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EXTRACTION OF BIODEGRADABLE SURGICAL THREADS BASED ON POLYLACTIDE

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Abstract. Conventional surgical sutures should be removed after wound healing, because they cause additional pain and discomfort for the patients. Polylactide (PLA) is an aliphatic polyester derived from the renewable resources, which is biocompatible and biodegradable; however, its relatively high stiffness can limit its surgical applications. This study has the purpose to develop biodegradable surgical sutures based, on PLA and poly(vinyl alcohol) (PVA), and to investigate their physicochemical, mechanical, and biodegradation properties. To reduce PLA stiffness, PLA has been blended with PVA to form composite fibers. The fibers have been prepared from the polymer blends, using ultrasonic treatment to improve mixing. The blend homogeneity has been assessed, using UV–Vis spectroscopy, chemical structure has been characterized by the IR spectroscopy, and surface morphology has been investigated by scanning electron microscopy (SEM). The SEM has revealed changes in the surface morphology and gradual degradation of the fibers over a 16- week period, which has also been supported by the mass-loss measurements in soil. The mechanical properties have been determined according to ASTM D2256. AN incorporation of PVA has increased fiber extensibility and elasticity, and the PLA–PVA composition (20:80 wt.%) has shown the most favorable mechanical performance among the tested formulations. Overall, the results suggest that the PLA–PVA composite fibers are promising candidates for absorbable surgical suture materials.

Keywords: polylactide, polyvinyl alcohol, surgical suture, biodegradable, composite fiber, surgical fibers

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1. Introduction

The biodegradable absorbable sutures have become essential in the surgical practice, since they eliminate the need to remove and minimize the tissue reaction. Polylactide (PLA) is a widely used biodegradable polymer, known for its biocompatibility and high strength. PLA-based sutures gradually hydrolyze into harmless products (CO_2 and H_2O) in vivo, avoiding the pain and complications of suture removal. They have been successfully applied in many types of surgeries, including internal organ operations and cosmetic procedures. However, monofilament PLA sutures can be relatively stiff and have a long resorption period, which may not meet all surgical requirements. To improve flexibility and performance, blending PLA with another biopolymer is a promising approach [1– 5].

Polyvinyl alcohol (PVA) is a biodegradable, water-soluble polymer that has found use in medicine (e.g., as a component of absorbable surgical threads, implants, and drug delivery systems) due to its biocompatibility and flexibility. Combining PLA with PVA could yield a composite fiber that leverages the strength of PLA and the flexibility of PVA. A major challenge in creating a PLA/PVA blended fiber is the incompatibility of the two polymers – they do not share a common solvent and can interact to form complexes that cause phase separation. Recent research has explored multi-block copolymers and composite fibers to address such challenges. In this study, we employ an ultrasonic solution blending method to produce a PLA–PVA block copolymer fiber and investigate its physicochemical properties as a potential biodegradable surgical suture. The work focuses on developing improved PLA-based biodegradable fibers and examining their mechanical properties and biodegradability. [6–7].

2. Materials and Methods

Polylactide (PLA) and polyvinyl alcohol (PVA) were used as the base polymers for fiber preparation. Tetrahydrofuran (THF) (as a solvent for PLA) and water (as a solvent for PVA) were used to dissolve the polymers. All reagents were of analytical grade [4–7].

Preparation of PLA–PVA Solution: To obtain a homogeneous polymer blend, a cosolvent approach was adopted. PLA was dissolved in THF to make a 1.5wt.% solution, and PVA was dissolved in water to make a 3wt.% solution. The PVA solution was gradually added to the PLA solution under continuous stirring. A preliminary solubility test was performed by mixing varying proportions of the two solutions and monitoring clarity (UV–Vis spectroscopy was used to monitor solution transmittance). It was found that adding up to approximately 10wt.% of the PVA solution (water content) to the PLA/THF solution did not cause turbidity. Therefore, the final PVA:PLA mass ratio was kept at 90:10 (i.e., 10wt.% PLA, 90wt.% PVA in the mixture) to ensure a homogeneous blend without precipitation [8,12].

