The PHILIPPINE JOURNAL OF
Veterinary Medicine

(Short Communication)

Comparative Dehydration and Room Temperature Plastination for Developmental Anatomy Specimens (Congenitally Malformed Piglets and Ruminant Gravid Uteri) as Museum and Educational Specimens

Jojo D. Cauilan[1,a]

[1]College of Veterinary Medicine, Cagayan State University, 3502 Tuguegarao City, Cagayan, Philippines

*Corresponding Author: cauilan.jojo@csu.edu.ph (Jojo Cauilan)

ORCID: [a] 0009-0008-4161-2114

Submitted: 02 Feb. 2026 Revised: 04 Jun. 2026 Accepted: 30 Jun. 2026 Published: 23 Jul. 2026

Abstract

Background: Developmental anatomy specimens offer valuable educational insights, but traditional preservation methods pose health risks, and safer alternatives like standard plastination remain prohibitively expensive for many institutions in developing countries like the Philippines. This preliminary study evaluates alternative plastination techniques for preserving piglet and ruminant specimens using room temperature dehydration with acetone (Treatment 1) and ethyl alcohol (Treatment 2), followed by passive glycerin impregnation. **Methodology**: Modified Elnady technique was used for plastination, two (2) piglets and one (1) gravid ruminant uterus (Treatment 1), while two (2) piglets and two (2) gravid uteri (Treatment 2) were subjected to acetone and ethyl alcohol dehydration, respectively. The plastination took about 28 weeks to complete. The weight and color of the specimens were recorded pre- and post-plastination and were analyzed descriptively. **Results**: Plastination caused minimal color changes, and specimens kept their flexibility, firmness, and realistic appearance. Acetone dehydration led to about 30.92–35.46% in piglets and 24.31% in ruminant uteri, while alcohol dehydration caused a similar weight loss of 33.18–35.82% in piglets and up to 34.03% in ruminant uteri, with alcohol causing slightly more tissue shrinkage than acetone, especially in piglets. Despite some shrinkage, the plastinated specimens remained morphologically intact, odorless, and appeared suitable for educational and display purposes and may serve as durable alternatives to formalin-fixed tissues. **Conclusion**: This study shows that both acetone and ethyl alcohol are feasible dehydration methods for room-temperature plastination of developmental anatomy specimens, producing weight reduction while preserving external morphology and yielding dry, odorless specimens with potential utility for teaching.

Keywords

Developmental anatomy specimens, Plastination, Elnady technique, Congenital malformations, Ruminant gravid uterus

1. Introduction

Developmental anatomy specimens provide valuable insights into developmental anatomy and teratology. However, preserving these specimens for educational and museum purposes poses significant challenges. Traditional preservation methods often use formalin solution as a fixative to prolong its lifespan. In such cases, when students wish to study the specimens in great detail, they are exposed to formalin fumes, which cause respiratory discomfort and eye irritation, limiting their focus and causing health risks [1].

Plastination allows the creation of durable, dry, and odorless specimens that retain their anatomical detail. This facilitates the creation of an anatomical specimen repository that is realistic, durable, and readily accessible. However, standard plastination is a relatively expensive procedure due to its requirement for an explosion-proof room and patented chemicals. This poses difficulty in certain developing countries to acquire such resources [2,3].

Researchers have established a simpler, affordable, and non-patented plastination technique using local chemicals at room temperature. Variations in the process include replacing acetone with alcohol for dehydration [4,5,6], and modifying impregnation agents by using alkyd resin [2] or mixing xylene with silicone for lighter specimens [7]. Plastinated models created from lightweight plastination offer numerous advantages for educational settings, including ease of transport, biosafe handling, and durability. They are odor-free, easier to handle, durable, dry, flexible, and maintain a natural appearance and feel, allowing them to be used long-term without deterioration. [2,4,6–11] Crucially, the development of these techniques has enabled resource-limited nations to manufacture their own specimens at room temperature using locally available materials [2].

