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Coloured organ specimen: An efficient tool in veterinary anatomy education

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Abstract
The museum in veterinary anatomy holds significant importance as it provides students with access to bones, wet specimens, models, charts, and dry specimens, thereby enhancing their interest and facilitating knowledge dissemination. In this study, we employed a colouring technique using acrylic paints, enamel paint, and transparent nail paint to highlight arteries, veins, nerves, and other structures in gross specimens. These coloured specimens were then preserved in jars filled with formalin. The colouring method not only enhances the visual appeal of the wet specimens but also actively engages students in the learning process, facilitating improved retention of information. The painted wet specimens remained stable in a 10% formalin solution without any noticeable changes in colour, making them valuable resources for studying and gaining a better understanding of the various organs within the animal body.

Keywords: Coloured, museum, anatomy, acrylic painting, wet specimen, formalin solution

Introduction
Veterinary anatomy is a fundamental science that focuses on the structure and form of the animal body. It plays a crucial role in providing veterinary students with an initial understanding of the various structures present in a normal animal body. A strong foundation in gross anatomy is essential for veterinary practitioners as it enables them to perform essential clinical tasks, including physical examinations, radiographic evaluations, emergency procedures, and other practical interventions (Dinsmore *et al.*, 1999; Turney, 2007) [2, 14]. Museums serve as invaluable resources for anatomy departments, housing anatomical specimens, bones, and models. They provide a treasure trove of knowledge, allowing for comprehensive study and appreciation of the subject matter. The educational effectiveness of museums stems from the principle that viewing objects facilitates better retention and recall compared to relying solely on written or verbal descriptions [4].
Various techniques have been employed by researchers to enhance the visualization of anatomical specimens. These techniques include using albuminous paints (Congdon, 1932) [1], intra-vascular injections of silicone, gelatin, latex, or epoxy to highlight vessels (Tiedemann and Hagens, 1982; Oostrom, 1987; Oostrom and von Hagens, 1988; Riepertinger and Heuckendorf, 1993; Grondin and Olry, 1996) [13, 8, 7, 10, 3], and the use of silicon for colouring plastinated specimens (Henry *et al.*, 1997) [4]. In our study, we employed a technique using acrylic paints mixed with white enamel paint to permanently colour anatomical landmarks, arteries, nerves, veins, ligaments, and other structures within glass jars filled with 10 per cent formalin. This colouring technique provides students with valuable information about the complex anatomical architecture and variations in the distribution of vessels, nerves, muscles, and more. It enhances the educational experience and contributes to a comprehensive understanding of veterinary anatomy.

Materials and Methods
The wet specimens used in this study were obtained from embalmed organs of well-arterial embalmed cadavers from the Department of Anatomy, Apollo College of Veterinary Medicine, Jaipur, India. The colouring technique involved the use of acrylic paints, synthetic enamel paints, painting brushes of various sizes, transparent nail polish, and turpentine oil for brush cleaning. Transparent nail polish was chosen for its cost-effectiveness and non-toxic nature, which also prevents colour bleeding into the mounting fluid and enhances the durability of the specimen.

The step-by-step procedure for preparing the wet-coloured specimens was as follows

1. The dissected organs from arterial embalmed cadavers were selected as wet specimens. The organs were properly aligned on an acrylic plastic sheet, with the desired surface facing upwards, and secured using surgical thread.
2. The specimens were left to dry at room temperature for 48 to 72 hours. Swabs of cotton were placed underneath vessels and nerves to elevate them from underlying structures and prevent the collapse of vessel walls.
3. Meanwhile, gelatin powder was mixed with water and heated to prepare a solution. The solution was allowed to cool to room temperature.
4. Once the organs were completely dry, a thin layer of the gelatin solution was applied to the entire surface using a paintbrush. The organs were then allowed to dry for 2-3 days, resulting in a glistening appearance. Additional coats of the gelatin solution were applied and dried.
5. Acrylic and enamel paint colours were prepared by mixing them on a glass colour plate to achieve the desired shades.
6. The structures that dry first, such as vessels and nerves, were painted with specific colours. For example, red paint was used for arteries, blue for veins, and yellow for nerves. Step by step, other structures were painted accordingly.
7. The specimen was left to dry for 24-48 hours, and any missing areas were thoroughly painted.
8. A final coat of transparent nail polish was applied to the painted surface and left to dry overnight. This top coating helps prevent the peeling of colours in the mounting media.
9. The organ was then left to dry completely for 2-4 days at room temperature.
10. Numbering was done on the selected areas for identification purposes.
11. The specimens were placed in glass jars containing a 10% formalin solution, supported with a perspex plate. The jars were sealed with lids and secured with cello tape, and then placed in the museum. Proper labelling was applied to each specimen.