Ultrasonic Treatment and Block Copolymer Formation: The combined PLA/PVA solution (at 90:10 ratio) was subjected to ultrasonic treatment to induce block copolymer formation between PLA and PVA. Ultrasonication was carried out for a fixed duration (20minutes) at room temperature, using an ultrasonic bath (35kHz) to promote polymer-polymer interactions. This process yields a PLA–PVA block copolymer in the solution. The resulting mixture was then centrifuged to isolate any formed polymer complex (precipitate). The precipitate was collected and washed to remove the unbound homopolymer. [9–10].

Isolation and Purification: The synthesized PLA–PVA product was purified by the selective solvent extraction. The precipitated polymer was first soaked in the fresh THF for 24 hours to dissolve and remove any unreacted PLA homopolymer. Subsequently, the remaining solid was soaked in water for 24 hours to remove any unreacted PVA. The recovered solid block copolymer was dried to constant weight in a vacuum oven. The yield of the block copolymer was determined gravimetrically by comparing the dried mass of the product to the initial total polymer mass.

Solubility and Swelling Tests: To evaluate the behavior of the PLA–PVA material in various media (relevant to bodily fluids and processing solvents), the pieces of the dried copolymer sample were immersed in different liquids: distilled water, physiological saline (0.9% NaCl), dimethylformamide (DMF), ethanol, and n-hexane. Swelling or dissolution was observed qualitatively after 24 hours at the room temperature, and categorized as “no change (–)”, “slightly swollen”, or “fully swollen/dissolved.”

3. Results and Discussion

Obtaining of biodegradable filaments, based on polylactide, and study of their physicochemical properties

The Formation of Homogeneous PLA/PVA Blends: The initial challenge was to find a common solvent system for PLA and PVA. PLA is soluble in organic solvents like THF, whereas PVA is soluble in water, but not in THF. We gradually combined the two solutions while monitoring clarity. It was observed that up to 10wt.% of PLA (in THF) could be introduced into the PVA aqueous solution (or vice versa) without phase separation. Beyond a PLA fraction of about 10%, the mixture turned cloudy and a precipitate formed. This cloud point indicates the formation of an interpolymer complex between PLA and PVA when one polymer’s concentration becomes too high. Figure 1 shows the appearance of the polymer mixture: at a PVA:PLA ratio of 90:10 (by mass) the solution remains transparent, whereas higher PLA content leads to precipitation. The successful blending at 90:10 suggests that a block copolymer or complex forms in small amounts but remains colloidally stable at lower PLA content [8, 11–13].

This finding guided the preparation of the fibers. The block copolymer formation during ultrasonicationwas further confirmed by FTIR spectroscopy. In the FTIR spectrum of the PLA–PVA precipitate (complex), the characteristic absorption bands of PVA (such as the O–H stretching around 3300cm^{-1}) were greatly diminished or no longer visible, and the intensity of the PLA carbonyl band (~1750cm^{-1}) was significantly reduced compared to pure PLA. This suggests strong intermolecular interactions (likely hydrogen bonding) between PVA and PLA chains in the complex.

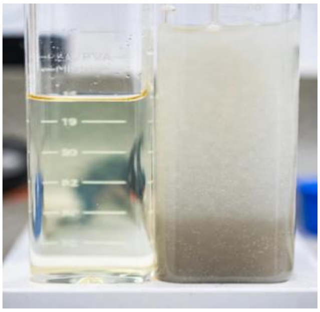

Figure 1 - Visual appearance of the PLA/PVA polymer mixture. The solution remains clear up to the PLA fraction of ~10 wt.% (left), while in case of the higher PLA content (right) the mixture becomes cloudy due to the polymer-polymer complex formation.

The disappearance of the distinct PVA peaks in the blend spectrum indicates that the PVA hydroxyl groups are involved in bonding with PLA, contributing to the formation of the PLA–PVA block copolymer. Figure 2 displays the IR spectra of pure PVA, pure PLA, and the PLA–PVA complex. In the complex, absorption peaks unique to each homopolymer are attenuated, confirming the successful integration of the two polymers at a molecular level [8, 11, 13].

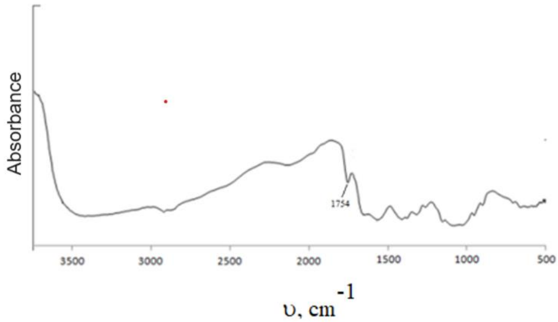

Figure 2 - FTIR spectra of pure PVA, pure PLA, and the PLA–PVA block copolymer. The spectrum of the PLA–PVA product shows the reduction of PVA's O–H bands and PLA's C=O band, indicating the formation of a combined polymer complex.

