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Konzervacija i restauracija orijentalnog rukopisa *Al-Qāmūs Al-Muḥīṭ* u Nacionalnoj i univerzitetskoj biblioteci Bosne i Hercegovine

Conservation and Restoration of the Oriental Manuscript *Al-Qāmūs Al-Muḥīṭ* at the National and University Library of Bosnia and Herzegovina

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Sažetak / Abstract

Cilj: Cilj ovog rada bio je provesti sveobuhvatan konzervatorsko-restauratorski tretman orijentalnog rukopisa *Al-Qāmūs al-Muḥīṭ*, s fokusom na obnovu funkcionalnosti uveza, stabilizaciju papira i očuvanje izvornosti materijala.
Metodologija: Metodologija rada je obuhvatila procjenu zatečenog stanja, hemijska ispitivanja (UV fluorescencija, test s kapljicom vode, "quick-blot", spot testovi i mjerenje pH vrijednosti papira) te niz konzervatorskih postupaka: fumigaciju butanolom radi uklanjanja biodeteriogenih agenasa, neutralizaciju i alkalizaciju *Bookkeeper* rastvorom prilagođenu vodotopivim tintama, mehaničko čišćenje *HEPA* filtracijom i vulkaniziranom spužvom, impregnaciju metilcelulozom radi stabilizacije vlakana, dopunjavanje oštećenih dijelova japanskim papirom *Kozo* vlakana te ponovno ušivanje formi u knjižni blok. Originalne kožne korice stabilizovane su *Klucelom G*, dok su nedostajući dijelovi dopunjeni novom, ručno stanjenom, goveđom kožom.
Rezultati: Rezultati nakon konzervatorsko-restauratorskog procesa pokazuju značajno poboljšanje hemijske i mehaničke stabilnosti rukopisa: pH papira povećan je s 4,6–4,9 na 7,7, uklonjene su spore plijesni i tragovi biodeterioracije, rekonstruisani su nedostajući dijelovi listova, a rukopisu je vraćena čvrstoća, funkcionalnost i estetska cjelovitost. Mokro čišćenje nije bilo moguće provesti zbog rastvorljivosti tinte, što je zahtijevalo izbor alternativnih, kontrolisanih metoda. Primijenjene konzervatorsko-restauratorske metode pokazale su se izuzetno djelotvornima u tretmanu rukopisa s osjetljivim tintama, degradiranim papirom i složenim kožnim uvezom, pri čemu je identifikacija izvornih materijala omogućila primjenu savremenih, ciljano odabranih stabilizacionih sredstava.
Praktična upotreba: Kombinacija tradicionalnih tehnika i modernih analitičkih postupaka osigurala je rezultate koji doprinose dugotrajnoj očuvanosti rukopisne građe Bosne i Hercegovine i njenoj dostupnosti budućim generacijama. Jasno opisani postupci konzervatorsko-restauratorskog procesa daju radu dodatnu edukativnu dimenziju, čineći ga korisnim resursom za mlade stručnjake i studente te referentnim primjerom kako se savremeni pristupi mogu uspješno primijeniti u zaštiti vrijednih rukopisa.

Aim: The aim of this study was to carry out a comprehensive conservation-restoration treatment of the oriental manuscript *Al-Qāmūs al-Muḥīṭ*, focusing on the restoration of the binding's functionality, paper stabilization and preservation of the original materials.
Methodology: The methodology included an assessment of the manuscript's condition, chemical analyses (UV fluorescence, water drop test, quick-blot test, spot tests, and pH measurement of the paper), as well as a series of conservation procedures: fumigation with butanol to remove biodeteriogenic agents, neutralization and alkalization with *Bookkeeper* solution tailored for water-soluble inks, mechanical cleaning using *HEPA* filtration and vulcanized sponge, impregnation with methylcellulose to stabilize the fibers, restoration of damaged areas using Japanese *Kozo* paper, and resewing the quires into the text block. Original leather covers were stabilized with *Klucel G*, while missing parts were filled in with new, hand-thinned calfskin.
Results: The results after the conservation-restoration process show a significant improvement in the manuscripts' chemical and mechanical stability: the papers' pH increased from 4.6–4.9 to 7.7, mold spores and traces of biodeterioration were neutralised, missing parts of leaves were reconstructed and the manuscript regained its

strength, functionality and aesthetic integrity. Wet cleaning could not be performed due to the solubility of the ink, which required the use of alternative, controlled methods. These applied conservation-restoration methods proved highly effective in treating manuscripts with sensitive inks, degraded paper and complex leather bindings, where the identification of original materials enabled the targeted use of modern stabilizing agents.

