

**Organic bench model applied to surgical suture training**

**Modelo de bancada orgânico aplicado ao treinamento de sutura cirúrgica**

**Modelo bancario orgánico aplicado al entrenamiento en sutura quirúrgica**

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## **Abstract**

Veterinary and human medicine students should be trained in skills necessary to perform surgical procedures. Regarding the practice of surgical sutures, the methods used include the use of various materials such as fabric device, sponge, pieces of the animals and pieces of ethylene vinyl acetate. This article proposes to use banana and eggplant to train surgical suture techniques. The work was carried out by monitors from the veterinary surgical technical discipline. These monitors performed sutures in the vegetables (green banana and eggplant) and completed a questionnaire on the method. All monitors agreed that vegetables are easy to handle. Most stated that it was a pleasant experience for not using live animals. An advantage of using vegetables is handling, including storage and disposal. Besides, they do not transmit diseases. Animal materials such as bovine tongue, and swine parts that are widely used in suture teaching, present the risk of zoonosis transmission. The proposed organic bench model (banana and eggplant) may be indicated as a complementary alternative to advanced surgical sutures training. In addition, the model in question avoids the use of animals, while respecting ethical and legal issues.

**Keywords:** Alternative teaching method; Green banana; Eggplant; Stitch.

## **Resumo**

Estudantes de medicina veterinária e humana devem ser treinados nas habilidades necessárias para a realização de procedimentos cirúrgicos. No que diz respeito à prática de suturas cirúrgicas, os métodos utilizados incluem a utilização de diversas ferramentas como equipamentos de tecido, esponja, peças de animais e artefatos de acetato de vinil etileno. Este artigo propõe o uso de banana e berinjela no treinamento de técnicas de sutura cirúrgica. O trabalho foi realizado por monitores da disciplina técnica cirúrgica veterinária. Esses monitores realizaram suturas nas hortaliças (banana verde e berinjela) e responderam a um questionário sobre o método. Todos os monitores concordaram que os vegetais são fáceis de manusear. A maioria afirmou que foi uma experiência agradável por não usar animais vivos. Uma vantagem do uso de vegetais é o manuseio, incluindo armazenamento e descarte. Além disso, não transmitem doenças. Material de origem animal, como língua bovina e peças de suínos, amplamente utilizado no ensino de sutura apresentam risco de transmissão de zoonoses. O modelo de bancada orgânico proposto (banana e berinjela) pode ser indicado como alternativa complementar ao treinamento avançado em suturas cirúrgicas. Além disso, o modelo em questão evita o uso de animais, respeitando as questões éticas e legais.

**Palavras-chave:** Método alternativo de ensino; Banana verde; Berinjela; Ponto cirúrgico.

## Resumen

Los estudiantes de medicina veterinaria y humana deben estar capacitados en las habilidades necesarias para realizar procedimientos quirúrgicos. Con respecto a la práctica de suturas quirúrgicas, los métodos utilizados incluyen el uso de diversos materiales como dispositivo de tejido, esponja, partes de animales y artefactos de etileno acetato de vinilo. Este artículo propone el uso de plátano y berenjena en el entrenamiento de técnicas de sutura quirúrgica. El trabajo fue realizado por monitores de la disciplina técnica de cirugía veterinaria. El trabajo fue realizado por monitores de la disciplina técnica de cirugía veterinaria. Estos monitores realizaron suturas en las verduras (plátano verde y berenjena) y respondieron un cuestionario sobre el método. Todos los monitores coincidieron en que las verduras son fáciles de manipular. La mayoría dijo que fue una experiencia agradable no utilizar animales vivos. Una ventaja de utilizar verduras es la manipulación, incluido el almacenamiento y la eliminación. Además, no transmiten enfermedades. Los materiales animales, como la lengua bovina y las partes porcinas, que se utilizan ampliamente en la enseñanza de suturas, presentan un riesgo de transmisión de zoonosis. El modelo de banco orgánico propuesto (plátano y berenjena) puede indicarse como una alternativa complementaria al entrenamiento avanzado en suturas quirúrgicas. Además, el modelo en cuestión evita el uso de animales, respetando cuestiones éticas y legales.