Results

The colouring technique using non-toxic, readily available, and cost-effective paints proved to be successful in colouring various important structures of the specimens with anatomically correct colours. The specimens were preserved in 10% formalin solution, and no bleeding of colours was observed in the painted specimens. The method was simple and required minimal time and labour. The mixture of acrylic colours and enamel paint allowed for the uniform spreading of colours over different structures. The top-coating of clear nail polish added shine and durability to the specimens. The painted specimens, when kept in formalin-filled jars, remained well-preserved without any visible colour bleeding.

These painted specimens serve as valuable tools for teaching anatomy, particularly in the cardiovascular, respiratory, digestive, and urogenital systems. The technique enhances the teaching and learning process by making the desired structures in wet specimens visually appealing and vibrant. The use of colours aids in long-term memory retention, facilitating the identification and understanding of the relationships between various structures in the specimens. Overall, this colouring technique enhances the aesthetic value of the museum and provides an effective means of teaching and learning anatomy.

Discussion

In the present study, we used acrylic paints, enamel paints, and transparent nail polish to colour the wet organ specimens. This technique provided a simple and cost-effective method for achieving anatomically correct colours and enhancing the visualization of anatomical structures. The use of non-toxic and commercially available paints made the process easily accessible and safe for both students and researchers.

Comparing our technique with previous studies, it can be noted that different methods have been employed to colour specimens, including the use of albuminous paint (Congdon, 1932) [1], intra-vascular injection of silicone, gelatin, latex, or epoxy (Tiedemann and Hagens, 1982; Oostrom, 1987; Oostrom and von Hagens, 1988; Riepertinger and Heuckendorf, 1993; Grondin and Olry, 1996) [13, 8, 7, 10, 3], silicon colouring of plastinated specimens (Henry *et al.*, 1997) [4], and other variations. Each technique has its own advantages and limitations, and the choice of method depends on the specific requirements and objectives of the study.

Our technique of using acrylic paints, enamel paints, and transparent nail polish offered several advantages. Firstly, the materials used were easily accessible and cost-effective, making it feasible for educational institutions with limited resources. Additionally, the use of transparent nail polish as a top coat provided a protective layer that prevented the peeling of colours and increased the durability of the specimens. The coloured organ specimens remained stable and well-preserved in 10% formalin solution without any visible colour change, indicating the long-term stability of the painted structures. This is essential for the longevity and usefulness of the specimens in teaching and learning activities.

The vibrant colours of the painted specimens significantly enhanced the visualization of anatomical structures, making it easier for students to identify and understand the gross features. The use of colours has been shown to enhance long-term memory retention, and by incorporating colours into the specimens, students are likely to have a better recall of the anatomical details and relationships.

Furthermore, the coloured specimens serve as valuable teaching tools, particularly in the study of cardiovascular, respiratory, digestive, and urogenital systems. They can be used to demonstrate specific structures, highlight anatomical variations, and aid in the understanding of complex anatomical relationships. The enhanced aesthetic value of the museum with the presence of vibrant and visually appealing specimens can also contribute to a more engaging learning environment.

Table 1: List of the materials used by different researchers for colouring wet specimens.