Practical use: The combination of traditional techniques and modern analytical procedures produced results that contribute to the long-term preservation of manuscript heritage in Bosnia and Herzegovina and its accessibility for future generations. Clearly documented conservation-restoration procedures also add an educational dimension to the study, making it a valuable resource for young professionals and students, as well as a reference example of how contemporary approaches can be successfully applied in the protection of valuable manuscripts.

1. Uvod

Specijalne zbirke Nacionalne i univerzitetske biblioteke Bosne i Hercegovine (NUBBiH) osnovane su 1951. godine i prvobitno su se sastojale od samo dvije podzbirke. Tokom ratnih razaranja u periodu 1992–1996. godine, veliki dio zbirki je nepovratno uništen, dok su se nakon premještanja Nacionalne i univerzitetske biblioteke Bosne i Hercegovine u nove prostorije od preostalih fondova formirale nove podzbirke. Danas se razlikuje pet podzbirki: Rukopisna zbirka i arhiv, zbirka Stare i rijetke knjige, Kartografska zbirka, Grafička zbirka i Muzička zbirka. Među njima su zbirka Raritet, Rukopisna zbirka i Kartografska zbirka 2020. godine proglašene nacionalnim spomenicima Bosne i Hercegovine. S obzirom na svoj jezik i sadržaj, rukopis *Al-Qāmūs al-Muḥīṭ* pripada zbirci orijentalnih rukopisa, koja obuhvata 840 jedinica na arapskom, turskom i perzijskom jeziku, pretežno iz oblasti islamskog prava, poezije i proze (Nacionalna i univerzitetska biblioteka, 2024; Zbornik radova. Međunarodni naučni skup Stare i rijetke rukopisne knjige – gdje su i koliko učimo i koristimo stoljetno knjižno blago, 2019).

Al-Qāmūs al-Muḥīṭ je jedan od najpoznatijih rječnika arapske leksikografije i djelo je Muḥammada b. Ya'qūba b. Ibrāhīma al-Fīrūzābādīja aš-Šīrāzīja (umro 817/1415), poznatog kao Abū Ṭāhir. Ovo djelo je nastalo krajem 14. stoljeća u Mekki i nazvano je *Al-Qāmūs al-Muḥīṭ* ("Sveobuhvatni okean") te predstavlja prerađenu ili skraćenu verziju Ğawharījevog rječnika. Značaj djela bio je toliki da je riječ *qāmūs* postala sinonim za rječnik u arapskom jeziku. Abū Naṣr Ismā'īl b. Ḥammād al-Ğawharī al-Fārābī (u. 393/1002) smatra se prvim autorom koji je napisao jednostavan rječnik redanja riječi prema alfabetu zadnjih konsonanata. Skraćene preradbe Ğawharījevog rječnika bile su znatno raširenije, čime su trajno potvrdile važnu ulogu i značaj ovog autora i njegovog djela u leksikografskoj tradiciji. Rukopisni primjerak rječnika *Al-Qāmūs al-Muḥīṭ* iz NUBBiH datira iz 15. stoljeća.

1. Introduction

The Special Collections of the National and University Library of Bosnia and Herzegovina (NUBBIH) were established in 1951 and initially consisted of only two sub-collections. During the wartime destruction between 1992 and 1996, a large part of the collections was irreversibly lost. However, after the relocation of NUBBIH to new premises, new sub-collections were formed from the remaining holdings. Today, five sub-collections can be distinguished: the Manuscript and Archive Collection, the Rare and Old Book Collection, the Cartographic Collection, the Graphic Collection, and the Music Collection. In 2020, the Rare Collection, Manuscript Collection, and Cartographic Collection were declared national treasures of Bosnia and Herzegovina. Considering its language and content, the manuscript *Al-Qāmūs al-Muḥīṭ* belongs to the Oriental Manuscript Collection, which comprises 840 units in Arabic, Turkish, and Persian, primarily covering Islamic law, poetry, and prose (Nacionalna i univerzitetska biblioteka, 2024; Zbornik radova. Međunarodni naučni skup Stare i rijetke rukopisne knjige – gdje su i koliko učimo i koristimo stoljetno knjižno blago, 2019).