**Palabras clave:** Método alternativo de enseñanza; Plátano verde; Berenjena; Puntuación.

## 1. Introduction

Veterinary and human medicine students should be trained in skills necessary to perform surgical procedures. Such skills include making sutures. For there to be effective learning, only theoretical classes are not satisfactory, requiring practical activities to teach this skill. The acquisition of psychomotor competence during graduation requires extensive training, inspiring the student to gain confidence in performing basic surgical maneuvers, allowing him to develop solid manual skills in his own time. In the training of human doctors, especially in areas such as Plastic Surgery, the training of suture techniques is essential in the training of such professionals (Bastos & Silva, 2011).

Surgical suturing is one of the fundamental stages of the surgical procedure, responsible for bearing physiological forces and allowing adequate tissue healing. For its correct execution, theoretical concepts combined with practical skills are required, avoiding

postoperative complications related to suture dehiscence, excess tension, and material in the surgical wound.

Currently, for legal and humanitarian reasons, live animals are not used for training in surgical techniques. In this context, the development and the use of simulators that allow surgical training, known as alternative methods, enable the student to develop motor skills without the need to use vivisection for this purpose, providing ethical thinking related to animal welfare, besides reducing errors caused by inexperience. Currently, the use of live animals in experimentation and teaching is considered incompatible with the principles of animal welfare, thus encouraging the use of alternative models (Carniatto, 2017; Valliyate, Robinson & Goodman, 2012).

Regarding the practice of sutures, the methods used include the use of various materials such as fabric device for suture training (Costa Neto et al., 2011), sponge (Jiang et al., 2012), bovine tongue (Franco et al., 2008; Otoch et al., 2012), pig pieces (Denadai, Oshiiwa & Saad-Hossne, 2012; Otoch et al., 2012) and pieces of ethylene vinyl acetate (EVA) (Bastos & Silva, 2011; Denadai et al., 2012), all with good results. The class method with theoretical content, video class and practice are effective, allowing the student to review the video images thus ensuring their learning and safety at the time of operative practice (Martins Filho, 2015).

Among the materials, the use of vegetables as bench models stands out, mainly in the field of human Plastic Surgery (Denadai & Souto, 2012; Wang et al., 2015). There are several materials of plant origin used for training in surgical techniques (Table 1).

However, before opting for the use of alternative techniques to the use of animals, they must be submitted to validation processes, to prove the methodology and the expected results<sup>3</sup>. Law No. 11,794, of October 8, 2008 in paragraph III, chapter II, establishes that the introduction of alternative techniques that replace the use of animals in teaching and research should always be monitored and evaluated (Lei n° 11.794, de 8 de outubro de 2008). In this sense, in this article, a process of validation of the use of the Prata green banana and eggplant as organic bench models for training suture techniques was initiated.

**Table 1.** Different vegetables used in practical surgical techniques classes.

Material	Use	Advantage	Disadvantage	Authors
Green banana	Incision; suture; biopsy	Allows you to analyze different 'layers'; blade depth	Does not imitate skin elasticity, rigid structure	Denadai and Souto (2012); Wang, et al (2015)
Ripe tomato	Subcutaneous injection; biopsy	Expresses the formation of a bubble when making the injection	Thin, friable structure	Wang, et al (2015)
Orange	Biopsy, suture, incision	Allows to analyze different 'layers'	Rigid structure	Denadai and Souto (2012); Wang, et al (2015)
Lemon	Incision, biopsy, suture	Allows to analyze different 'layers'	Risk of spotting the skin; Rigid structure	Denadai and Souto (2012); Wang, et al (2015)
Melon	Incisional and excisional biopsy	Simulates different types of injury		Denadai and Souto (2012)
Eggplant	Biopsy, suture, incision	Allows to analyze different 'layers'		Denadai and Souto (2012); Wang, et al (2015)

Source: The authors.

Table 1 presents the main vegetables and their indications for teaching techniques used to handle and suture tissues. Such vegetables represent a good option in this type of teaching because they are accessible, cheap and easy to dispose of (without prejudice to the environment) and without the possibility of transmitting diseases as can happen with animal parts also used in this type of teaching.