In the Philippines, developmental anatomy specimens remain to be fixed in formalin and stored in glass containers. However, the unpleasant and harmful repercussions of formalin fume exposure on students limit their appreciation of specimens during practical study. Hence, this preliminary study explores room-temperature plastination of congenitally malformed piglets and gravid ruminant uteri, employing acetone and ethyl alcohol for dehydration and glycerin for passive impregnation, to compare dehydration solutions and establish a reproducible protocol for producing museum and teaching specimens.

2. Methodology

Specimens

The specimens used in this study were obtained from an existing embryology laboratory preserved collection. The samples consisted of piglets with congenital malformations and ruminant gravid uteri containing fetuses, which had been previously fixed in formalin and stored for approximately one to three years. As no live animals were used, the study qualified for ethical exemption in accordance with institutional animal care use guidelines.

Plastination Procedure

The plastination method employed was an adapted version of the Elnady technique [9]. Steps such as dye injection, muscle dissection, and bone drilling were omitted. The dehydration protocol was altered by using progressively higher concentrations of ethyl alcohol instead of the standard acetone-based approach. Because the specimens in this preliminary study had been fixed and stored for varying lengths of time, the overall plastination timeline did not include fixation. Specimens were subjected to washing under running water for 72 hours to remove residual formalin and then allowed to drain prior to weighing. After washing, specimens were subjected to a series of dehydration. Both dehydration and impregnation were performed passively at room temperature. Prior to beginning the dehydration stage, the piglets and ruminant uteri were purposively allocated into two treatment groups rather than randomly assigned.

Dehydration

Dehydration was carried out at room temperature (approximately 25–28 °C) throughout the procedure using airtight stainless steel containers. For Treatment 1 (acetone-based dehydration), two piglets with congenital malformation and one ruminant gravid uterus were submerged in three successive baths of pure (100%) acetone each lasting for three weeks, totalling nine weeks. For Treatment 2 (alcohol-based dehydration), two piglets with congenital malformation and two ruminant gravid uteri were submerged in ascending concentration of ethyl alcohol (75%, 85%, 95%) with each concentration maintained for three weeks for a total of nine weeks. Specimens were considered fully dehydrated once the solution consistently maintained a concentration of 98–99% using a hydrometer, monitored before every change was made. This level was reached after three acetone changes and four ethyl alcohol changes, including two cycles with 95% alcohol. During each solution change, both the piglets and ruminant uteri were placed together in the same container, which held 25 liters of acetone and 20 liters of ethyl alcohol per cycle.

Glycerin Impregnation

Following dehydration, specimens were removed from their respective containers and placed in a draining tray to allow excess solvent to run off before being transferred into sealed containers with glycerin at a 5:1 glycerin-to-specimen volume ratio [9]. A total of 22 liters of glycerin were used for Treatment 1, while 20 liters were used for Treatment 2. Passive impregnation was conducted for eight weeks for both treatment groups to allow gradual replacement of dehydrating solution with glycerin. After impregnation, the specimens were removed from the glycerin bath and left to drain for five days.

Curing with Corn Starch

Any remaining glycerin on the specimens was blotted away with absorbent paper. The specimens were then wrapped in cheesecloth, placed in plastic containers, and fully covered with cornstarch for a 10-day curing phase with periodic rotation. The cornstarch was replaced whenever clumping was observed which indicates that it became saturated with glycerin; this required two replacements over the 10-day period. Once curing was complete, the specimens were removed and any remaining cornstarch was brushed off.

Data Collection and Analysis

The weight of specimens after washing was obtained as pre-plastination weight and was then measured after curing as its post-plastination weight using a digital weighing scale. Data were presented in frequencies and percentages and analyzed descriptively. The percentage reduction was calculated using the formula:

Percentage Reduction (%) = [(Pre-plastination weight – Post-plastination weight) ÷ Pre-plastination weight] x 100

The researcher recorded qualitative observations on color, texture, flexibility, and any morphological integrity alterations. Flexibility was assessed based on how easily the organs or body structures could be manipulated and whether they returned to their original shape afterward. Morphological changes were identified by comparing the post-plastination appearance with the specimens' features prior to plastination. Shrinkage was determined by the reduction in specimen weight following the plastination process.