Al-Qāmūs al-Muḥīṭ is one of the most acclaimed dictionaries in Arabic lexicography and is the work of Muḥammad b. Ya'qūb b. Ibrāhīm al-Fīrūzābādī al-Shīrāzī (d. 817/1415), also known as Abū Ṭāhir. This work originated at the end of the 14th century in Mecca and is titled *Al-Qāmūs al-Muḥīṭ* ("The Comprehensive Ocean"). It represents a revised or summarized version of Al-Ğawharī's dictionary. The importance of this work was so profound that the term *qāmūs* came to be synonymous with "dictionary" in the Arabic language. Abū Naṣr Ismā'īl b. Ḥammād al-Ğawharī al-Fārābī (d. 393/1002) is considered the first author to compile a methodical dictionary arranging words according to the alphabet order of the final consonants. The summarized versions of Al-Ğawharī's dictionary were far more widespread, thus firmly establishing the lasting im-

2. Tehničke karakteristike i zatečeno stanje rukopisa

Al-Qāmūs al-Muḥīṭ je rukopisno djelo autora Muḥammada b. Ya'qūba al-Fīrūzābādīja (Abū Ṭāhir), napisano na arapskom jeziku i arapskim pismom. Djelo ima dimenzije 180 x 260 x 50 mm. Ovo leksikografsko djelo karakteriše pažljivo ispisan tekst s naglašenim elementima u crvenoj tinti i pozlati, čime se dodatno ističu važni pojmovi unutar rukopisa.

Klasični orijentalni uvez sastoji se od prednje i zadnje korice, hrbata, preklopa i klapne. Korice su dimenzionirane tačno prema knjižnom bloku, bez prelaska preko ivica papira, a karakterišu ih simetrične dekoracije na svim dijelovima. Kod rukopisa *Al-Qāmūs al-Muḥīṭ* korice su izrađene od smeđe kože, ukrašene slijepim tiskom i floralnim središnjim medaljonom. Uvez je pohaban i djelimično odvojen od bloka, pri čemu je središnji medaljon na koricama jedva primjetan. Hrbat je oslabljen, s gubitkom kože duž rubova. Preklop je sačuvan, ali vidno oštećen, dok je koža suha, ispucala i ljušti se na rubovima. Desna korica je potpuno odvojena od kartonske osnove. Predlist i zalist su također kožni, s utisnutim suhim žigom.

Knjižni blok rukopisa je kompletan, ali pokazuje znakove značajnog fizičkog propadanja. Na više mjesta vidljive su tamne mrlje nastale djelovanjem vlage, a papir, koji je ručno pravljen i srednje debljine, pokazuje različit stepen oštećenja. Njegova struktura je oslabljena – djeluje porozno, gotovo poput upijača, te se lako ljušti pri najmanjem kontaktu s vlagom. Posebno je zabrinjavajuća prisutnost aktivne plijesni, najizraženija na prvim stranicama, kao i duž unutarnjih margina središnjih formi. Pojedini listovi su ranije reparirani bijelim papirnim trakama, što svjedoči o pokušajima očuvanja. Predlist i zalist izrađeni su od kože. Oštećenja nastala djelovanjem insekata su minimalna, ali ipak prisutna, uglavnom duž margina.

Glavni tekst rukopisa ispisan je crnom, dok su naglašene riječi označene crvenom tintom, a povremeno i detaljima u pozlati, što doprinosi vizuelnoj dinamici i estetskoj vrijednosti rukopisa. Tinte su na pojedinim dijelovima, posebno onima oštećenim vlagom, primjetno izblijedile. Ipak, nije uočena značajna korozija tinte, što ukazuje na upotrebu kvalitetnih pigmenata. Svaka stranica sadrži po 25 redova pažljivo ispisanog teksta, što svjedoči o standardizaciji i urednosti pisanja.

portance and significance of both the author and his work in the lexicographical tradition. The transcript of the dictionary *Al-Qāmūs al-Muḥīṭ* from NUBBIH dates back to the 15th century.

2. Technical Specifications and Present State of the Manuscript

Al-Qāmūs al-Muḥīṭ is a manuscript transcript written in Arabic language by Muḥammad b. Ya'qūb al-Fīrūzābādī (Abū Ṭāhir). The work measures 180 x 260 x 50 mm. This lexicographical work is characterized by carefully inscribed text with highlighted elements in red ink and gilding, which further emphasize important terms within the manuscript.