## 2. Methodology

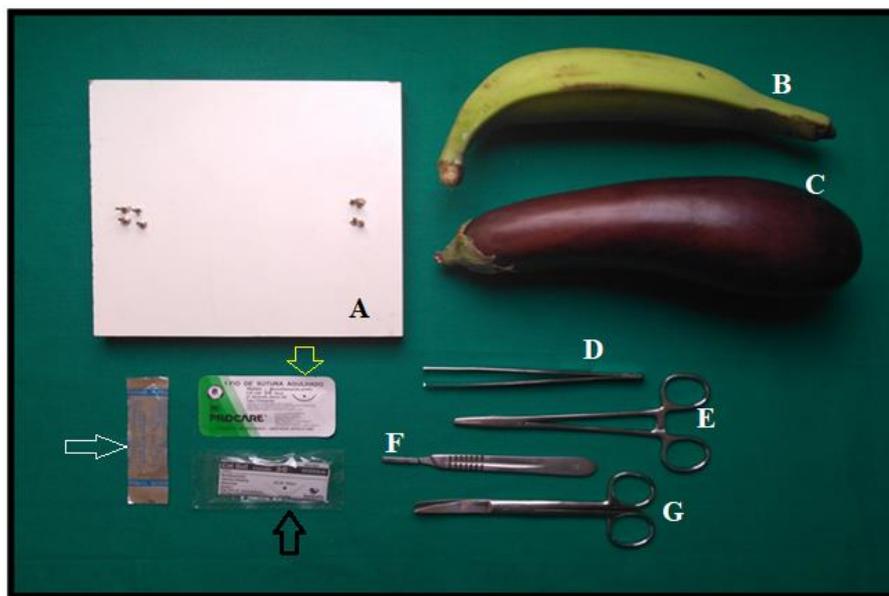
In order to carry out this study, a qualitative field experimentation was carried out as described by Pereira et al. (2018). The data obtained were submitted to descriptive statistics.

The following items were used to make the model: a medium density fiberboard (MDF) measuring seven centimeters in length, seven centimeters in width and half a centimeter in height pierced by two sets of four nails (2.70 centimeters by 0.48 mm) for positioning and fixing the material, preventing its movement.

Two vegetables were used as pieces for suture training, green banana variety Prata and eggplant (*Musa* spp. And *Solanum melongena* L., respectively). For the experiment, the surgical instruments used were blunt-thin surgical scissors, a Mayo-Hegar needle holder, anatomical forceps with a rat tooth, a Bard-Parker scalpel handle number 4 and a scalpel

blade number 24. The suture was made using 3-0 Nylon threads with 3/8 circumference triangular needle and 3-0 Catgut thread with 3/8 circumference blunt needle, mono and multifilament suture materials, respectively (Figure 1).

**Figure 1** - Material used for the training of surgical sutures in organic bench models. A: Medium density fiberboard (MDF) measuring seven centimeters long, seven centimeters wide and half a centimeter high perforated by two sets of four nails (2.70 centimeters by 0.48 mm). B: Green banana. C: eggplant. D: Anatomical forceps with rat teeth. E: Mayo-Hegar needle holder. F: Bard-Parker scalpel handle number 4. G: Blunt-thin surgical scissors. White arrow: scalpel blade number 24. Yellow arrow: Nylon thread 3-0 with triangular needle of 3/8 circumference Black arrow: Catgut thread 3-0 with blunt needle with 3/8 circumference.

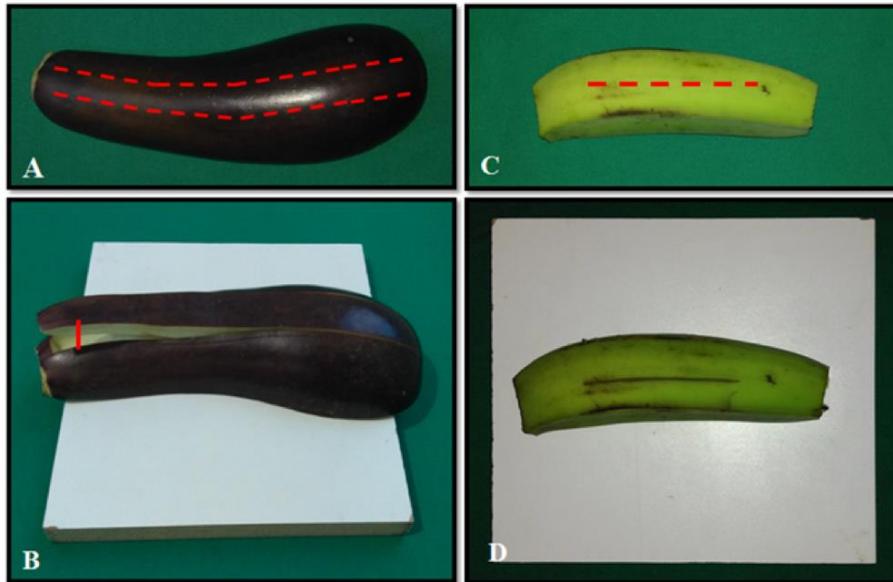


Source: The authors.