Data were analyzed descriptively, and summary values were presented as percentages, ranges, and comparative observations between treatments. Due to small sample size, inferential statistics were not applied.

3. Results and Discussion

A preliminary study was conducted to compare the dehydration process using acetone and alcohol on piglets with developmental malformations and ruminant gravid uteri impregnated with glycerin through a passive process, with emphasis on changes in weight, color, flexibility, and gross morphology. During the process of plastination, minimal changes in the coloration of specimens were noted, as shown in Figures 1 and 2.

Both dehydration methods resulted in measurable reductions in specimen weight, reflecting moisture loss and tissue shrinkage during plastination. Piglets with congenital

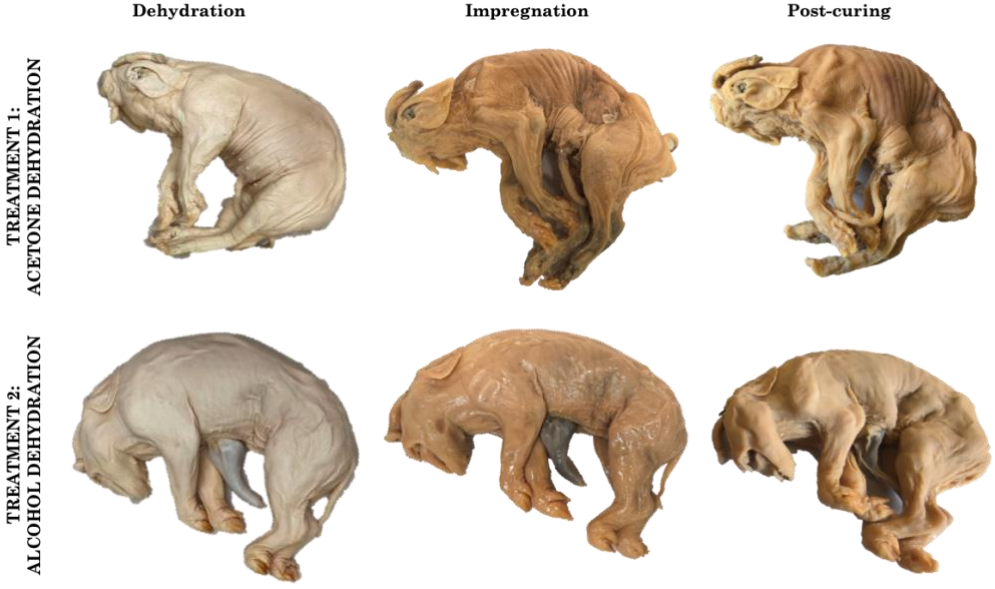

Figure 1. Piglets with congenital malformations at different stages of plastination under two dehydration treatments. Treatment 1 (acetone dehydration) and Treatment 2 (ethyl alcohol dehydration) are shown for each specimen across three stages: dehydration, glycerin impregnation, and post-curing. Images illustrate changes in external appearance, including color and surface texture.

