Original Article

Innovative glycerin impregnation of female livestock genital organs and satisfaction assessment for veterinary anatomy education in Thailand

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Abstract

Veterinary anatomy education faces several challenges, including increasing student enrollment, regulatory restrictions on animal use, and limitations of traditional preservation methods. Formalin preservation poses health risks, while plastination is costly and lacks flexibility. The conventional and modified Elnady Techniques present a safer and more cost-effective alternative, offering soft and flexible specimens; however, the adverse features still appear, and some steps require expensive equipment. This study aims to refine these Elnady Techniques, called 'innovative glycerin impregnation' for preserving female reproductive organs by reducing costs and simplifying the process using basic equipment. Additionally, veterinary students' satisfaction with glycerin-preserved specimens was compared to that with plastinated specimens. Results showed that glycerin-preserved livestock genital tracts demonstrated superior characteristics, including softness, flexibility, endurance, and neutral odor. Fixation and dehydration at 4°C contributed to well-preserved specimens suitable for anatomical education. Veterinary students significantly ($P < 0.05$) preferred glycerin-preserved specimens over plastinated specimens for realism, clarity of anatomical details, softness, flexibility, artificial insemination (AI) training, and more effective for prosection-based learning in veterinary anatomy courses. In conclusion, glycerin impregnation proves to be a reliable preservation technique for high-quality anatomical specimens, meeting educational standards while being practical, cost-efficient, and environmentally friendly. This method can be easily implemented in general laboratories using simple equipment and chemicals, making it an accessible option for preserving animal specimens.

Keywords: glycerin permeation, livestock genitalia, preservative technique, teaching application, veterinary anatomy

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Introduction

In the veterinary anatomy II course, the content is directly associated with different animals composed of large ruminants, small ruminants, pigs, and horses. The Department of Anatomy, Faculty of Veterinary Science, Chulalongkorn University, has recognized the importance of the contribution of various teaching materials to assist veterinary students in comprehensively understanding the anatomical structures and functions in animals. At present, the number of veterinary students has increased due to Thailand's requirement and implementation of the Animals for Scientific Purposes Act, which impacts the use of animals for research and teaching. In such constricting situations, the development of novel techniques for the preservation of specimens is required to prepare suitable specimens for anatomical teaching in the laboratory, with the principles of health and safety for veterinary students and instructors. Notably, the process of a new method during specimen preservation must not cause environmental pollution.

An understanding of veterinary anatomy is necessary for reliable clinical practice and the enrichment of surgery (Turney, 2007). This skill requires constant revision and analysis to determine the teaching tools and approaches that best enhance the learning procedure (Moxham and Plaisant, 2007). For the visceral organs, especially the female reproductive tracts, the main important issue is finding mature female animals with fully developed reproductive organs to be used for study. Although purchasing the female reproductive organs of mature livestock animals from the local abattoirs is the main possibility for veterinary anatomy classes, it requires high financial support as well as the fresh organs might not be sufficient for veterinary students. For the outdated choice is to preserve the female reproductive organs with formalin for learning during anatomy laboratory sessions. Undoubtedly, formalin, as the condition of formaldehyde vapor, can cause irritation of the respiratory system, eyes, and skin, and formaldehyde is currently recognized as carcinogenic and genotoxic to humans (Adamović *et al*., 2021). An additional method used for preserving organs for anatomical studies is the technique called plastination, which is a process of preservation of anatomical specimens by impregnation with curable polymers to produce dry, enduring, odorless, and life-like organs (von Hagens *et al*., 1987). However, the cost of explicit silicone polymers is a crucial factor in plastination techniques. Furthermore, the plastinated organs are rigid and deficient in natural flexibility, which is a burden for the anatomy education and learning process, particularly for the visceral organs (Musumeci *et al*., 2003).

The recent procedure, 'the Elnady Technique', has been developed, and the specimens produced by this technique demonstrate realistic, lasting, soft, and flexible (Elnady, 2016; 2019). Better flexible specimens than plastinated organs are a great benefit for the veterinary anatomy teaching-learning practice. Moreover, the steps of the Elnady Technique permit a conservation process at room temperature, eliminating the expensive substances and equipment as required in a plastination laboratory (Elnady, 2016). However, the acetone-based dehydration of the Elnady Technique was done at room temperature, in which the samples produced, demonstrating shrinkage and an explosive risk of acetone (Brown *et al*., 2002).

The key objective of this study is, therefore, to adjust some steps of the 'Elnady Technique' to preserve the female reproductive organs of livestock. These improvements will result in more natural and realistic preserved glycerin specimens while reducing both time intervals and overall expenses. An additional aim is to evaluate the satisfaction of second-year veterinary students regarding the use of preserved glycerin specimens compared to the plastinated specimens.

Materials and Methods

Specimens: Female reproductive tracts from a cow (n = 1) and a sow (n = 1) were obtained from local slaughterhouses in Nakhon Pathom Province, while a reproductive tract from a nanny goat (n = 1) was generously provided by the Department of Pathology, Faculty of Veterinary Medicine, Chulalongkorn University. The donated specimen was confirmed to be free from infectious diseases, including Brucellosis. The female reproductive organs were transported to the laboratory within 6–10 hours postmortem. All specimens were in optimal external condition, free from trauma, bruising, hemorrhages, tears, or any abnormal lesions, such as abscesses or tumors. All experimental procedures in this study were conducted at the Department of Anatomy, Faculty of Veterinary Science, Chulalongkorn University, Thailand.