After the ultrasonic synthesis and solvent extraction steps, the yield of the PLA–PVA block copolymer was high. Most of the PVA and PLA were successfully linked or entangled in the precipitated product. A small fraction of PLA remained unreacted (dissolved in THF and removed in the first extraction). The yields for different initial PLA ratios are presented in Table 1. As the initial PLA content in the mixture increased from 10% to 30%, the fraction of unreacted PLA also increased slightly (from 4.3% to 7.4%), and consequently the copolymer yield decreased from 95.7% to 92.6%. This trend is expected because higher PLA content makes it more challenging for all PLA chains to find PVA partners to bond with, leaving some PLA homopolymer free [9–10].

Despite the slight decrease in yield at higher PLA content, the overall high yield (>92%) indicates the ultrasonic blending method is effective for creating PLA–PVA copolymers. The presence of any unreacted PLA (particularly at 30wt.% initial PLA) suggests that some PLA remained as separate phases or did not fully integrate, possibly due to its higher molecular weight fractions that were less susceptible to ultrasonic breakup and coupling.

Table 1 - Unreacted PLA and block copolymer yield for different initial PLA fractions in the mixture

The proportion of PLA in the initial mixture, %	Unreacted homopolymer (PLA), %	block copolymer yield, %
10	4.3	95.7
20	5.8	94.2
30	7.4	92.6

Despite the slight decrease in yield at higher PLA content, the overall high yield (>92%) indicates the ultrasonic blending method is effective for creating PLA–PVA copolymers. The presence of any unreacted PLA (particularly at 30 wt.% of the initial PLA) suggests that some PLA remained as separate phases or did not fully integrate, possibly due to its higher molecular weight fractions that were less susceptible to the ultrasonic breakup and coupling.

Solubility and Swelling Behavior: The resulting PLA–PVA copolymer fibers were tested for solubility and swelling in various solvents, as it was summarized in Table 2. In water and in 0.9% saline (which simulate physiological conditions), the fibers did not dissolve. They showed only slight swelling in saline solution and essentially no swelling in pure water. This is a favorable result, indicating that the material is water-insoluble and would retain integrity when used as a suture in body fluids (saline represents blood or tissue fluid). In organic solvents, the fibers behaved differently: in dimethylformamide (DMF) and n-hexane, the material swelled significantly. These solvents can penetrate and plasticize or partly dissolve one of the components (DMF is a good solvent for PVA and moderate for PLA; n- hexane can swell PLA). Ethanol caused no swelling or dissolution, likely because neither PLA nor PVA is significantly soluble in ethanol at room temperature. The solvent resistance in aqueous media confirms that the PLA–PVA threads will remain intact during the wound-healing period, yet the material can still absorb some fluids (slight swelling) which might be beneficial for knot tightening and drug release if used as a delivery vehicle [6–7, 11, 13].

Table 2 - Swelling behavior of PLA–PVA (5/95, 10/90, 15/85 by wt.%) block copolymers in different solvents

Solvents	Initial reaction mixture composition, PLA-PVS Mol,%		
	05-95	10-90	15-85
Water	-	-	-
NaCl(0,9%)	slightly swollen	slightly swollen	slightly swollen
Dimethylformamide	swollen	swollen	swollen
Ethanol	-	-	-
n-hexane	swollen	swollen	swollen

Note: "–" indicates no noticeable swelling or dissolution.