The traditional Oriental binding consists of a front cover, back cover, spine, for-edge flap and envelope flap. The covers are precisely sized to fit the book block without overlapping the edges of the paper, and they feature symmetrical decorations on all parts. In the case of the *Al-Qāmūs al-Muḥīṭ* manuscript, the covers are made of brown leather, decorated with blind tooling and a floral central medallion. The binding is deteriorated and partially detached from the block, with the central medallion on the covers barely visible. The spine is weakened, with leather loss along the edges. The flap is preserved but visibly damaged, while the leather is dry, cracked and flaking at the edges. The right cover is completely separated from the cardboard base. Both the front and back endpapers are also made of leather, featuring a dry stamp.

The text block of the manuscript is complete but shows signs of significant physical deterioration. Dark stains caused by moisture are visible in several areas, and the handmade, moderately thick paper shows various levels of deterioration. Its structure is weakened—it appears porous, almost like a sponge, and flakes easily upon the slightest contact with moisture. Of particular concern is the presence of active mold, found on the first pages and along the inner margins of the central quires. Some folios have been previously repaired with white paper strips, indicating past conservation efforts. The front and back endpapers are made of leather. Insect damage is minimal but still present, mainly along the margins.

The main text of the manuscript is written in black ink, with emphasized words marked in red ink and occasionally highlighted with gilded details, contributing to the visual dynamism and aesthetic value of the manuscript. In certain areas, especially those affected by moisture, the inks have noticeably faded. However, no significant ink corrosion has been observed, indicating the use of high-quality pig-

Slika 1. Izgled rukopisa prije konzervacije i restauracije: A) Pohabani smeđi kožni uvez, djelomično odvojen od bloka; B) Oštećenja i mrlje od vlage na stranicama rukopisa; C) Fragmenti konca na hrbatu
Figure 1. Appearance of the manuscript before conservation and restoration: A) Worn brown leather binding, partially detached from the book block; B) Damage and tidelines on the manuscript pages; C) Thread fragments on the spine

3. Hemijsko ispitivanje materijala

Hemijske analize provedene na rukopisu *Al-Qāmūs al-Muḥīṭ* su: UV fluorescencija (UVF), osnovni test s kapljicom vode, "quick-blot" metoda testiranja medija za rastvorljivost te spot testovi.

3.1. Pregled pod UV svjetlom

Prilikom pregleda rukopisa pod ultraljubičastim (UV) zračenjem, evidentirane su vizuelne promjene koje ukazuju na prisustvo vlage i potencijalne tragove mikrobiološke kontaminacije (prisustvo plijesni). Dobijeni rezultati pregleda ukazali su na potrebu provođenja fumigacije radi uklanjanja mogućih biodeteriogenih agenasa.

3.2. Osnovni test s kapljicom vode

Osnovni test s kapljicom vode koristi se za procjenu stanja papira i njegove reakcije na vlagu. Test se izvodi tako da se kapljica destilirane vode nanese na površinu papira, a zatim se promatra kako papir reagira: brzo upijanje, stvaranje mrlja ili promjena boje mogu ukazivati na oštećenje, dok sporije upijanje sugerira veću stabilnost. Osnovni test s kapljicom vode proveden je u skladu sa standardom TAPPI T 432 (2013). Utvrđeno je da se kapljica destilirane vode apsorbira u papir u vremenu kraćem od 1 sekunde. Dobijeni rezultat ukazuje na povećanu poroznost i oslabljenu strukturu celuloznih vlakana, što potvrđuje da je proces degradacije papira već započeo.

ments. Each page contains 25 carefully inscribed lines of text, reflecting a high level of standardization and writing precision.

3. Chemical Examination of Materials

The chemical analyses conducted on the manuscript *Al-Qāmūs al-Muḥīṭ* included: UV fluorescence (UVF), a basic water-drop test, the quick-blot method for testing media solubility, and spot tests.

3.1. UV Light Examination

During the examination of the manuscript under ultraviolet (UV) light, visual changes were observed indicating the presence of water damage and potential signs of microbiological contamination (presence of mold). The results of the examination highlighted the need for fumigation to eliminate possible biodeteriogenic agents.

3.2. Basic Water-Drop Test

The basic water-drop test is used to assess the condition of the paper and its reaction to moisture. The test is performed by applying a drop of distilled water onto the papers' surface and observing the reaction: rapid absorption, stain formation or color change may indicate damage, while slower absorption suggests better stability of paper. The basic water-drop test was conducted in accordance with the TAPPI T 432 (2013) standard. It was determined that the drop of distilled water was absorbed into the paper in less than one second. This result indicates increased porosity and weakened cellulose fiber structure, confirming that the paper degradation process has already begun.