Figure 1 highlights an easy device to be constructed with accessible material (MDF), the surgical instruments necessary for making sutures and the vegetables to be used in teaching tissue suture techniques.

The vegetables were cut along their longitudinal axis, providing two halves that were fixed to the wooden supports, with the convex face facing upwards. Two incisions measuring fifteen centimeters in length each with an internal spacing of two centimeters and a depth of one and a half centimeters were made in the eggplant, forming a detachable flap. In the banana, incisions were made from seven to ten centimeters in length (Figure 2).

**Figure 2** - Vegetables (green banana and eggplant) used for training in surgical technique. A and C: Determination of incision sites. B and D: Final appearance after eggplant and banana incision.



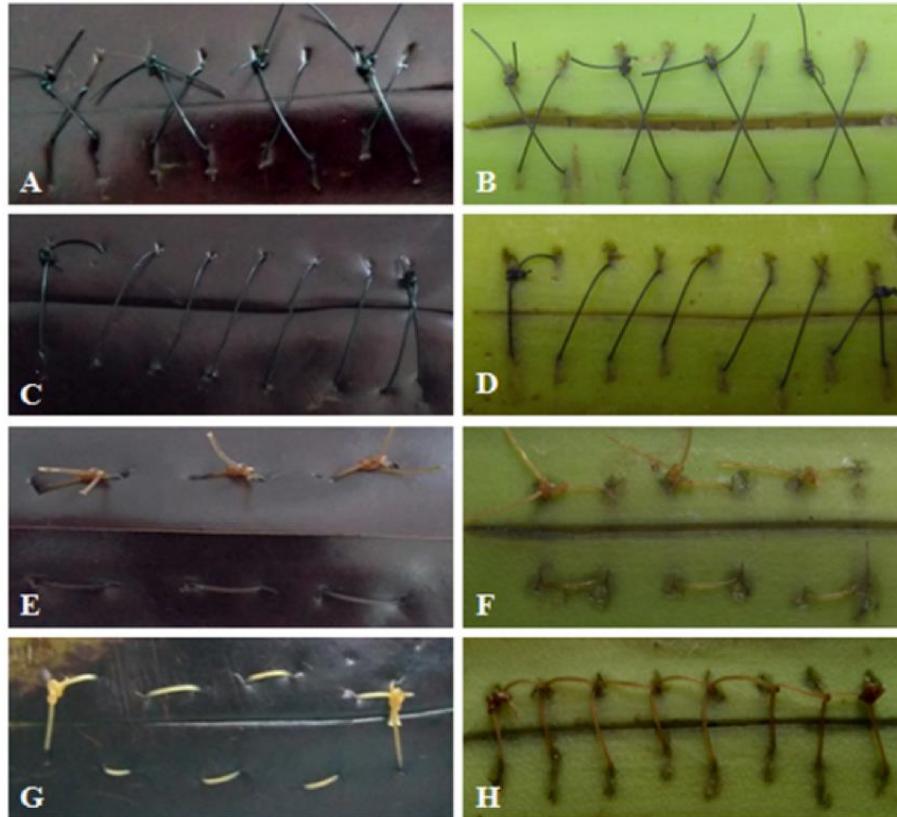
Source: The authors.

Figure 2 shows the preparation of vegetables used to teach suturing techniques in tissues, demonstrating that it is a simple process.

To verify the acceptance rate of the model, a study was conducted in a University Veterinary Hospital with the participation of four student monitors in the discipline of Veterinary Surgical Technique of the Veterinary Medicine course, which were arranged in four work-tables. For each evaluator, two vegetable models (an eggplant and a green banana) and the instruments necessary for performing the surgical sutures were provided. It was previously defined, for comparative questions, that both eggplant and banana would have two layers, one superficial, the peel, and the other deep, the pulp.