Mechanical Properties of Fibers: Tensile testing was performed on fibers with 10%, 20%, and 30% PLA content (balance PVA). The 10 wt.% PLA fiber had a breaking force of 40.5 N and an elongation at break of about 13%. However, this sample did not meet the ASTM D2256 requirements for surgical sutures (in terms of minimum strength for a given size). The 20 wt.% PLA fiber showed a breaking force of 49.9 N and elongation of 11.7%, which did meet the required standard. The 30 wt.% PLA fiber had a breaking force of 51.0 N and elongation of 17%, but interestingly this sample, despite a higher load capacity, did not meet the standard's requirements either (likely due to an overly high elongation or other criteria such as knot security not measured here). The data indicate that incorporating a moderate amount of PLA (around 20%) into PVA yields the strongest fiber that still retains adequate flexibility without becoming too much stiff or brittle. [3, 18–19]

For all samples, the stress–strain curves indicated that the incorporating PVA into the blend markedly increased the fiber elasticity (strain at break), as compared with the neat PLA. PVA is a ductile polymer, and its inclusion improved the ultimate elongation. At the same time, the presence of PLA provided the reinforcement of strength. The 20% PLA fiber achieved the best balance of strength and flexibility. By adjusting the PLA/PVA ratio in the copolymer, it is possible to tune the mechanical properties of the suture fibers. This tunability is advantageous for meeting different surgical needs (e.g., some applications might prefer a higher stiffness, others - more elasticity). Figures 3–5 illustrate the stress–strain curves for the samples with 10%, 20%, and 30% PLA, respectively, demonstrating the differences in the tensile performance. [3, 18]

The improvements in the mechanical properties with the addition of PVA can be attributed to the formation of the PLA–PVA block copolymer which likely results in a phase-separated morphology of hard (PLA-rich) and soft (PVA-rich) domains. Such morphology can increase toughness. The presence of PVA (a flexible polymer) in the matrix helps to absorb energy and to prevent the crack propagation, while PLA provides reinforcement. In short, the PLA/PVA ratio effectively determines the tensile strength and ductility of the fibers [11, 13].

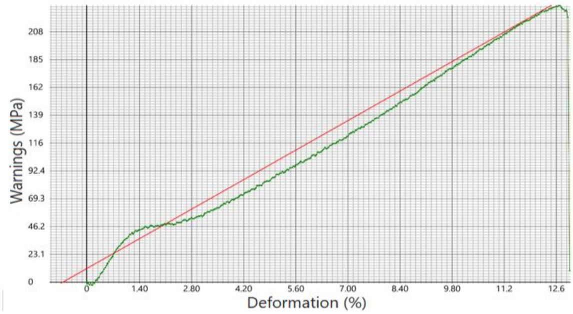

Figure 3 – The stress–strain curve of the PLA/PVA 10/90 (wt.%) fiber sample. The fiber shows a moderate strength (breaking load ~40 N) and relatively a high elongation (~13%).

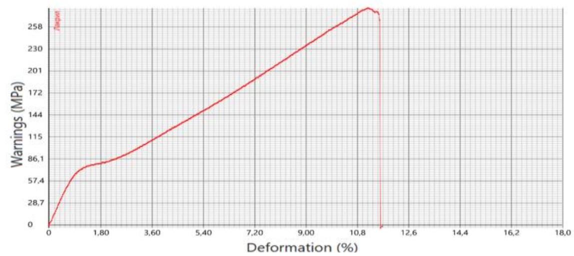

Figure 4 – The stress–strain curve of the PLA/PVA 20/80 (wt.%) fiber sample. This composition exhibits the highest tensile strength (~50 N) with ~12% elongation, meeting the standard requirements for the surgical suture materials.

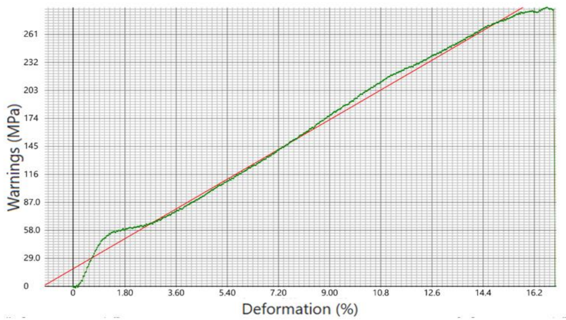

Figure 5 – The stress–strain curve of the PLA/PVA 30/70 (wt.%) fiber sample. The strength (~51 N) is high, but the elongation (~17%) is larger; this sample did not meet one of the standard criteria (likely due to its mechanical profile outside the optimal range).