Sr. No.	Authors	Year	Materials Used
1	Congdon [1]	1932	Albuminous paint
2	Saunders and Rice [11]	1944	Lacquer
3	Henry *et al.* [4]	1997	Silicon
4	Jain and Babel [5]	2014	Camlin oil paints and white enamel paints
5	Prabhu *et al.* [9]	2015	Acrylic or poster paint, nail paint & amyl acetate
6	Kaur *et al.* [6]	2017	Acrylic paints, white synthetic enamel paint, transparent nail paint
7	Shrestha *et al.* [12]	2020	Acrylic paints, transparent nail polish

In Table 1, Congdon (1932) [1] used albuminous paints to colour the specimen [1]. Intra-vascular injection of silicone, gelatin, latex or epoxy was used to highlight the vessels (Tiedemann and Hagens, 1982; Oostrom, 1987; Oostrom and von Hagens, 1988; Riepertinger and Heuckendorf, 1993; Grondin and Olry, 1996) [13, 8, 7, 10, 3]. Saunders and Rice (1944) emphasized the use of lacquer for painting wet specimens which proved satisfactory for larger vessels but not for the smaller tissues as the colours blurred and peeled away [11]. Henry *et al.* (1997) [4] preferred silicon to colour-plastinated specimens [4]. Jain and Babel (2014) [5] used camlin oil paints mixed with white enamel paint to colour the specimens and kept these specimens in a 10 per cent formalin-filled jar [5]. Prabhu *et al.* (2015) used acrylic colours and commercially available nail polish with amyl acetate to colour structures on wet specimens [9]. In our work, we used a mixture of acrylic paint and synthetic enamel paint which can dry very quickly and provides excellent coverage. This method is also supported by Kaur *et al.* (2017) [6] and Shrestha *et al.* [12] who explained that acrylic paint can produce a film of great clarity and use of transparent nail polish is cost-effective, non-toxic and prevents the running of colour in the mounting fluid [6, 12]. Jain and Babel (2014) [5], Prabhu *et al.* (2015) [9] and Kaur *et al.* (2017) [6], have reported no deterioration of the colours for a period of more than five years which was in accordance with our results.

Proper drying of the wet specimen should be done before the application of colour and that structure which dry first like vessels and nerves should be coloured first which was in agreement with the technique followed by Jain and Babel (2014) [5], Prabhu *et al.* (2015) and Kaur *et al.* (2017) [5, 9, 6]. The final coating was done with transparent nail paint as it prevents the peeling of acrylic colour in formalin solution and brings some glistening effect to the specimen which was also supported by Prabhu *et al.* (2015), Kaur *et al.* (2017) and Shrestha *et al.* (2020) [9, 6, 12]. The mounting technique is very crucial for the preservation of the specimen. Our work involves the use of an acrylic plastic sheet to which the specimen was tied with the help of surgical thread and needle. This technique was quite different from that used by Jain and Babel (2014) [5] who explained that the coloured specimen placed in a glass jar filled with 10% formaldehyde solution, can be supported by transparent cylindrical pieces of the plastic bottle without the use of needle and thread [9]. Shrestha *et al.* (2020) [12] supported the specimen with a glass rod or clear plastic water bottle in formalin-filled glass jars [12]. In the present work, we used 10% formalin for the preservation of coloured specimens. Kaur *et al.* (2017) [6] emphasize the use of glycerine, mixed with 10% formaldehyde which has a clearing effect on the tissues and can improve the optical properties of the preservation fluid visualizing fine structural details [6]. The formalin-filled glass jars were covered with a lid and sealed by cello tape as proper sealing of the jars is very important as also explained by Jain and Babel (2014) [5], Kaur *et al.* (2017) and Shrestha *et al.* (2020) [5, 6, 12]. We have used standard colour coding for different anatomical structures like red colour for arteries, blue for veins and yellow for nerves etc. This was in concurrence with the technique of Jain and Babel (2014) [5], Kaur *et al.* (2017) and Shrestha *et al.* (2020) [5, 6, 12]. Therefore, the Acrylic colour technique for wet specimens allows the specimen to be stored in formalin without any peeling of colour with time and is cost-effective, non-toxic, creates great interest and aids the long-term memory of the student.