Each evaluator individually performed eight interrupted suture patterns: simple interrupted, simple inverted, horizontal mattress (Wolf), vertical mattress (Donatti), X point (Sultan), Helical, Jacket, interrupted Lembert; and seven continuous suture patterns: simple continuous, continuous suture with anchored stitches, continuous horizontal mattress (Wolf continuous), Shimidien, Cushing, Intradermal and continuous Lembert. All sutures patterns were made with Nylon yarn and Catgut yarn in each supplied organic model (Figure 3).

**Figure 3** - Organic bench model for suture training. (A) X point (Sultan) on eggplant and (B) on banana with Nylon thread. (C) Simple continuous in the eggplant and (D) in the banana with Nylon thread. (E) Horizontal mattress (Wolf) in eggplant with catgut thread. (G) Continuous horizontal mattress (Wolf continuous) in eggplant and (H) continuous anchored (continuous scalloped suture) in banana with catgut thread.



Source: The authors.

Figure 3 shows the types of sutures that can be trained on the proposed vegetables (banana and eggplant). Sutures are widely used in the surgical practice of human and veterinary medicine.

After performing the sutures, the evaluators were asked to complete a questionnaire with questions regarding the use of the proposed method, using the Likert scale to assess psychometric responses. This scale allows to analyze the acceptance of the proposed model through qualitative attributions previously established, and thus to verify the attitude and the degree of conformity of the interviewee (Silva Júnior & Costa, 2014). The data obtained in the questionnaire were evaluated using percentage frequencies.

To assess suture patterns singly, the evaluators descriptively commented on the ability to make the knot. Resistance and tissue approximation also were evaluated, and finally, the final aspect of the suture pattern.

The project was approved by the Human Ethics Committee at the institution where it was carried out (NN) [eliminated for the purposes of peer review] with protocol number 2,134,561.

### **3. Results and Discussion**

Considering suturing as a fundamental phase of the surgical procedure, such sutures are procedures of extreme relevance in everyday medical practice. Its accomplishment requires, in addition to theoretical foundation, the development of manual dexterity that allows the apprentice surgeon to perform basic surgical maneuvers (Tudury & Potier, 2008). However, most students do not develop basic and satisfactory surgical skills during their academic training. Thus, it is necessary to complement the undergraduate curriculum teaching about small surgical procedures (Marcondes et al., 2014). In this context, suture training is of fundamental importance for the acquisition of psychomotor skills (Matera, 2009), with several training models described in the literature, such as the fabric device for suture training (Costa Neto et al., 2011) pieces of post-mortem animal (Denadai et al., 2012; Franco et al., 2008; Otoch et al., 2012), EVA plaques (Bastos & Silva, 2011; Denadai et al., 2012) and organic models (Denadai & Souto, 2012; Denadai, Saad-Hossne & Souto, 2013), avoiding the use of vivisection for this purpose.

The use of alternative methods for teaching sutures is well accepted by many students, and in a study comparing the teaching of specific suture for the intestine (Gambie suture) in cadaver and in artificial simulator it was demonstrated that the level of learning was equal (Caston et al., 2016).

Among the materials proposed for training medical and surgical practices are vegetables (Denadai & Souto, 2012; Wang et al., 2015). To our knowledge, a limited number of studies evaluate the application of vegetables as organic bench models and their standardization. The choice of vegetables was substantiated by the related literature (Denadai & Souto, 2012; Denadai et al., 2014), which cite banana and eggplant as the most used vegetables for training in surgical suture. The choice to use the green banana variety Prata is due to its coarser ecotexture that causes less tissue damage. Most works do not specify the variety to be chosen (Valliyate et al., 2012). The acquisition of the vegetables used in the training was quite easy since such vegetables are easily found in supermarkets and other places that sell these products.

The advantage of using organic bench models is the low cost when compared to other models, such as the fabric device for suture training (Costa Neto et al., 2011), post-mortem animal parts (Denadai et al., 2012; Denadai et al., 2013; Franco et al., 2008; Otoch et al., 2012), EVA plates (Bastos & Silva, 2011; Denadai et al., 2012) and, mainly, three-dimensional synthetic models like the tissue models of SutureSkin®. In current quotation (end of June 2017) the banana was quoted at \$ 0.40 (kg) and eggplant at \$ 0.80 (kg) (Ceasa, 2017). One of the most used materials for suture training is the bovine tongue (Carniatto, 2017, Franco et al., 2008; Otoch et al., 2012). In a quick survey by phone in butchers in the region, the price of bovine tongue was around \$ 2.50 (Kg). Therefore, the cost of vegetables is much lower, making them preferred materials for teaching sutures from an economic point of view. Low cost is one of the advantages of using simulators in teaching (Smeak, 1999).

