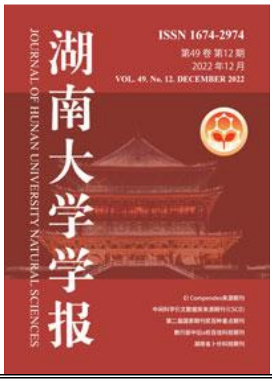

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Characterization of Nanofibers Matrix as Extract Media of Dragon's Blood for Wound Healing

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Abstract: Dragon's blood is traditionally used for treating diarrhea and producing natural dyes. An in vitro study of dragon's blood ethyl acetate extract showed that it promotes blood coagulation and can heal wounds in rabbits. Its resin extract heals injury in rabbits using PVDF nanofibers matrix as a medicine medium. Therefore, this research aimed to determine the PVDF nanofibers as medicine mediums. The characteristics of the samples were observed using SEM/EDX, FTIR, and X-Ray diffraction. The SEM morphological examination showed that the nanofibers were still clearly visible without the dragon's blood extract. Furthermore, the higher the concentration of this extract in the sample, the less it becomes. The elements in the PVDF nanofibers matrix are C (carbon) and F (fluorine). Adding dragon's blood resin extract to the matrix increases the number of elements other than C and F, such as O (oxygen). The infrared spectrum (IR) of the matrix nanofibers absorption peak at about 2921.85 cm-1 is for the vinylidene C-H stretching vibration. Meanwhile, approximately 1400.79 cm-1, 879.11 cm-1, and 839.83 cm-1 are characteristic absorptions of C-F bonds. The nanofibers matrix has a crystallinity of 63.71%, which is then reduced to 41.22% and 35.16%, adding 5% and 10% resin extract, respectively.

Keywords: dragon's blood, ethyl acetate, matrix, nanofibers.

纳米纤维基质作为龙血提取介质用于伤口愈合的表征

摘要：龙血传统上用于治疗腹泻和生产天然染料。龙血醋酸乙酯提取物的体外研究表明，它可以促进血液凝固，并且可以治愈兔子的伤口。其树脂提取物使用聚偏氟乙烯纳米纤维基质作为药物介质治愈兔子的损伤。因此，本研究旨在确定聚偏氟乙烯纳米纤维作为药物介质。使用扫描电镜/能谱、红外光谱和X射线衍射观察样品的特性。扫描电镜的形态检查表明，没有龙血提取物，纳米纤维仍然清晰可见。此外，样品中这种提取物的浓度越高，它变得越少。聚偏氟乙烯纳米纤维基质中的元素是C（碳）和F（氟）。将龙血树脂提取物添加到基质中会增加C和F以外的元素的数量，例如欧（氧）。基体纳米纤维在约2921.85厘米-1处的红外光谱(红外线)吸收峰为亚乙烯基C-H伸缩振动。同时，大约1400.79厘米-1,879.11厘米-1和839.83厘米-1是C-F键的特征吸收。纳米纤维基质的结晶度为63.71%，然后分别添加5%和10%的树脂提取物，

将其降至41.22%和35.16%。

关键词：龙血，乙酸乙酯，基质，纳米纤维。

1. Introduction

Since the 1970s, nanotechnology, including nanocomposites, nanofibers, nanocarbons, nanotubes, and others, has continued to develop. [1]. Recently, nanofibers have attracted attention because of their unique properties and promising potential for applications in various fields such as biology, chemistry, electronics, engineering, biomedical, and protective products [2]-[4]. It is applied in the medical field to increase drug usage efficiency [5]-[7], thereby acting as a medicine medium [7]-[9]. Also, it is used in the biomedical field to fill antibiotics in the nanofiber matrix for wound healing [8], [10].

Dragon's blood is a red resin secreted by the fruit of *Daemonorops* spp. rattan plants (Arecaceae). It has many uses, including antioxidant, antibacterial, dysentery, antidiabetic, injury therapy, anti-inflammatory, and others [11]-[14]. Its ethyl acetate and ethanol extract enhance coagulation in vitro using rabbit blood [15]. Therefore, dragon blood extract can accelerate the clotting process and be used as a drug for wound treatment [8], [10], [16]. Furthermore, research has been conducted using matrix PVDF nanofibers as a medium for dragon blood extract as a wound healing medication. The results showed that the success rate of injury treatment within 7 days ranged from 70-80% in experimental rabbits [17]. There has been no investigation of the change in the properties of the nanofibers matrix after being filled with dragon blood extract. Therefore, this study aimed to determine the characteristics and properties of matrix PVDF nanofibers, which function as dragon's blood extract media for injury treatment drugs.