3.3. "Quick-blot" metoda testiranja medija za rastvorljivost

Metoda "Quick-Blot" služi za mjerenje brzine kojom mediji poput tinte, boje ili ljepila reagiraju na vlagu. U slučaju rukopisnih dokumenata, kap destilirane vode se nanosi na površinu papira pomoću kapaljke, a odmah potom se tekućina upija upijačem. Praćenjem promjena u mediju uzrokovanih vlagom može se procijeniti koliko je taj medij osjetljiv na vodu i koliko brzo dolazi do otapanja (TAPPI, 2011a). Rezultati testa pokazali su da su i crna i crvena tinta vodotopive, što znači da se pod utjecajem vlage lako otapaju i razmazuju. Dobijeni rezultati direktno su utjecali na konzervatorsku odluku da se ne primjenjuje postupak mokrog čišćenja vodenim otapalima, budući da bi takva intervencija mogla povećati rizik od otapanja i trajnog oštećenja tinte.

3.4. Spot testovi

Spot testovi su preliminarna metoda za identifikaciju prisustva metala te organskih i anorganskih komponenti u materijalima, a zasnivaju se na hemijskim reakcijama koje proizvode karakteristična obojenja (Stuart, 2007). *Spot* testovi se provode izravno na površini predmeta i podrazumijevaju primjenu male količine hemijskih reagenasa. Reakcije daju karakteristična obojenja koja pomažu u prepoznavanju prisutnih materijala. Rezultati mikrohemijskih testova posmatraju se optičkim ili digitalnim mikroskopom.

3.3. The Quick-Blot Method for Testing Media Solubility

The Quick-Blot method is used to measure the rate at which media such as ink, paint, or adhesive react to moisture. In the case of manuscript documents, a drop of distilled water is applied to the paper surface using a pipette, and the droplet is immediately absorbed with blot paper. By tracking the effects of moisture on the media, it is possible to evaluate its sensitivity to water and how quickly it dissolves (TAPPI, 2011a). The test results showed that both black and red inks are water-soluble, meaning they smear and easily dissolve when exposed to moisture. These results directly influenced the conservation decision to avoid wet cleaning with aqueous solutions, as such intervention could increase the risk of ink dissolution and permanent damage.

3.4. Spot tests

Spot tests are a preliminary method for identifying the presence of metals, as well as organic and inorganic components in materials, based on chemical reactions that produce characteristic color changes (Stuart, 2007). Spot tests are performed directly on the surface of the object and involve the application of small amounts of chemical reagents. The reactions result in specific color changes that assist in detecting the materials present. The results of microchemical tests are observed using optical or digital microscopy.

Tabela 1. Rezultati prisustva komponenti u pulpi kroz mikrohemijske testove
Table 1. Detection of components in the pulp via microchemical testing

Spot test	Ispitivana komponenta Tested component	Al-Qāmūs al-Muhīt
Test fluoroglucinolom Phloroglucinol Test	lignin Lignin	+
Lugolov test Lugol's Solution Test	škrob Starch	+
Test ninhidrinom Ninhydrin Test	proteini Proteins	+
Test aluminonom Aluminon Test	stipsa Alum	-

3.4.1. Test fluoroglucinolom

Prisustvo lignina u papiru može se dokazati upotrebom otopine fluoroglucinola, koji pri pozitivnoj reakciji razvija karakterističnu magenta boju. Jačina ove boje proporcionalna je količini lignina prisutnog u pulpi (Konstadinovska & Spirovska, 2015; Kropf & Baker, 2013). Fluoroglucinol je specifičan reagens koji omogućava detekciju lignina u sastavu