Fixation and dissection: All specimens were initially immersed in plastic containers with adequate specific solutions, in which 1 L of this solution was composed of 700 mL of tap water, 100 mL of 37% formaldehyde, 100 mL of 95% alcohol, 90 mL of glycerin, and 10 mL of phenol. For the fixative medium, this experiment was adapted by using phenol instead of thymol crystal as presented in a former study (Bernal *et al*., 2022). The solution was stirred for 5 min, and the solution/organ ratio was about 5 times the original volume of the sample. To avoid floating, the specimens were submerged in the fixative solution and covered with cotton cloths. The solution and the samples were kept in properly closed plastic boxes and stored at temperatures of 4°C. This process was different from the previous reports (Elnady, 2016; Bernal *et al*., 2022) since the fixation step in this research was done in a household refrigerator. The fixation time of all specimens in this study was 30 days. After the fixation was finished, the samples were removed and washed with running tap water for 48 hours. Following, dissections were accomplished by removing excessive fat and other connective tissue from the specimens. Furthermore, the fixative specimens were bleached with hydrogen peroxide (H_2O_2) at a volume ratio of 5:1, depending on the volume of the specimen, for 24 hours. The formula to convert weight (kg) to volume (L) is Volume (L) = Mass (kg)/Density (kg/L), in which the density of the female reproductive tract in domestic

animals is approximately 1.06 kg/L (Halper and Kjaer, 2014).

Acetone-based dehydration: This step was performed to remove water and lipids from tissues. After fixation and bleaching were completed, the reproductive organs were immersed in 80% acetone at 4°C for 2 weeks, followed by 90% acetone at 4°C for 2 weeks, and finishing with 100% acetone at room temperature for 4 weeks. The volume of acetone used for immersing the samples was 5 times the volume of the organs. This process was partially different from the earlier report (Bernal *et al*., 2022) because the dehydration step in this study was applied in a household refrigerator.

Glycerin impregnation: This process was performed once the dehydration step was finished. After rinsing the specimens from acetone, they were then immersed in a tightly sealed container filled with glycerin at a volume ratio of 5:1, depending on the volume of the specimens, and left at room temperature for 12 weeks. To protect the floating, each female genital specimen was pressed with cotton clothes.

Curing specimens: This step was composed of draining and finishing. After the specimens were saturated with pure glycerin, they were removed from the container, drained of excess glycerin for 10 days, and wiped the excess glycerin with adsorbent paper or a sponge. Then, the finishing step was done by storing it in the cornstarch. The female organs were kept in sealed cotton bags to ensure that specimens were not in direct contact with the cornstarch. The containers were left at room temperature for 4 weeks until glycerin exudation was no longer detected. Once the curing process was completed, the female reproductive specimens were scrubbed with soft brushes or air compressors and stored at room temperature.

Satisfaction evaluation: A questionnaire was created to assess the learning satisfaction between glycerin-impregnated specimens and plastinated specimens as prosection-based learning (Appendix 1). The anonymous second-year students (n = 20) who formerly attended both Veterinary Anatomy I and II courses (academic year 2024) at the Faculty of Veterinary Science, Chulalongkorn University were participated randomly in this evaluation. The questions were composed of; 1) realistic nature of shape and size, 2) suitability of color and external texture, 3) clarity of anatomy details, 4) softness and flexibility of handling for study purposes, 5) durability of specimen, 6) safety in handling and health risks, 7) suitability of odor during study, 8) easiness of cleaning and storage, 9) capability to apply in clinical practice (e.g., inserting a catheter for artificial insemination), and 10) overall suitability or satisfaction as prosection-based anatomy learning. A closed questionnaire using a five-point numerical assessment Likert scales (1 = least satisfied/strongly disagree, 2 = slightly satisfied/slightly disagree, 3 = moderately satisfied/somewhat agree, 4 = very satisfied/agree, and 5 = most satisfied/strongly agree) was prepared for all students referring to the effectiveness of two different specimens.

Statistical analysis: Statistical analyses were performed using SAS software (version 9.4, SAS Institute Inc., Cary, NC, USA). Satisfaction scores are reported as mean ± standard deviation (S.D.). Comparisons between glycerin-preserved and plastinated specimens were performed using Wilcoxon rank-sum tests, with statistical significance defined as $P < 0.05$.

Result

All female livestock genital tracts made by an innovative glycerin permeation procedure exhibited the necessary conditions that we certainly required in the present trial, that is, the softness, flexibility, endurance, and neutral odor of specimens. The interval operated to accomplish the total steps in this experiment was approximately 213 days (Table 1).