To use the model, the plant must be fixed on a support that prevents its movement during the suture. The literature suggests the use of polystyrene (styrofoam) (Denadai & Souto, 2012), however, as it is a lightweight material, stability is compromised. Therefore, a wooden plate pierced by nails was created, which provided adequate stability (Figure 1). Associated with the support, the vegetable must be cut along its longitudinal axis, helping to fix it and providing two pieces for training (Figure 2).

In related works (Denadai & Souto, 2012; Denadai et al., 2014) there is no standardization regarding the incision technique that allows the approximation of the edges through the suture. The methodology used with two incisions along the longitudinal axis measuring fifteen centimeters in length each, separated by a distance of two centimeters, provided the formation of a detachable flap, favoring tissue approximation after the suture in the eggplant. In bananas, longitudinal incisions measuring seven to ten centimeters were shown to be equally effective for training (Figure 2). It should be noted that the application of vegetables in the teaching of sutures allows simulation of tissues, as the colored surface of the peel may represent the epidermis, just below, the white portion may be similar to the subcutaneous cellular tissue (Figure 2) and the pulp may be compared to the muscle (Denadai & Souto, 2012; Wang et al., 2015).

Different suture patterns such as simple interrupted suture, vertical mattress (Donati), horizontal mattress (Wolf interrupted), simple continuous suture, and simple anchored are cited in the literature for suturing training in plant (Denadai & Souto, 2012). Expanding the list of suture patterns, in this work, patterns of apposition, inversion, eversion and overlap were tested, totaling eight interrupted patterns and seven continuous patterns. It was possible to verify that due to the insufficient tissue resistance of the vegetables, mainly of the upper

layer (peel), patterns such as Cushing, Jackets, Intradermal, interrupted, and continuous Lembert, are impractical. The viable suture patterns for training (Figure 3) observed were simple. Therefore, it is important to note that both vegetables did not allow for the training of all sutures, contrary to what was observed in other bench models, such as the fabric device for suture training (Costa Neto et al., 2011) and pieces of post-mortem animal (beef tongue, pork paw) (Denadai et al., 2012; Denadai et al., 2013; Franco et al., 2008; Otoch et al., 2012), indicated for initial training.

Once the student has the necessary dexterity, vegetable training can be carried out. It is emphasized that the use of animals is necessary for learning but must be instituted after the student demonstrates skill without causing harm to animals (Costa Neto & Martins Filho, 2017). Simulators allow repetitive practice, and this helps to strengthen motor skills and increases confidence and efficiency (Smeak, 1999). Therefore, an important advantage in teaching sutures using vegetables is that suture techniques can be repeated as many times as necessary for effective learning. No single method can offer enough repetition to provide proficiency and confidence in students without using an unacceptable number of animals (Scalese & Issenberg, 2005).

In addition, it is worth noting that the eggplant showed little tissue resistance, so training in this model is possible when performed in a delicate way, like performing sutures in friable tissues. Perhaps it is interesting to use eggplant for students of more advanced level as students of plastic surgery, where the delicate handling of the tissues is especially important. Such material adapts to the practice of incisional biopsies, even without obtaining the elasticity of human skin (Wang et al., 2015). In an article on the subject, the authors comment that when choosing products, preference should be given to those that have harder peel, as the vegetable can knead or spoil, making it difficult to handle with needles and threads (Denadai & Souto, 2012). Banana is already used in teaching sutures with good results (Denadai & Souto, 2012; Wang et al., 2015) Although it was not the focus of this study, green bananas can also be used to teach tissue divulsion (Wang et al., 2015).

Two surgical wires were tested, a monofilament, Nylon, and a multifilament, Catgut, both with surgical number 3-0. Nylon, due to its low friction coefficient and smaller diameter (0.200 to 0.249 mm) when compared to Catgut (0.300 to 0.339 mm) (Arruda & Viana, 2014), allowed better sliding through the fabrics. However, the Nylon wire when tractioning to perform the final node, caused damage to the outer layer. The training with Catgut wire implied repeated superficial rips in the eggplant. It is important to note that the black coloring

of the nylon used made visibly difficult to perform sutures in the eggplant due to the absence of contrast between the thread and the vegetable.