2. Materials and Methods

2.1. Materials and Tools

The material used in this research is a resin of dragon's blood (*Daemonorops draco* Bl.), while the chemicals are ethanol, ethyl acetate, n-hexane, PVDF (Polyvinylidene Fluoride), and N.N. Dimethyl acetamide. The tools used include Soxhlet extractor, rotary evaporator, analytical balance, oven, electrospinning, SEM/EDX, X-Ray diffraction, and FTIR.

2.2. Method

2.2.1. Dragon's Blood Extraction

The stages involved in this process include extracting 50 g of fine dragon's blood resin with n-hexane, ethyl acetate, and ethanol solvents. The extraction was performed using Soxhlet for 3 hours or until the extract in the tube was colorless. The results are then concentrated on a rotary evaporator until the solvents have evaporated. Finally, the ethyl acetate extract was used for this study because it treats injuries [14].

2.2.2. Formation of Nanofibers Matrix

The nanofibers matrix was formed using Polyvinylidene Fluoride (PVDF) polymer material dissolved with N.N solvent and dimethyl acetamide at a ratio of 1:5 w/v. The polymer solution that has wholly dissolved is allowed to stand for at least 6 hours until it becomes clear. Subsequently, it is fed into an electrospinning device to create a matrix composed of PVDF nanofibers.

The surface of the PVDF nanofibers matrix was dripped with ethyl acetate extract solutions of 0% (control/without dragon's blood extract), 5%, and 10% concentration. Finally, the ethyl acetate solution was evaporated.

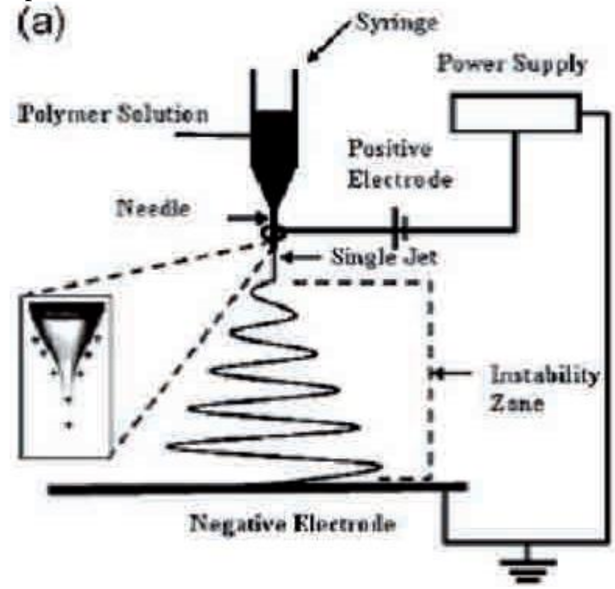


Fig. 1 Formation of PVDF nanofibers matrix using electrospinning

2.2.3. The Property Test of PVDF Nanofibers Matrix

In an integrated laboratory at the Forest Products Research and Development Center, Bogor, Indonesia, matrix nanofibers (control and treatment with dragon's blood extract) were analyzed using SEM/EDX, FTIR, and X-Ray differs. In the SEM/EDX test, the nanofibers matrix was coated with a gold solution.

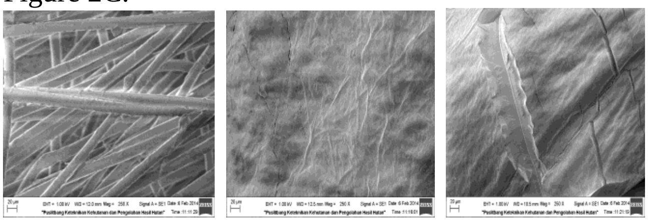
3. Results and Discussion

3.1. Nanofiber Morphology

The nanofibers matrix was examined to determine the surface morphology of the nanofiber matrix without treatment (without adding dragon's blood extract/control) and with dragon's blood extract added using an SEM tool.

Observations in Figure 2A show that the nanofibers matrix (without treatment) has clusters in the form of straight fibers, and cavities are still visible between the nanosized fibers [18]. Additionally, it does not contain any beads. The occurrence of beads in the process can be caused by several things, including the solution viscosity (solution concentration), surface tension, and the net change density. The higher the viscosity and net change density of a solution, the less the resulting fiber will form beads. A high net change density can affect the fineness of the fiber. Meanwhile, the surface tension of the solution produces good results when it is smaller [19]-[20].

This differs from the nanofibers to which dragon's blood extract has been added. According to figure 2B, the surface showed a few fibers with no cavities after adding 5% dragon blood extract. Furthermore, after adding 10% dragon's blood extract, the surface was covered with extract, and the fibers, as well as the cavities between them, were not visible, as presented in Figure 2C.