In this experiment, the primary modifications involved changes to the fixation and dehydration steps, where specimens were stored in a fixative medium and acetone at 4°C (using a household refrigerator). Additionally, a minor adaptation was made by replacing thymol with phenol to inhibit fungal growth. Although slight alterations such as shrinkage and distortion were observed in all female reproductive tracts (Figs. 1–3), the key anatomical structures including the ovaries, uterine tubes (oviducts), uterus (comprising the uterine horns, body, and cervix), broad ligament, vagina, vulva, urinary bladder, urethra, and rectum, were distinctly recognized (Figs. 1–3). The external characteristics of all specimens were well-preserved, whereas the internal features observed by longitudinally cutting through the uterine horns and urinary bladders were also adequately conserved. Additionally, for the softness and flexibility, our study found that all specimen surfaces were easily pierced by small pins, and the genital specimens were twisted in every direction. Regarding the color change, specimens preserved by this method expressed deep yellow compared with the fresh reproductive organs collected from the abattoir. However, the homogeneous dark yellow tissue did not impair the identification of the compulsory anatomical structures. Unexpectedly, the caprine genital tract in this study was in the pregnant stage, therefore the anatomical terms such as goat fetus, umbilical cord, and concaved placentomes (caruncles and cotyledons) appeared in the right uterine horn (Fig. 3). The preserved glycerin specimens, developed through modifications in fixation and dehydration at temperatures of 4°C, demonstrated excellent and natural characteristics for anatomical education, particularly in prosection-based courses.

The satisfaction results between preserved glycerin specimens and plastinated specimens from veterinary students obtained for each question are shown in Figure 4. Definitely, most questions in the questionnaire were related to the effectiveness of using the specimens as a prosection-based strategy during the anatomy course. In questions 1–4 (1: realistic nature of shape and size, 2: suitability of color and external texture, 3: clarity of anatomical details, 4: easiness and flexibility of handling) the levels of student satisfaction

with the preserved glycerin specimens were significantly higher ($P < 0.05$) than the plastinated specimens (Fig. 4). In contrast, the evaluation in question 5 (durability of specimens), the plastinated samples exhibit significant greater ($P < 0.05$) than the glycerin samples. However, the mean scores of student satisfaction in questions 6–8 (6: safety and health risks, 7: suitability of odor during study, and 8: ease of cleaning and storage) were not significantly different ($P > 0.05$). Remarkably, the capability to apply the specimens in clinical practice (question 9), the results showed that the preserved glycerin specimens were better ($P < 0.05$) for artificial insemination (AI) practice than the plastinated specimens with mean scores of 3.65 ± 1.04 and 1.65 ± 0.74, respectively. Finally, the overall suitability as prosection-based anatomy education (question 10), most veterinary students believed that the preserved glycerin specimens improved their ability to better understand and learn veterinary anatomy ($P < 0.05$) than the plastinated specimens, with the mean scores of 4.60 ± 0.59 and 2.25 ± 0.85, respectively.

Table 1 Procedures and interval of modified glycerin permeation technique required for preservation of mature reproductive tracts of sow (n = 1), cow (n = 1), and nanny goat (n = 1).

Preservation procedures	Day/days
Fixation and dissection:	
Fixation (4°C)	30
Rinsing	2
Dissection	2
Bleaching (room temperature)	2
Acetone-based dehydration:	
80% Acetone (4°C)	14
90% Acetone (4°C)	14
100% Acetone (room temperature)	28
Glycerin impregnation:	84
Curing:	
Draining (room temperature)	10
Finishing (room temperature)	28
Total	214