3.4.1. Phloroglucinol Test

The presence of lignin in paper can be detected using a solution of phloroglucinol, which, upon a positive reaction, develops a characteristic magenta color. The intensity of this color is proportional to the amount of lignin present in the pulp (Konstadinovska & Spirovska, 2015; Kropf & Baker, 2013). Phloroglucinol is a specific reagent that enables the

papira, a pripravak otopine urađen je prema originalnoj recepturi (TAPPI, 2015). Pozitivna reakcija s fluoroglucinolom (magenta boja) ukazuje na prisustvo lignina, što je neočekivano s obzirom na to da se do 19. stoljeća papir izrađivao isključivo ručno, od čistih celuloznih vlakana poput lana, konoplje i pamuka – materijala koji prirodno ne sadrže lignin. Iako se općenito smatra da se historijski papir (do 19. stoljeća) pravio od čistih celuloznih vlakana (lan, konoplja), ovaj nalaz pokazuje da je u nekim slučajevima korišten i materijal koji sadrži lignin, poput slame. Slama se kao biljni materijal koji sadrži i celulozu i lignin veoma rijetko i eksperimentalno koristila u ranoj proizvodnji papira, pa bi se na taj način moglo opravdati prisustvo lignina (Ferrer & Sistach, 2005). Za detaljnije analize, bilo bi potrebno analizirati vlakna papira koja u ove svrhe nisu izvršena. Drugi mogući razlog prisustva lignina u papiru jeste migracija kiselih komponenti iz materijala za pohranu ili restauraciju (npr. drvenih ploča, kartonskih kutija, kiselih omota i ljepila) u strukturu papira, posebno ako je dokument bio u dugotrajnom direktnom kontaktu s tim materijalima. Takva migracija mogla je značajno uticati na sniženje pH vrijednosti papira, posebno u uslovima neadekvatne mikroklime – odnosno pri povišenoj relativnoj vlažnosti i temperaturnim oscilacijama – što dodatno ubrzava degradacijske procese (Novak et al., 2024).

3.4.2. Lugolov test

Škrob se dodavao u pulpu tokom proizvodnje radi poboljšavanja čvrstoće i otpornosti na vlagu ili poslije prerade, kao preparacija, gdje bi nakon glačanja papir bio spreman za ispisivanje teksta. Lugolovom otopinom dokazuje se prisustvo škroba u sastavu papira (TAPPI, 2011b). Receptura korištena u svrhu mikrohemijskih testova u ovom radu je: rastvoreno je 1,25 g I_2 u rastvoru od 2,5 g KI u 25 ml destilovane vode. Ovaj test je vrlo osjetljiv i daje pozitivnu reakciju i pri vrlo niskim koncentracijama škroba. Pozitivna Lugolova reakcija ukazuje na prisutnost škroba karakterističnom tamnoplavo-ljubičastom bojom, koja može varirati do gotovo crne. Dekstrini, kao produkti razgradnje škroba, daju crvenu do crveno-ljubičastu boju (Kraigher-Hozo, 2007). Testirani uzorak papira pokazao je tamnoplavu boju, što potvrđuje prisustvo škroba korištenog za preparaciju površine papira, s ciljem poboljšanja glatkoće, nepropusnosti i pripreme za pisanje.

detection of lignin in paper composition, and the solution was prepared according to the original recipe (TAPPI, 2015). A positive reaction with phloroglucinol (magenta color) in the paper sample indicates the presence of lignin, which is unexpected considering that until the 19th century paper was made exclusively by hand from pure cellulose fibers such as flax, hemp, and cotton—materials that naturally do not contain lignin. Although it is generally believed that historical paper (until the 19th century) was made from pure cellulose fibers (flax, hemp), this finding shows that in some cases materials containing lignin, such as straw, were also used. Straw, as a plant material containing both cellulose and lignin, was very rarely and experimentally used in early paper production, which could explain the presence of lignin (Ferrer & Sistach, 2005). For further analyses, it would be necessary to examine the paper fibers, which has not been done for this purpose. Another possible reason for the presence of lignin in paper is the migration of acidic components from storage or restoration materials (e.g., wooden boards, cardboard boxes, acidic covers and adhesives) into the paper structure, especially if the document was in prolonged direct contact with these materials. Such migration could have significantly contributed to the lowering of the papers' pH value, particularly under inadequate microclimate conditions—that is, elevated relative humidity and temperature fluctuations—which further accelerates degradation processes. (Novak et al., 2024).

3.4.2. Lugol's Solution Test

During production, starch was added to the pulp to enhance strength and water resistance, or it was applied as a sizing agent after processing to prepare the paper for writing. The presence of starch in the paper composition is detected using Lugol's solution (TAPPI, 2011b). The reagent used for microchemical tests in this study was prepared by dissolving 1.25 g of I_2 in a solution of 2.5 g KI in 25 ml of distilled water. This test is very sensitive and produces a positive reaction even at very low starch concentrations. A positive Lugol's reaction indicates the presence of starch by a characteristic dark bluish-purple color, which can range to almost black. Dextrins, as degradation products of starch, give a red to reddish-purple color (Kraigher-Hozo, 2007). The tested paper sample revealed a dark blue color, confirming the presence of starch used for surface treatment of the paper to improve smoothness, impermeability, and preparation for writing.