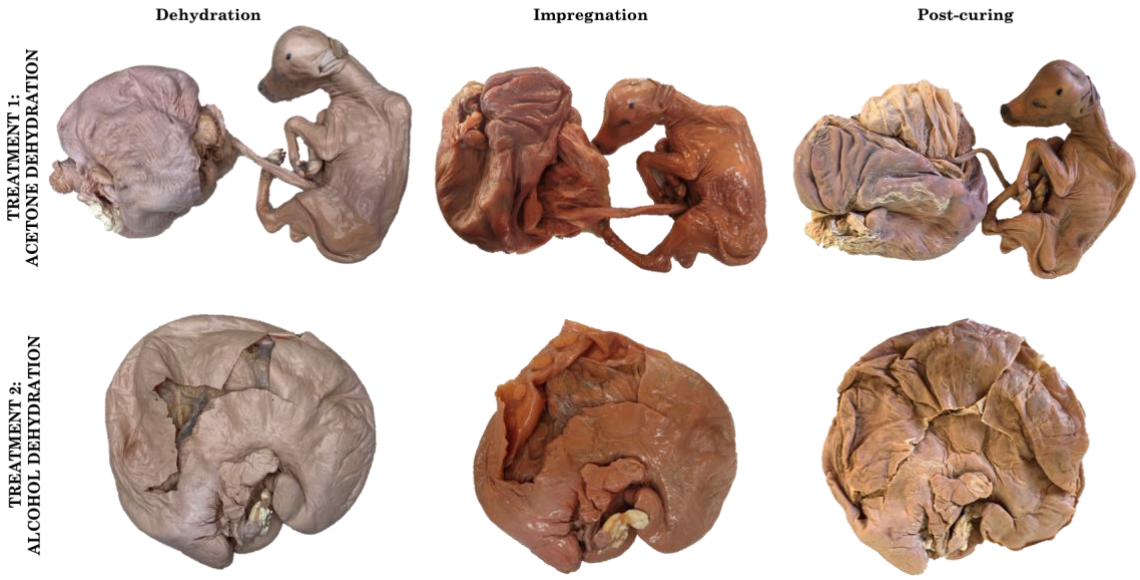

Figure 2. Color changes in ruminant gravid uteri following dehydration, impregnation, and post-curing with corn starch. Ruminant gravid uteri subjected to two dehydration treatments. Treatment 1 (acetone dehydration) and Treatment 2 (ethyl alcohol dehydration) are shown for each specimen across three stages: dehydration, glycerin impregnation, and post-curing. Images demonstrate changes in external morphology and coloration across treatments and stages.

malformations subjected to acetone dehydration showed weight reductions of 30.92% and 35.46%, while those dehydrated using ethyl alcohol exhibited reductions of 33.18% and 35.82% (Table 1).

Similarly, ruminant gravid uteri showed a 24.31% reduction under acetone treatment and 31.37–34.03% under alcohol treatment (Table 2). It can be noted that at room temperature, ethyl alcohol dehydration has shown a slight increase in

Table 1. Pre- and post-plastination weight of piglets with congenital malformation specimens.

Treatment	Pre-Plastination Wt. (g)	Post-Plastination Wt. (g)	Percent Difference
Treatment 1: Piglet with Anophthalmia and Agnathia	524	362	30.92%
Treatment 1: Piglet with Cyclopia	784	506	35.46%
Treatment 1 Mean weight	**654**	**434**	**33.64%**
Treatment 2: Piglet - Cephalopagus Twin	458	306	33.18%
Treatment 2: Piglet with Anophthalmia and Arrhinia	776	498	35.82%
Treatment 2 Mean weight	**617**	**402**	**34.85%**

Table 2. Pre- and post-plastination weight of ruminant gravid uteri.

Treatment	Pre-Plastination Wt. (g)	Post-Plastination Wt. (g)	Percent Difference
Treatment 1: Cattle gravid uterus	3567	2,700	24.31%
Treatment 2: Sheep gravid uterus	1154	792	31.37%
Treatment 2: Cattle gravid uterus	1243	820	34.03%

the shrinkage of tissues when compared to acetone dehydration. These results were higher when compared to those reported by Brown *et al.* [12], who observed a mean shrinkage of 20.2% for specimens dehydrated with acetone at room temperature and 22.6% for specimens dehydrated with methanol at room temperature. However, the pattern is similar to the findings of this study, where acetone dehydration has a slight difference when compared to alcohol dehydration, except for the piglet with cyclopia in Treatment 1, which exhibited greater shrinkage than the other specimens (Table 1; Figs. 1–3). Similarly, the tissue shrinkage observed in piglets has been relatively natural appearance, which is important for anatomical visualization and educational use.