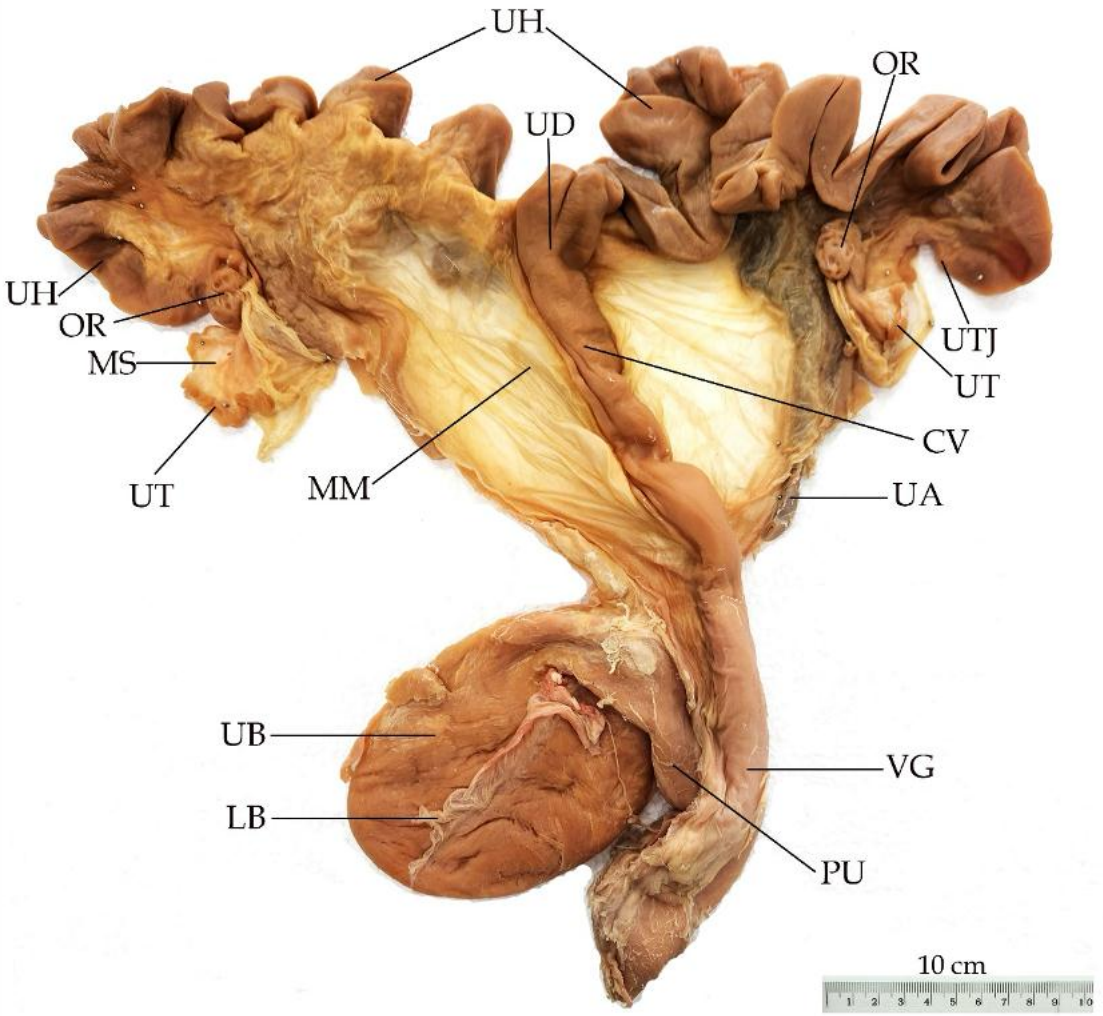

Figure 1 Dorsal view of the porcine female reproductive tract preserved by the adapted glycerin permeation technique. UH = uterine horn; UD = uterine body; CV = uterine cervix; UT = uterine tube (oviduct); UTJ = utero-tubal junction; OR = ovary; MS = mesosalpinx; MM = mesometrium; UA = uterine artery; UB = urinary bladder; LB = lateral ligament of the bladder; VG = vagina; PU = pelvic urethra. Scale bar = 10 cm.