We chose to use needles with the same circumference size (3/8) for both wires. However, a traumatic needle was used for the monofilament thread, and a blunt needle for the multifilament thread. The proportion of trauma caused to the tissues, mainly the superficial one, was lower when using a blunt needle, indicated in the literature for friable tissues because it provides less tissue damage (Arruda & Viana, 2014).

The subjective analysis of the data obtained in the questionnaire applied to student monitors of the discipline Veterinary Surgical Technique allowed to verify that all the evaluators (100%) agreed on the ease in handling the vegetables used, providing a pleasant experience for not using live animals in the development of skills basic regarding surgical sutures (75%), in addition to allowing the application of theoretical concepts related to surgical sutures (75%). The values found corroborate with other alternative methods (Costa Neto et al., 2011; Martins Filho, 2015).

Regarding the development of psychomotor skills, the dexterity with which the movements were performed was superior in eggplant when compared to banana (50% and 25%, respectively). Most respondents (75%) agreed that both vegetables allow repetition of training and recommend them for training in surgical sutures. These data make it possible to observe that the organic bench model meets the ideological conception of the principles of the 3R (Herrmann, Pistollato & Stephens, 2019), aiming at reducing the use of animals for teaching surgical sutures, in addition to repetition and ability gain.

As for the technical realization of the suture patterns, tissue penetration and approximation were adequately verified in eggplant (100% and 75% respectively), while tissue resistance was better verified in banana (75%). Regarding the patterns performed, the observed result was impartial between patterns interrupted as continuous, with no predilection among of the vegetal.

Another advantage of using vegetables is handling, including storage and disposal, being a portable and easy to use material. Given these characteristics, the student can carry out training both in the classroom and in the home environment. The vegetable must be used quickly because it is a perishable product and must be stored outside the refrigeration environment, allowing the top layer (peel) not to become friable. In this work, after the training was performed, the suture materials (surgical threads) were removed and the vegetables were destined for animal feed, avoiding waste. Other alternative materials such as animal parts require disposal as hospital material, which can make the process more

expensive. Disposal of plastic materials also requires care since many have an environmental impact as they are difficult to degrade. The disposal of the vegetables proposed in this study is quite simple and can be done in common garbage and is considered organic, bringing little impact on the environmental point of view.

An under-mentioned advantage for the use of vegetables is that such materials are inert from the point of view of disease transmission in the teaching of suture techniques. Products from animals such as bovine tongue and pig parts are widely used in teaching sutures (Denadai et al., 2012; Denadai et al., 2013; Franco et al., 2008; Otoch et al., 2012). However, there is a risk of transmission of diseases such as brucellosis detected in Brazil in bovine tongue (Lima et al., 2015) and in pigs (Leite et al., 2014). Tuberculosis has also been recorded in bovine tongue in the country (Herrmann et al., 2019) as well as leptospirosis in pigs (Rigo et al., 2013). Therefore, the use of vegetables does not require the use of individual protective equipment. In addition, as they are perishable material, animal parts may give off an unpleasant smell after handling for a certain time and release liquids. This fact is not discussed in the literature, but it can be important for learning. The unpleasant odor and the release of liquids can cause rejection of the method by the students.

Although it is considered as a low-fidelity material, the use of vegetables does not present differences in learning when compared to other high-fidelity methods (those of higher cost, including synthetic models, anatomical models, cadaver or live animals) that are more attractive to students (Denadai & Souto, 2012; Denadai et al., 2014; Otoch et al., 2012; Pereira et al., 2016; Rodrigues, Mendes & Silva, 2013; Tudury & Potier, 2008).

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Analyzing the use of the different materials proposed in the literature, including vegetables, it is concluded that all can be used in teaching techniques for handling and tissue suture. Based on advantages and disadvantages, the selection must be based on criteria of familiarity of the professional with the material, availability, cost and level of learning intended.

#### 4. Final Considerations

The proposed organic bench model (banana and eggplant) has low cost, practicality, easy availability, storage, handling and disposal, being indicated as a complementary alternative to advanced surgical sutures training, allowing the student to develop important psychomotor skills for the surgical experience.

In addition, the model in question makes it possible not to use animals in practical classes, either live animals or in cadavers, respecting legal ethical issues.

Other studies may demonstrate that diverse vegetables and different materials can be used to teach tissue handling techniques. Several maneuvers can be included in these studies, like as medication administration, substance infiltration in sites with lesions and other indications.

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