The Suture Handling Properties: In the practical surgical use, sutures should not only be strong, but also be well handled — they should tie securely into knots without slipping, and have sufficient flexibility. All the prepared PLA–PVA fiber samples were observed to tie knots easily. The 10% PLA fibers, being very pliable (due to high PVA content), were easiest to knot, but somewhat weaker. The 30% PLA fibers were the strongest, but slightly stiffer, which could make knot tying more difficult. The 20% PLA fiber struck a good middle ground, maintaining flexibility while providing a high strength. These qualitative observations align with the quantitative tensile results. In general, modern surgical suture materials require a combination of strength, flexibility, knot security, and predictable absorption time. The PLA– PVA fibers developed here meet those general requirements: they are biocompatible, sufficiently strong, and have good handling characteristics due to the PVA component. [1–3]

In Vitro Degradation (SEM Analysis): Biodegradability is a critical feature of absorbable sutures. The PLA–PVA fibers were designed to gradually degrade in the body. SEM images of the fiber surface at different degradation times are presented in Figure 6. Initially (Figure 6a), the fiber surface is relatively smooth with slight texture from the extrusion process. After 8 weeks in phosphate-buffered saline (Figure 6b), the surface shows noticeable roughening: the smoothness has disappeared and small cracks or pits are evident. By 16 weeks (Figure 6c), the fiber surface is extensively eroded with many more cracks and some fragmentation visible. This progressive development of surface porosity and cracking confirms that the fibers biodegrade over time in a simulated physiological environment. The degradation appears to initiate at the surface and work inward, which is typical for hydrolytically degradable polymers like PLA (surface erosion is enhanced by water penetration into amorphous regions). The uneven degradation pattern (localized cracks) may be due to the two-phase nature of the material – PVA-rich domains might erode faster (being hydrophilic) leaving behind PLA-rich regions until they too break down. The SEM evidence supports that after several weeks, the structural integrity of the fiber will diminish as needed for absorption in tissue. [14–17]

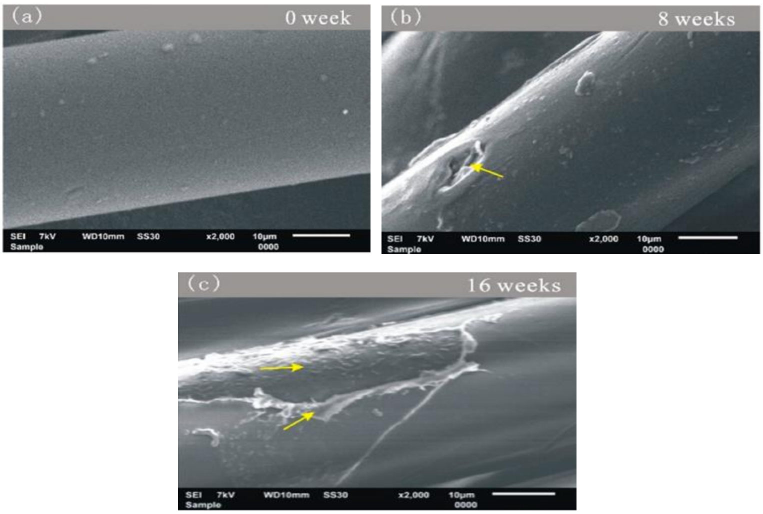

Figure 6 - SEM images of PLA–PVA fibers at different degradation times: (a) initial (no degradation), (b) after 8 weeks in PVA at 37 C, and (c) after 16 weeks. The initially smooth fiber surface develops roughness and cracks over time, indicating the gradual biodegradation of the suture.

Accompanying the physical changes, there was measurable mass loss of the fibers over time. A higher PLA content generally slows the degradation because PLA is more hydrophobic and degrades slower than PVA. This effect was observed in the soil burial test results (which provide an environmental perspective on degradation) shown in Table3. After 8 weeks being buried in soil, the sample with 10% PLA retained only about 17% of its original mass (0.0212g of 0.121g), whereas the sample with 30% PLA retained about 35% of its mass (0.05315g of 0.1503g). The 20% PLA sample was intermediate, with about 32% remaining (0.0532g of 0.1660g). The trend across 1, 3, and 8weeks illustrates that all samples lose mass over time (indicating biodegradation), but higher PLA content yields slower mass loss. This is consistent with PLA's known slower biodegradability relative to PVA. Notably, even the 30% PLA sample lost more than 60% of its mass in 8 weeks, confirming that the block copolymer remains biodegradable despite the presence of a substantial fraction of the more recalcitrant PLA. The combination of PLA with PVA thus allows tuning the degradation rate: more PVA leads to faster degradation (which might be useful for fast-healing tissues), while more PLA prolongs the suture's presence (for wounds that need longer support). [8, 14–15]