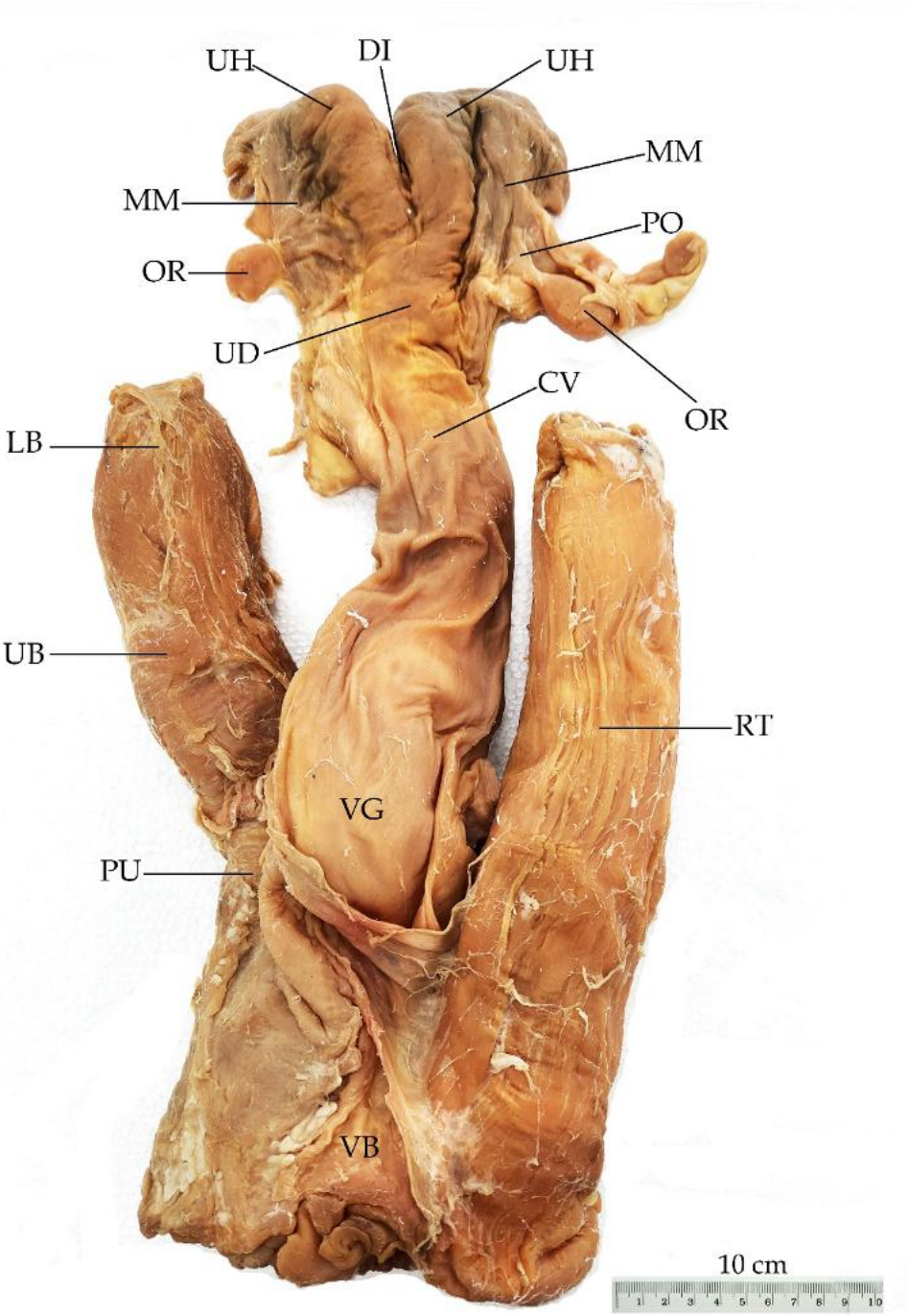

Figure 2 Dorsal view of the bovine female reproductive tract preserved by the adapted glycerin permeation technique. DI = dorsal intercornual ligament; UH = uterine horn; UD = uterine body; CV = uterine cervix; OR = ovary; MM = mesometrium; PO = proper ligament of the ovary; UB = urinary bladder; LB = lateral ligament of the bladder; VG = vagina; PU = pelvic urethra; VB = vestibule; RT = rectum. Scale bar = 10 cm.

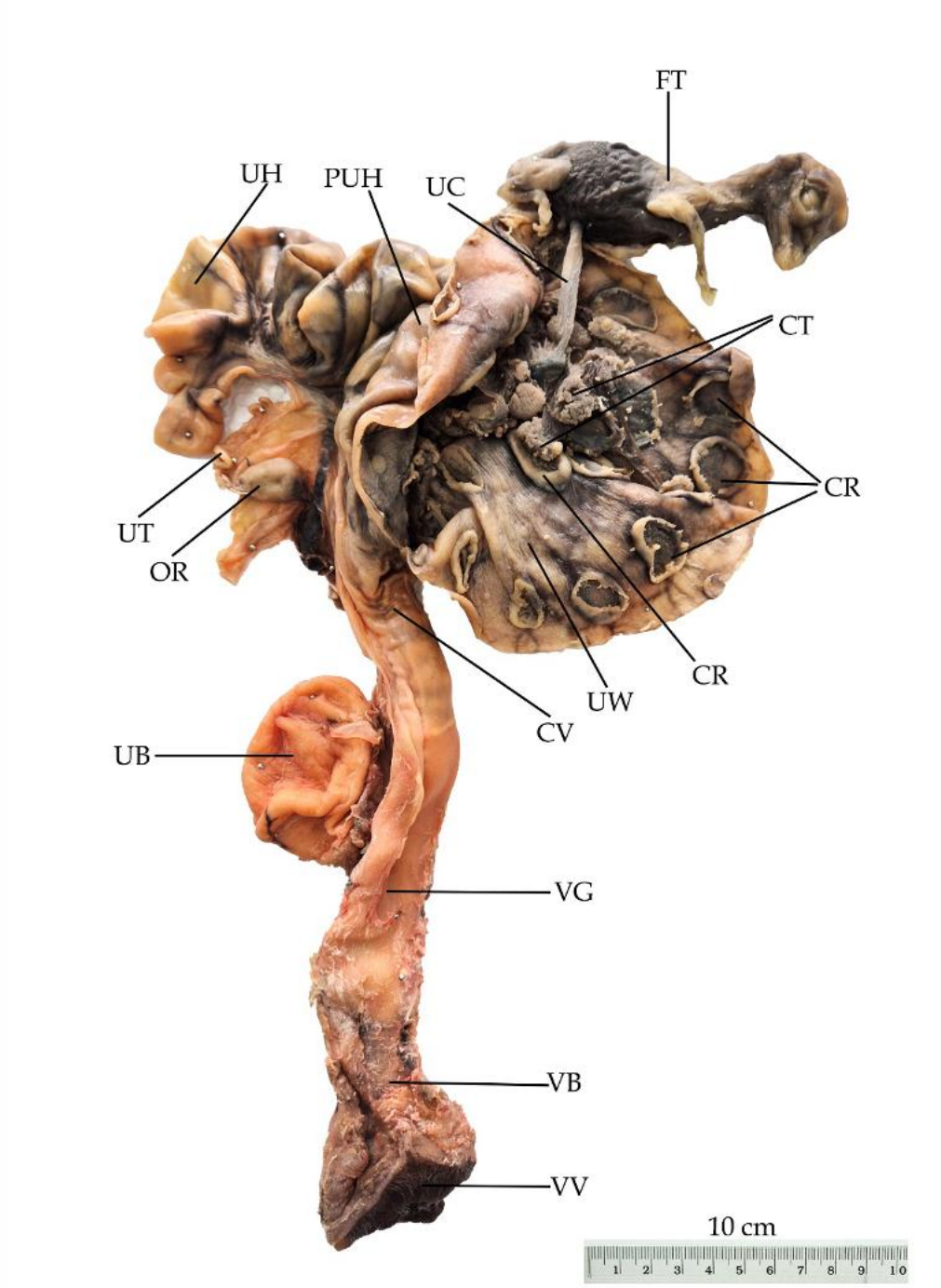

Figure 3 Dorsal view of the caprine female reproductive tract preserved by the adapted glycerin permeation technique. UH = normal uterine horn; PUH = pregnant uterine horn; UW = uterine wall; CR = caruncle; CT = cotyledon; UC = umbilical cord; FT = goat fetus; UT = uterine tube (oviduct); OR = ovary; CV = cervix; UB = urinary bladder; VG = vagina; VB = vestibule; VG = vagina; VV = vulva. Scale bar = 10 cm.