3.4.3. Test ninhidrinom

Test ninhidrinom služi za detekciju prisustva proteina i aminokiselina, što omogućava identifikaciju proteinskih ljepila (kao što su želatin i kazein) u uzorcima. Receptura koju su naveli Afifi i Ciliberto (2021), a koja je korištena za mikrohemijske testove u ovom istraživanju, sastoji se od 0,2 g ninhidrina rastvorenog u 100 ml etanola visoke čistoće. Pozitivna reakcija s ninhidrinom očitovala se pojavom roze-ljubičaste mrlje duž rubova papira, što upućuje na prisustvo proteinskih ostataka. Pretpostavlja se da papir, odnosno njegova površinska preparacija, sadrži proteine poput želatina ili bjelanjka jajeta, koji su se tradicionalno koristili u arapskoj tehnici pripreme papira (Hadžimejlić, 2011). Iako je trag preparacije vidljiv i golim okom, zbog degradacije papira proteinske komponente prisutne su u tragovima.

3.4.4. Test aluminonom

Test aluminonom je mikrohemijski test koji služi za dokazivanje prisustva stipse u preparaciji papira. Prema opisu u radu Kostadinovska i sar. (2019), koristi se rastvor aluminona pripremljen prema standardnoj proceduri za ovaj test. Prisustvo stipse nije potvrđeno mikrohemijskim testom aluminonom, budući da je rezultat bio bezbojna mrlja. To ukazuje na odsustvo aluminijskih iona, koji bi u prisustvu aluminona dali karakterističnu crvenu ili ružičastu obojenost (Konstadinovska & Spirovska, 2015). Odsustvo stipse, uz prisustvo škroba i proteina u tragovima, ukazuje na to da je papir prepariran organskim materijalima – najvjerovatnije bjelancetom jajeta ili želatinom. Budući da je test na stipsu bio negativan, a proteini prisutni samo u tragovima, pretpostavlja se da je korišteno bjelance jajeta. Međutim, prisustvo škroba također otvara mogućnost da je papir bio prepariran kombinacijom bjelanca i škrobnog ljepila. Takva kombinacija nije neuobičajena, jer škrob povećava nepropusnost i ravnotežu upijanja, dok bjelance daje dodatnu čvrstoću i sjaj površini. Dakle, u nedostatku stipse i s ograničenom količinom proteina, najvjerovatnije je primijenjena upravo takva dvokomponentna preparacija od bjelanceta i škroba (Vizárová et al., 2012; Mahmoud et al., 2023).

3.5. Mjerenje pH vrijednosti

Mjerenje pH vrijednosti papira ključno je za određivanje njegove trajnosti, jer brzina razgradnje papira ovisi o njegovoj kiselosti ili alkalnosti. Degradacija papira često počinje hidrolizom, koja razbija molekule celuloze i uzrokuje da papir postane krhak

3.4.3. Ninhydrin Test

The ninhydrin test is used to detect the presence of proteins and amino acids, enabling the identification of protein-based adhesives (such as gelatin and casein) in samples. The formulation reported by Afifi and Ciliberto (2021), which was used for the microchemical tests in this study, consists of 0.2 g of ninhydrin dissolved in 100 ml of high-purity ethanol. A positive ninhydrin reaction was observed as a pinkish-purple stain along the edges of the paper, indicating the presence of protein residues. It is assumed that the paper, or its surface treatment, contains proteins such as gelatin or egg white, which were traditionally used in the Arabic technique of paper sizing (Hadžimejlić, 2011). Although traces of the sizing treatment are visible to the naked eye, due to paper degradation, the protein components are present only in traces.