Table 3 - Biodegradation of PLA–PVA fibers under soil burial conditions (Remaining mass of samples over time)

The proportion of PLA in the initial mixture, %	initial weight, g/g	1 pound, g/g	3 pound, g/g	7 pound, g/g
10	0.1215	0.0735	0.0357	0.0212
20	0.1660	0.1183	0.0728	0.0532
30	0.1503	0.1263	0.1135	0.05315

The loss of mass and structural integrity over time demonstrates that the PLA–PVA sutures are indeedbiodegradable. In surgical terms, this means the suture will gradually weaken and be absorbed by the body, aligning with the healing timeline so that the suture's support is present only as long as needed. The differences between compositions suggest that by varying PLA content one can tailor how long the suture persists: e.g., 30% PLA might be used when a longer support period is desired, while 10% PLA might be suitable for faster-healing tissues. [14, 17]

The Proposed Production Technologies: Based on the experimental findings, we propose two approaches to produce the PLA-based sutures on a larger scale:

Method 1. Precipitation (Wet) Spinning of PLA: In this approach, a PLA solution of a relatively high concentration (≥25% w/v in a suitable solvent) is prepared. This viscous solution is pumped through a spinneret (a nozzle with the fine orifices) into a coagulation bath, containing a nonsolvent (for example, ethanol or water). As the PLA solution jets enter the bath, PLA precipitates into solid filaments. These filaments are drawn out and wound onto a spool. The process may be aided by an applied electric field or just by the force of extrusion.

The fibers can then be washed and dried. This method is analogous to traditional wet spinning, where a polymer is precipitated from solution into fibers. Figure 7 illustrates this method: a reservoir holds the PLA solution, which is extruded through capillaries into a coagulation bath, and the resulting fiber is collected on a take-up roll. This method could produce pure PLA fibers; however, it may not directly yield a PLA–PVA blend fiber unless PVA is also integrated (which is challenging since PVA isn't soluble in the same solvent). Thus, this method is mainly considered for PLA alone or if a second polymer can be co-spun. [3, 12]

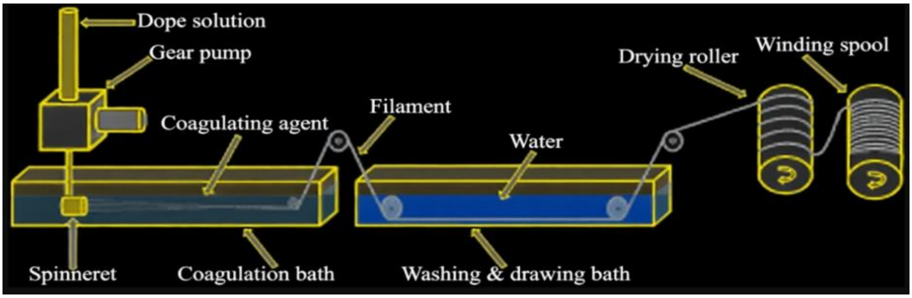

Figure 7 - Schematic of precipitation (wet) spinning for PLA fibers: The PLA solution is extruded through a spinneret into a coagulation bath, forming fibers that are stretched and collected on a spool.

Method 2: Solution Mixing and Wet Spinning of PLA–PVA: This approach stems from our laboratory process. Here, calculated amounts of PVA solution and

PLA solution are first mixed in a reactor (as we did in small scale) to form a homogenous spinning dope containing both polymers. This mixed solution is then fed to an extrusion system. (1) The mixed PLA/PVA solution is loaded into a spinning pump, (2) extruded through a multi-hole spinneret into a coagulation bath (water or another non-solvent that precipitates both polymers together), forming a fiber that contains intimately mixed PLA and PVA. (3) The fiber is drawn through the bath and can undergo stretching (to align polymer chains and improve strength) and washing. Finally, (4) the fiber is collected on a bobbin and dried. Additional post-treatments (like cross linking or coating) can be applied if needed. Figure 8 shows a proposed flow diagram: two input streams for PLA and PVA solutions combine, and then go through the spinneret into a bath, followed by rollers for stretching and a winding system. This method allows co-spinning of PLA and PVA, effectively implementing the laboratory synthesis in a continuous fiber production process. It is a wet-spinning variant tailored for two polymers. [3, 12]