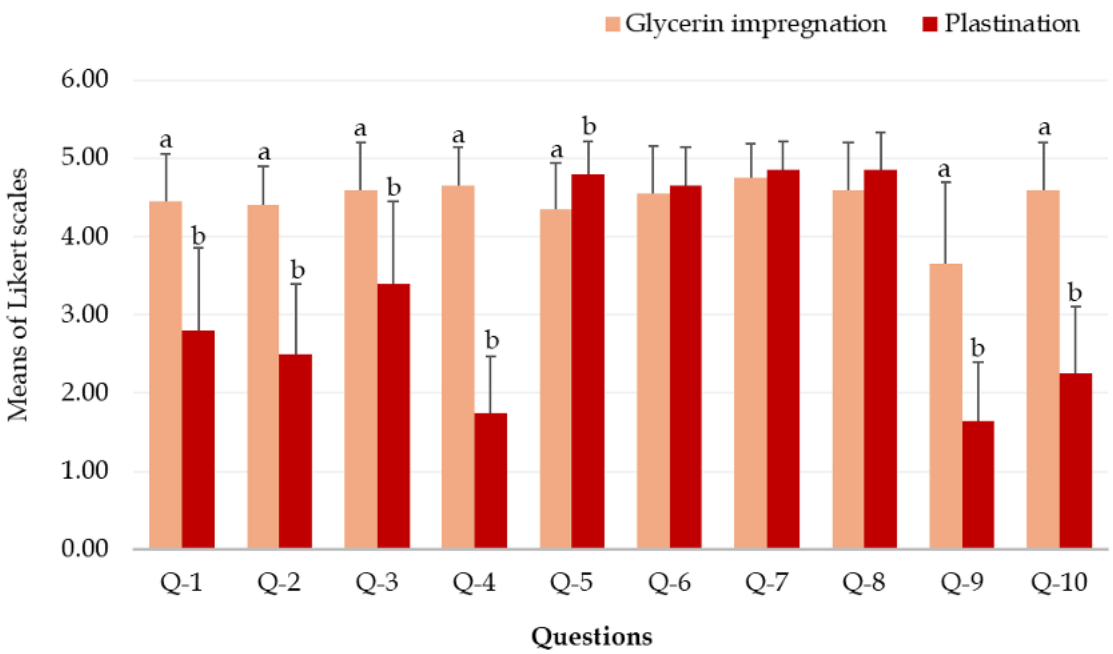

Figure 4 Comparison of satisfaction answers (mean ± S.D.) by the second-year veterinary students (n = 20) from the Faculty of Veterinary Science, Chulalongkorn University, for learning evaluation between glycerin impregnation specimens and plastinated specimens in prosection-based anatomy education. The letters a and b indicate the significant differences between glycerin-impregnated and plastinated specimens ($P < 0.05$).

Discussion

A more effective approach to advanced veterinary anatomy education is the integration of multiple resources that complement one another, enhancing students' understanding. One such method, known as "prosection", involves expert-led dissection of specimens specifically prepared for teaching purposes (Dinsmore *et al*., 1999; Turney, 2007). Since certain structures, for example, female reproductive organs, including their blood vessels and associated ligaments, are located deep within the pelvic cavity, dissection can be challenging. Consequently, traditional dissection does not align well with a system-based learning approach. Instead, prosection is recommended as an alternative methodology, replacing the conventional regional approach to dissection (Leung *et al*., 2006). Prosection-based learning offers numerous advantages due to its flexibility, contextual relevance, and time efficiency, as anatomical structures are easily identifiable (Dinsmore *et al*., 1999). This approach has been implemented in veterinary anatomy courses within our department for an extended period, using formalin-fixed specimens. Improvements in plastination techniques, however, plastinated specimens have become the preferred choice for prosection-based learning over formalin-fixed specimens due to their odorless nature, ease of handling, and convenient storage (Fruhstorfer *et al*., 2011). Despite these benefits, plastinated specimen has limitations, including tissue shrinkage, stiff texture, unnatural coloration, and loss of fine anatomical details (Estai and Bunt, 2016). Compared to plastinated specimens, the innovative glycerin-preserved specimens developed in this study offer superior softness, flexibility, and anatomical clarity, resulting in higher satisfaction scores as learning aids. Subsequently, glycerin-preserved specimens are better suited for prosection-based learning in anatomical education.