Plate 1: Showing the liver of a pig. 1, left lateral lobe; 2, hepatic artery; 3, left median lobe; 4, gall bladder; 5, right median lobe; 6, right lateral lobe; 7, caudate lobe; 8, portal vein; 9, caudal vena cava

Plate 2: Showing the liver of the dog. 1, left lateral lobe; 2, papillary process; 3, left median lobe; 4, hepatic artery; 5, gall bladder; 6, right median lobe; 7, caudate lobe; 8, right lateral lobe portal vein; 9, caudal vena cava

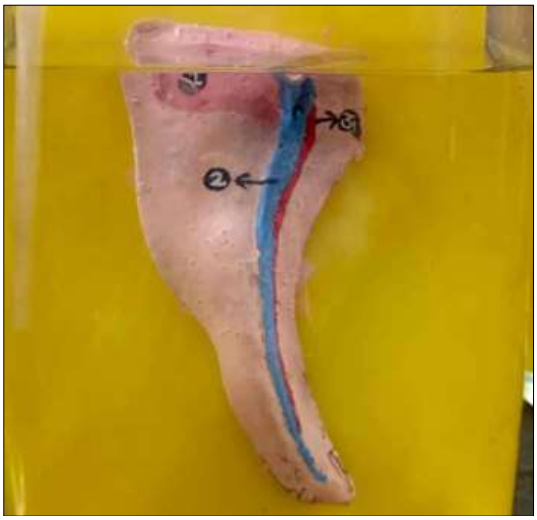

Plate 3: Showing the spleen of the horse. 1, reno splenic ligament; 2, splenic vein; 3, splenic artery

Plate 4: Showing the omasum of cattle. 1, omaso abomasal opening; 2, 3rd order lamina; 3, 2nd order lamina; 4, 1st order lamina

Plate 5: Showing the reticulum of cattle. 1, the interior of the reticulum (honeycomb); 2, 3, the rumen reticular groove; 4, an external surface

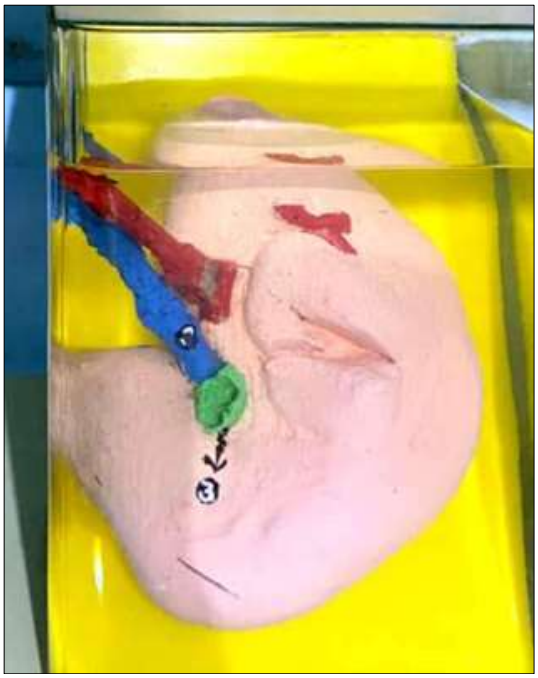

Plate 6: Showing the left kidney of the horse. 1, renal artery; 2, renal vein; 3, ureter

Conclusion

In conclusion, the colouring technique using acrylic paints, enamel paints, and transparent nail polish proved to be a simple, cost-effective, and practical method for enhancing the visualization of anatomical structures in wet organ specimens. The painted specimens remained stable and well-preserved, and they served as valuable tools for teaching and learning anatomy. Further research and exploration of different colouring techniques can contribute to the continuous improvement of anatomical education and enhance the understanding of the complexities of the animal body.

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