Despite measurable shrinkage, the overall morphological conformation of the specimens was preserved. External anatomical structures remained clearly identifiable, and specimens retained flexibility and firmness after curing. Localized shrinkage was observed in certain structures, particularly the eyes, appeared collapsed, possibly due to dehydration-associated fluid loss (Figs. 1–3). However, these changes did not substantially compromise the overall anatomical integrity of the specimens. These

Figure 3. Color of piglets with congenital malformation and ruminant gravid uteri post-plastination process. Treatment 1 – Acetone dehydration [A) Piglet with anophthalmia and agnathia, B) Piglet with cyclopia, C) Cattle gravid uterus] and Treatment 2: Alcohol dehydration [D) Cephalopagus twin, E) Anophthalmia and arhinia, F) Ruminant gravid uteri] after six months post-plastination.

evident, as shown in Figure 2. This observation may be associated with the fact that the fetal body consists of about 70%–90% water, with a lower percentage close to term [13,14].

For the color changes of the specimen during the plastination process, the skin of the specimens on both treatments had a light brown color after impregnation; however, the color of the skin became lighter in color after drying (Figs. 1 and 2). These changes were assessed qualitatively based on visual observation, and no quantitative color analysis was performed. Although changes in coloration were noted, the specimens retained a findings were similar to Srisuwatanasagul *et al.* [6] who reported that acetone dehydration preserved a more natural coloration and produced negligible shrinkage in specific tissue, whereas alcohol dehydration yielded darker coloration and greater shrinkage.

Tissue shrinkage commences during the dehydration phase and is therefore a critical parameter in plastination research. In the present study, although substantial shrinkage was evident, as reflected by a substantial reduction in specimen weight following plastination, the morphological characteristics remained well

preserved. Specimens were dry, and devoid of odor even after a post-plastination period of six months. Comparable findings have been reported in multiple studies employing locally available materials and room-temperature plastination techniques. These investigations have demonstrated that organ plastinates are odorless, safer to handle than formalin-preserved specimens, mechanically robust, dry, flexible, and durable, while retaining a natural color and texture. Such specimens can be used over extended periods without decomposition, are lightweight and easily transportable, are convenient for educational use and as museum display material and require substantially less maintenance than conventional cadavers [2,4,6,7,9-11,15].

At present, most anatomical specimens are fixed in formalin and stored in liquid-filled glass jars. While formalin immersion is economical and affords long-term preservation, specimens remain bulkily housed, pose increased risk of formalin fume exposure, and limit the perceptible, hands-on interaction afforded by plastinates for instructional use [16]. Plastination offers a durable preservation technique for well-prepared specimens that have been stored for years to centuries in containers, rendering them easier to handle in practical anatomy courses [1,16,17]. These plastinated specimens can be used as an alternative animal model in the study of comparative anatomy to supplement gross dissection and reduce the exposure to formalin fumes during wet laboratory dissection.

4. Conclusions

This preliminary study demonstrates that both acetone- and ethyl alcohol–based dehydration methods are feasible for room-temperature plastination of developmental anatomy specimens, including piglets with congenital malformations and ruminant gravid uteri. Both dehydration protocols produced a reduction in specimen weight while maintaining good preservation of external morphological features. The plastinated specimens were flexible, firm, odorless, and retained a generally natural appearance, with some color variation observed between the acetone- and ethyl alcohol–treated groups. Ethyl alcohol was shown to be a feasible alternative to acetone for dehydration, with the added advantage that acetone is a controlled chemical and more difficult to procure. The findings indicate that this alternative plastination approach is a valuable method for the long-term preservation of anatomical specimens such as fetuses and ruminant gravid uteri, offering opportunities for repeated hands-on educational use while reducing exposure to formalin for educational and exhibition purposes.

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