A (250X) B (250X) C (250X)

Fig. 2 SEM image of nanofibers matrix

Notes: A – nanofiber matrix (control); B – nanofiber matrix (filled with 5% dragon's blood extract); C – nanofiber matrix (filled with 10% dragon's blood extract)

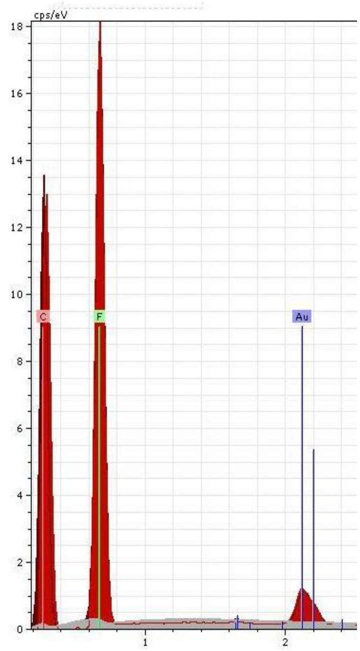
3.2. PVDF Nanofibers Matrix Elements

Observations using the EDX tool describe the elements in the matrix. The elements contained in the untreated PVDF nanofibers matrix (Figure 3) consist of carbon (C), fluorine (F), and gold (Au). The primary elements are C and F. Meanwhile, Au is generated by a matrix of the samples before being examined in coating with its solution [21].

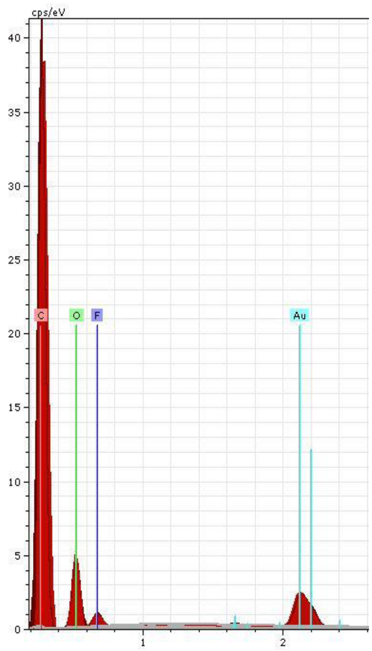
Furthermore, the nanofibers matrix to which the dragon's blood resin extract was added consisted of carbon (C), fluorine (F), gold (Au), and oxygen (O). C and F are used for the formation of the nanofibers. Meanwhile, Au is a coating used for nanofibers matrix before being observed using SEM/EDX. Dragon's blood organic resin elements O and C are present in the nanofibers matrix to which the extract has been added. Therefore, the dragon's blood resin increased the percentage of C and O and decreased that of F, as shown in Table 1 and Figure 3.

Table 1 Elements contained in nanofibers

Elements	**Untreated nanofibers matrix**	**Nanofibers matrix filled with dragon's blood 5% ethyl acetate extract**	**Nanofibers matrix filled with dragon's blood 10% ethyl acetate extract**
Carbon (C)	29.21%	47.71%	62.33%
Fluorine (F)	62.52%	25.80%	4.17%
Gold (Au)	8.27%	10.38%	15.97%
Oxygen (O)	--	16.11%	17.52%



Matrix nanofibers + dragon's blood extract



Matrix nanofibers resin

Fig. 3 EDX matrix nanofibers result

3.3. Observations with FTIR

In addition to being characterized using SEM-EDX, PVDF nanofibers were analyzed using FTIR to determine their functional groups. An absorption peak at 2921.85 cm-1 was observed in the nanofiber matrix (control), which indicates the vinylidene C-H stretching vibration. The peaks at 1400.79 cm-1, 879.11 cm-1 and 839.83 cm-1 are typical absorptions of the C-F bond [22,23,24]. Therefore, the absorption peaks represent the PVDF nanofiber structure, as shown in Figure 4. The vinylidene C-H stretching vibration is characterized at 2921.06 cm-1 in the nanofiber matrix containing 5% dragon's blood resin extract. Subsequently, 1398.87 cm-1, 874.54 cm-1, and 811.30 cm-1 are typical absorptions of C-F bonds, as shown in Figure 5. There was an absorption peak at 2920.87 cm-1 for the nanofiber matrix containing 10% extract, which indicates the vinylidene C-H stretching vibration. The peaks at 1446.08 cm-1, 811.50 cm-1 and 694.72 cm-1 are typical absorptions of the C-F bond, as presented in Figure 6.