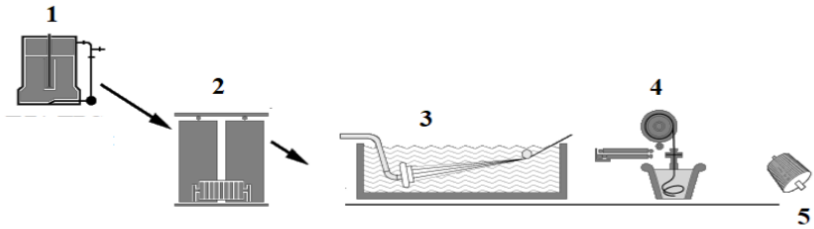

Figure 8 - Proposed technological scheme for producing PLA–PVA surgical suture fibers (Method 2: solution mixing and wet spinning). 1 – Mixing reactor for PLA and PVA solutions; 2 – holding tank for spinning dope; 3 – coagulation bath; 4 – stretching and washing rollers; 5 – take-up spool (bobbin).

Between these two methods, the second is directly related to our research outcome and is preferred for making PLA/PVA blend fibers. The first method (precipitation spinning) could be an alternative for pure PLA fibers or potentially used as a first step to create a core that is later coated with PVA. Further research and development would be required to optimize these processes, such as adjusting solvent choices, extrusion rates, coagulation bath composition, and draw ratios to achieve fibers with the desired diameter and properties.

In summary, the results demonstrate that a block copolymer approach to combining PLA with PVA is feasible and effective. The PLA–PVA fibers have achieved the high tensile strength (nearly 50N for 20% PLA content in our sample, which is comparable to, or better than some commercially available absorbable sutures), and they show the predictable degradation behavior. The ability to modulate the mechanical properties and degradation by simply changing the PLA/PVA ratio gives this material a versatility for various medical applications. The fibers also fulfill the general requirements for the suture materials in terms of knotting behavior and handling. The proposed manufacturing schemes provide a foundation for scaling up production of these fibers, bridging the gap between the laboratory samples and the mass-produced surgical sutures.

4. Conclusion

A novel biodegradable surgical suture material, based on a polylactide/polyvinyl alcohol (PLA–PVA) block copolymer, has been developed and characterized. By using an ultrasonic solution blending technique, we have successfully combined PLA and PVA into a homogeneous fiber, overcoming the challenge of their incompatibility. The PLA–PVA fibers have shown excellent tensile properties, with the PLA 20% (wt.) content, yielding the strongest fiber (breaking load ~50 N) that meets the standard surgical suture requirements. A lower PLA content has increased flexibility, but reduced strength, while a higher PLA content has increased strength marginally, but at the cost of knot security and compliance. [1–3, 8, 11, 13–17]

The fibers have been found to be biocompatible and absorbable. They have remained intact in the aqueous environments, swelling only slightly in saline, which is advantageous for maintaining the wound support during the initial healing. The infrared spectroscopy has confirmed the formation of the intermolecular bonds between PLA and PVA in the copolymer. The scanning electron microscopy and mass loss measurements have demonstrated that the sutures biodegrade gradually: the surface erosion and mass reduction have occurred over weeks, and the rate of degradation can be tuned by adjusting the PLA/PVA ratio. In particular, the fibers with a higher PVA content degrade faster, which can be useful for the wounds that heal quickly, whereas those with a higher PLA content persist longer for the extended support. [1, 3, 8, 11, 14–17]

The study has also proposed practical methods for scaling up the production of the PLA-based sutures, including a co-spinning process for the PLA/PVA blends. These methods can be further refined to produce fibers with the consistent quality, suitable for medical use.

In conclusion, the developed PLA–PVA biodegradable sutures exhibit a combination of the desirable properties: high strength, flexibility, and controlled biodegradability. These threads are promising for surgical applications, potentially improving patient outcomes by eliminating the removal procedures and reducing the tissue reaction. The further studies will be focused on the *in vivo* performance and will refine the fabrication process, while the current findings support the potential of the PLA–PVA fibers as the next-generation absorbable suture materials. [1–3, 8, 11, 13–19].

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Conflict of interests: The authors declare that there is no conflict of interest between the authors that requires disclosure in this article.

