museums and cultural heritage preservation institutions now use less invasive conservation methods.

The survey collected information from a limited and specific group of participants. Although the participants did not fully represent all staff working on cultural heritage in all locations, the responses do represent geographical trends of past and current practices.

The research conducted by S.G. de Brito provides valuable information about Brazilian cultural heritage staff. It is evident from the results that trust in non-chemical treatments needs to be strengthened in Latin American countries, reflecting similar findings from the international survey. A positive point is that people working in the area are interested in receiving more information about the gamma radiation technique in order to overcome their prejudices and fears.

It is necessary to develop strategies for ensuring that this knowledge is disseminated to people involved in cultural heritage preservation in a systematic, effective and timely manner. By opening communication channels with organizations such as the International Council of Museums — Committee for Conservation, the International Centre for the Study of the Preservation and Restoration of Cultural Property and local conservator associations, it is possible to increase information exchange, especially in Latin America, where confidence in non-chemical techniques needs to be strengthened.

It will be possible in the future to enhance this research through new consultations and interviews, particularly in geographical areas that had a low rate of response in the current survey.

The survey's full results can be found by entering the URL<sup>2</sup> or scanning the QR code below:




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<sup>2</sup> <https://app.powerbi.com/viewr=eyJrIjoiYzcyMGY5YWUtZmNjOS00NjI3LTk-2YWUtMGIwZWMyMjlyNjFjIiwidCI6IjdlOTNlMjg2LWlyOWEtNDQ1NC1hNDFhLUU4NDE5ZWMyZGVhNSJ9>

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