The conventional 'Elnady Technique' is an adapted plastination procedure comprising five key steps: fixation with formalin, dye injection and dissection, dehydration with acetone, impregnation in glycerin, and curing with cornstarch (Elnady, 2016). Consequently, this technique has undergone modifications, including prolonged durations for each of the main steps and an adjustment to the dehydration process, in which acetone is applied at –5°C instead of room temperature (Bernal *et al*., 2022). In the present study, glycerin-preserved specimens were produced using a four-step process: fixation and dissection, dehydration, impregnation, and curing. The duration of most steps followed the protocol outlined by Bernal *et al*. (2022) for canine heart, except for the glycerin impregnation, which was conducted about 84 days, as applied for equine heart. Notable modifications in this experiment were implemented during the fixation and dehydration steps. Fixed specimens were maintained at 4°C throughout the process, and dehydration with 80% and 90% acetone was conducted at 4°C rather than −5°C. It is known that tissue fixation procedures are able to differ between laboratories, normally based on the characteristics of the organs and the experience of the technician or anatomist (Sadeesh *et al*., 2020). In this study, the collected female reproductive tracts were immediately preserved in specific fixative without dissection. This approach was adopted to prevent prolonged handling, as extensive dissection may be time-consuming and could lead to tissue deterioration if specimens are left exposed for an extended period during the process. In practice, this protocol is widely used for the preservation of visceral organs isolated from domestic animals, and the 30-day interval

ensures the complete penetration of formalin and other chemical agents into the tissues of female genital organs (Kalanjati *et al*., 2012). Furthermore, fixation was performed in a household refrigerator at 4°C to decelerate tissue decomposition in large specimens, mitigate discoloration, and reduce the hardening effects of formalin (Oostrum, 1987). This temperature control was a crucial factor in maintaining the softness, flexibility, and natural coloration of the female livestock reproductive tracts after the fixation step. Additionally, refrigerated storage of fixed specimens plays an important role in reducing formaldehyde exposure for anatomy staff, thereby enhancing laboratory safety.

In this experiment, phenol was incorporated into the fixative medium as a fungicide, replacing thymol crystals. Both chemicals are phenolic compounds known for their broad-spectrum antifungal activity, primarily by disrupting fungal cell membranes and metabolic processes (Sinnott *et al*., 1993). However, concerns arise regarding the toxicity of phenolic compounds to humans, as they have been linked to various health effects (Liu and Mabury, 2020). Boric acid has demonstrated a strong antifungal effect against *Penicillium expansum*, completely inhibiting its growth at higher concentrations (Lai *et al*., 2016), while being notably less toxic to humans and animals (Palanti and Feci, 2013). Given its eco-friendly nature, boric acid must be considered as a sustainable alternative for fungal inhibition in future experiments.

In the dehydration process, the fundamental principle is to replace tissue water and fluids with a dehydrating agent. Acetone is widely regarded as an effective dehydration agent due to its ability to efficiently extract water from tissues. Additionally, it serves as a powerful defatting agent and an intermediary solvent, facilitating thorough dehydration while preserving tissue integrity (Henry, 1992). In silicone plastination, the dehydration process involves freeze substitution in acetone at −25°C for 3–5 weeks, effectively minimizing tissue shrinkage (Mustafa and Tatar, 2014). The acetone-based dehydration process at room temperature is known to cause excessive tissue shrinkage and is insufficient for achieving complete dehydration of specimens. This limitation stems from the rapid evaporation of acetone, which can result in uneven fluid exchange within the tissue, ultimately compromising its structural integrity (Brown *et al*., 2002). Using standard laboratory equipment, the dehydration process in this study was conducted sequentially with acetone concentrations of 80% and 90% at 4°C, followed by final dehydration with 100% acetone at room temperature (27–30°C). Although direct comparisons of tissue shrinkage between 4°C (in a general refrigerator) and −25°C (in the freezer) were not performed, maintaining a low temperature in a household refrigerator was effective in minimizing tissue shrinkage and preserving the structural integrity of the specimens. As a result, these modifications ensured that all female genital organs exhibited minimal shrinkage, making them optimal for educational purposes.

Regarding glycerin permeation, glycerin is utilized in this procedure due to its key preservation properties, including non-toxicity, plasticizing effects, hygroscopic nature, and strong penetrating ability. Definitely, these characteristics make glycerin an effective agent for maintaining tissue integrity and flexibility in isolated visceral organs of both humans and animals (Reihl *et al*., 2022; Ahmed *et al*., 2024; Daneil and Kukor, 2024). In this experiment, the duration of glycerin impregnation for preserving female livestock genital organs was approximately 12 weeks, consistent with a previous study on adult equine hearts (Bernal *et al*., 2022). This period is significantly longer than the 1 to 2 weeks described in the original technique (Elnady, 2016). Factors that affect the duration of glycerin permeation are related to the type of specimens and the environmental conditions, such as the surrounding temperature. Due to glycerin's viscosity having an inverse correlation with temperature, the impregnation rate at high temperatures is faster than at lower temperatures (Bernal *et al*., 2022). The extended 12-week interval was chosen due to the substantial size and thickness of livestock reproductive organs, particularly in cows, and aligned with the average annual temperature (25–30°C) in Thailand. Under these conditions, the preserved female genital tracts in this study exhibited suitable characteristics, indicating the effectiveness of this protocol for maintaining flexibility in livestock tubular organs.