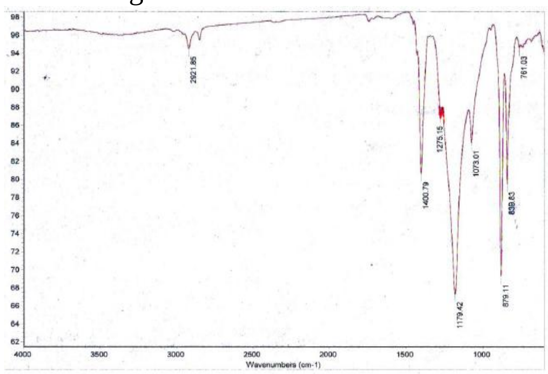


Fig. 4 FTIR spectrum of PVDF matrix nanofibers

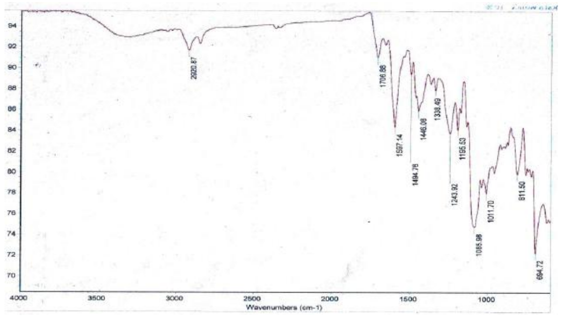


Fig. 5 FTIR spectrum of PVDF nanofibers matrix with 5% dragon's blood extract

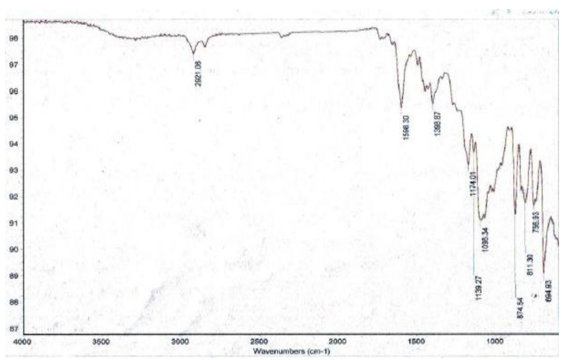


Fig. 6 FTIR spectrum of PVDF nanofibers matrix with 10% dragon's blood extract

3.4. Observations with X-RD

Figure 7 shows the characterization result using X-RD as a diffractogram. The figure indicates the X-RD pattern of the PVDF matrix (control) and PVDF with the addition of 5% and 10% dragon's blood extracts.

The crystallinity of the control PVDF nanofibers matrix is 63.71%. This was no significant difference from the Nasir et al. (2016) result of 65% [24]. The nanofibers matrix crystallinity with 5% and 10% dragon's blood resin extracts was 41.22% and 35.16%, respectively. Therefore, adding this extract to the nanofiber matrix reduces the crystallinity degree. This is because it only fills the matrix cavities and does not combine with the elements contained in the nanofibers.

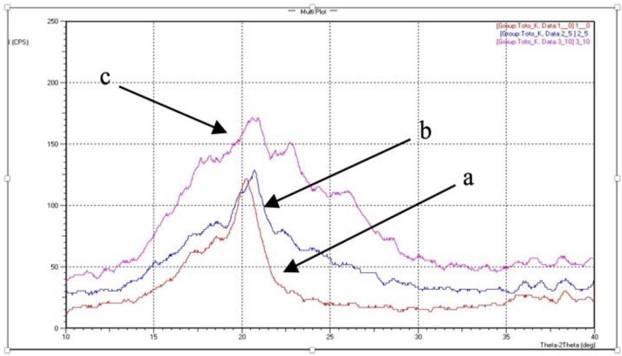


Fig. 7 X-RD matrix nanofibers diffractogram: a – nanofiber matrix (control); b – nanofiber matrix with 5% dragon's blood extract; c – nanofiber matrix with 10% dragon's blood extract

4. Conclusion

The elements in the PVDF nanofibers matrix are C (carbon) and F (fluorine). Adding dragon's blood resin extract increases the number of components other than C and F, including O (oxygen). Vinylidene C-H stretching vibration is characterized by the infrared (IR) spectrum absorption peak of matrix nanofibers at approximately 2921,85 cm-1. Meanwhile, the peaks at about 1400.79 cm-1, 879.11 cm-1, and 839.83 cm-1 are characteristic absorptions of C-F. The PVDF nanofibers matrix has a crystallinity degree of 63.71%. Adding 5% and 10% resin extract of dragon's blood reduces this value to 41.22% and 35.16%, respectively.

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