ПОЛИЛАКТИД НЕГІЗІНДЕГІ БИОЫДЫРАЙТЫН ХИРУРГИЯЛЫҚ ЖІПТЕРДІ АЛУ

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Түйіндеме. Дәстүрлі хирургиялық тігіс жіптері жара жазылғаннан кейін алып тастауды қажет етеді, бұл пациенттерге қосымша ауырсыну мен қолайсыздық тудырады. Полилактид (ПЛА) – жаңартылатын шикізат көздерінен алынатын, биоүйлесімді және биоыдырайтын алифатты полиэфир; алайда оның салыстырмалы түрде жоғары қаттылығы хирургиялық тәжірибеде қолданылуын шектеуі мүмкін. Осы зерттеудің мақсаты полилактид (ПЛА) және поливинил спирті (ПВС) негізінде биоыдырайтын хирургиялық тігіс жіптерін әзірлеу және олардың физика-химиялық, механикалық қасиеттері мен биоыдырау қабілетін зерттеу болды. ПЛА-ның қаттылығын төмендету үшін ПЛА ПВС- пен араластырылып, композиттік талшықтар түзілді. Талшықтар полимер қоспаларынан ультрадыбыстық өңдеу қолдану арқылы алынды, бұл компоненттердің біртекті араласуын жақсартуға мүмкіндік берді. Қоспалардың біртектілігі ультракүлгін-көрінетін спектроскопия әдісімен бағаланды, химиялық құрылымы инфрақызыл спектроскопия арқылы талданды, ал беткі морфологиясы сканерлеуші электрондық микроскопия (СЭМ) көмегімен зерттелді. СЭМ нәтижелері 16 апта ішінде талшықтардың беткі морфологиясының өзгеруін және біртіндеп деградацияға ұшырауын көрсетті, бұл топырақта массаның жоғалуын өлшеу нәтижелерімен де расталды. Механикалық қасиеттер ASTM D2256 стандартына сәйкес анықталды. ПВС енгізілуі талшықтардың созылғыштығы мен серпімділігін арттырды, ал ПЛА–ПВС (20:80 мас.%) композициясы зерттелген құрамдар ішінде ең қолайлы механикалық сипаттамаларды көрсетті. Жалпы алғанда, алынған нәтижелер ПЛА–ПВС композиттік талшықтарының сорылатын хирургиялық тігіс материалдары ретінде перспективалы кандидаттар екенін дәлелдейді.

Түйінді сөздер: полилактид, поливинил спирті, хирургиялық тігіс материалы, биоыдырайтын, композиттік талшық, хирургиялық талшықтар

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ПОЛУЧЕНИЕ БИОРАЗЛАГАЕМЫХ ХИРУРГИЧЕСКИХ НИТЕЙ НА ОСНОВЕ ПОЛИЛАКТИДА

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Аннотация. Традиционные хирургические швы необходимо удалять после заживления раны, что вызывает дополнительную боль и дискомфорт у пациентов. Полилактид (ПЛА) - это алифатический полиэстер, получаемый из возобновляемых ресурсов, который является биосовместимым и биоразлагаемым; однако его относительно высокая жесткость может ограничивать его применение в хирургии. Целью данного исследования было разработать биоразлагаемые хирургические швы на основе ПЛА и поливинилового спирта (ПВС) и изучить их физико-химические, механические свойства и биоразлагаемость. Для снижения жесткости ПЛА, ПЛА смешивали с ПВС для образования композитных волокон. Волокна получали из смесей полимеров с использованием ультразвуковой обработки для улучшения смешивания. Однородность смесей оценивали с помощью ультрафиолетово-видимой спектроскопии, химическую структуру анализировали с помощью инфракрасной спектроскопии, а морфологию поверхности исследовали с помощью сканирующей электронной микроскопии (СЭМ). СЭМ выявила изменения морфологии поверхности и постепенную деградацию волокон в течение 16 недель, что также подтверждается измерениями потери массы в почве. Механические свойства определялись в соответствии со стандартом ASTM D2256. Включение ПВС увеличило растяжимость и эластичность волокон, а композиция ПЛА– ПВС (20:80 мас.%) показала наиболее благоприятные механические характеристики среди исследованных составов. В целом, результаты свидетельствуют о том, что композитные волокна ПЛА–ПВС являются перспективными кандидатами для рассасывающихся хирургических шовных материалов.

Ключевые слова: полилактид, поливиниловый спирт, хирургический шовный материал, биоразлагаемый, композитное волокно, хирургические волокна

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