This study aimed to improve the glycerin impregnation technique to enhance the natural appearance of female livestock reproductive specimens for prosection-based anatomy teaching. The satisfaction evaluation results highlight the superior suitability of preserved glycerin specimens compared to plastinated specimens, particularly in improving veterinary students' comprehension and engagement with anatomical structures. Notably, glycerin-preserved specimens scored significantly higher ($P < 0.05$) in key aspects such as anatomical detail clarity, softness, flexibility, and overall suitability. These findings suggest that glycerin specimens provide a more accurate representation of animal anatomy and facilitate a more effective hands-on learning experience, aligning with previous research (Elnady, 2019; Daniel and Kukor, 2024). Regarding durability, plastinated specimens received higher evaluation scores compared to glycerin-preserved samples. However, to assess long-term durability, the glycerin specimens will be monitored and recorded annually. Factors such as safety, odor, ease of cleaning, and storage did not show statistically significant differences between the two preservation methods ($P > 0.05$), indicating that glycerin-preserved specimens maintain quality comparable to plastinated specimens (Elnady, 2016; Bernal *et al*., 2022). Furthermore, for clinical practice in female livestock, such as artificial insemination (AI), glycerin-preserved specimens were found to be significantly more effective ($P < 0.05$) than plastinated specimens. This suggests that glycerin specimens not only serve as valuable educational tools for prosection-based anatomy teaching but also closely mimic physiological properties essential for clinical training. Overall, these findings support the integration of glycerin-preserved specimens into veterinary anatomy curricula to enhance student

engagement, comprehension, and hands-on skill development.

In conclusion, this study establishes that innovative glycerin impregnation is an effective preservation technique for producing high-quality anatomical specimens with optimal softness, flexibility, and safety, aligning with the standards for prosection-based learning in veterinary anatomy education. This cost-effective and adaptable method can be easily implemented in normal anatomy laboratories using basic equipment and readily available chemicals, making it a practical alternative to conventional preservation techniques for animal specimens.

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Appendix 1 Student satisfaction questionnaire use of female reproductive specimens preserved by two different techniques in prosection-based learning for Veterinary Anatomy II

Rating Scale (5 Levels):
5 = Most satisfied / Liked it the most / Strongly agree
4 = Very satisfied / Liked it / Agree
3 = Moderately satisfied / Neutral
2 = Slightly satisfied / Liked it less / Disagree
1 = Least satisfied / Did not like it / Strongly disagree

Topics	Types of specimens	
	1) Modified glycerin impregnation technique	2) Plastination method
1. Realism of Shape and Size (Deformation, distortion, shrinkage, or noticeable differences from the actual anatomical structure)	□ 5 □ 4 □ 3 □ 2 □ 1	□ 5 □ 4 □ 3 □ 2 □ 1
2. Appropriateness of Color and External Surface (Color closely resembles that of the actual organ; the outer surface is clean and free from contaminants or foreign materials)	□ 5 □ 4 □ 3 □ 2 □ 1	□ 5 □ 4 □ 3 □ 2 □ 1
3. Visibility of Relevant Anatomical Structures (Essential features of the organ are clearly identifiable for educational purposes)	□ 5 □ 4 □ 3 □ 2 □ 1	□ 5 □ 4 □ 3 □ 2 □ 1
4. Practical Handling and Manipulation of the Specimen (Assessed by the ease of dissection, ability to tie anatomical structures, and suitability for pinning without damage)	□ 5 □ 4 □ 3 □ 2 □ 1	□ 5 □ 4 □ 3 □ 2 □ 1
5. Long-Term Usability and Physical Robustness (Evaluated by the specimen's strength upon handling and its ability to withstand repeated use without deterioration)	□ 5 □ 4 □ 3 □ 2 □ 1	□ 5 □ 4 □ 3 □ 2 □ 1
6. Specimen Handling Safety and Potential Health Concerns (Assessment of whether the specimen can be safely touched and whether any chemicals used in its preparation may present health risks)	□ 5 □ 4 □ 3 □ 2 □ 1	□ 5 □ 4 □ 3 □ 2 □ 1
7. Suitability of Specimen Odor for Educational Use (Evaluates whether the odor released during study is tolerable and does not distract or cause discomfort)	□ 5 □ 4 □ 3 □ 2 □ 1	□ 5 □ 4 □ 3 □ 2 □ 1
8. Convenience of Maintenance and Storage Conditions (Evaluation of how easily the specimen can be cleaned and whether it requires specialized chemical solutions or can be kept in a regular container)	□ 5 □ 4 □ 3 □ 2 □ 1	□ 5 □ 4 □ 3 □ 2 □ 1
9. Practical Utility for Clinical Skill Development (Including the specimen's capacity to support hands-on training in procedures like artificial insemination)	□ 5 □ 4 □ 3 □ 2 □ 1	□ 5 □ 4 □ 3 □ 2 □ 1
10. Comprehensive Evaluation of Specimen Use for Teaching Anatomy through Prosection	□ 5 □ 4 □ 3 □ 2 □ 1	□ 5 □ 4 □ 3 □ 2 □ 1

Many thanks in advance for taking part in this survey. Your responses will be anonymized, and your data will be securely stored in accordance with the Data Protection Act.