3.4.4. Aluminon Test

The aluminon test is a microchemical test used to detect the presence of alum in paper sizing. An aluminon solution was prepared according to the standard protocol described by Kostadinovska et al. (2019) and used for this test. The presence of alum was not confirmed by the aluminon microchemical test, as the result showed a colorless spot. This indicates the absence of aluminum ions, which would produce a characteristic red or pink coloration in the presence of aluminon (Konstadinovska & Spirovska, 2015). The absence of alum, along with the presence of starch and trace amounts of proteins, suggests that the paper was sized with organic materials—most likely egg white or gelatin. Since the test for alum was negative and proteins were present only in minimal quantities, it is presumed that egg white was used. However, the presence of starch also opens the possibility that the paper was sized with a combination of egg white and starch-based adhesive. Such a combination is not uncommon, as starch enhances impermeability and absorption balance, while egg white adds surface strength and gloss. Therefore, in the absence of alum and with limited protein content, the most likely scenario is that a dual-component sizing of egg white and starch was applied (Vizárová et al., 2012; Mahmoud et al., 2023).

3.5. pH value of paper

Assessing paper pH is fundamental to evaluating its stability, as its chemical composition significantly affects the rate of degradation. Paper degradation often

i lomljiv (Carter, 2007). Za određivanje pH vrijednosti papira u konzervatorskoj praksi najčešće se upotrebljava pH-metar, koji omogućuje kvantitativno mjerenje, dok pH-indikatorske trakice pružaju brzu i jednostavnu procjenu površinskog pH, što je korisno za preliminarna ispitivanja ili u situacijama kada nije moguće koristiti instrument.

Mjerenje pH vrijednosti papira rukopisa *Al-Qāmūs al-Muḥīṭ* izvršeno je pomoću *Crison 507 pH-metra* s ravnom elektrodom. Rezultati mjerenja pH uzoraka papira pokazali su kiselu sredinu. Kroz šest mjerenja dobiveni su rezultati pH vrijednosti između 4,6 i 4,9. Papir korišten za izradu ovog rukopisa izrađivan je najvjerovatnije od prirodnih vlakana, prije početka industrijske proizvodnje papira i preparacije sa želatinom (Area & Cheradame, 2011; Vizárová et al., 2012; Mahmoud et al., 2023). Dobiveni rezultati mjerenja pH su na granici s kritičnom tačkom kiselosti papira koja iznosi < 4,5, pri kojoj se očekuje ubrzana degradacija.

Margine i unutrašnji dio papira, u području uveza rukopisa, bili su potpuno izloženi vlažnom okruženju. To se očitovalo pojavom vodenih mrlja, nastalih uslijed kretanja vode kroz papir sve do mjesta isparavanja. Ti dijelovi su vrlo krhki i na dodir se pretvaraju u prašinu, pa će zbog toga biti ojačani u procesu restauracije tankim japanskim papirom *Tosa Tengujo*, *1,6 g/m², 100% Kozo vlakna*.

4. Konzervacija i restauracija rukopisa

4.1. Fumigacija

Fumigacija je konzervatorski postupak kojim se rukopisi zatvaraju u hermetičku komoru, gdje hlapljive supstance isparavaju i tokom tog procesa djeluju na sprečavanje aktivnosti spora, plijesni i štetočina bez direktnog kontakta s papirom (Sequeira et al., 2012; 2016). Zbog sumnjivih mrlja i mogućeg prisustva spora preventivno je provedena fumigacija butanolom (80–96%), koji sporije isparava i dugotrajnije djeluje u odnosu na etanol (Karbowska-Berent et al., 2016). Tradicionalno su za slične svrhe korišteni i etanol ili metanol, no butanol se pokazao efikasnijim zbog dužeg vremena djelovanja i smanjenog rizika od direktnog oštećenja papira (Sequeira et al., 2012). Knjiga je rastavljena na dvolisnice radi ravnomjernog djelovanja, a proces je trajao 48 sati po seriji, uz kontrolu mikroklime nakon tretmana. Butanol pri isparavanju učinkovito uništava spore i gljivice pri 25°C (Sequeira et al., 2012).

begins with hydrolysis, which breaks down cellulose molecules and causes the paper to become brittle and fragile (Carter, 2007). In conservation practice, a pH-meter is most commonly used for measuring pH, as it allows for quantitative results, while pH indicator strips provide a quick and simple assessment of surface pH, which is useful for preliminary testing or when instrumentation is not available.

The pH measurements of the paper from the manuscript *Al-Qāmūs al-Muḥīṭ* were conducted using a Crison 507 pH-meter with a flat electrode. The results indicated an acidic environment. A series of six readings indicated a pH range between 4.6 and 4.9. The paper used in this manuscript was most likely made from natural fibers, before the appearance of industrial paper production and sizing with gelatin (Area & Cheradame, 2011; Vizárová et al., 2012; Mahmoud et al., 2023). The obtained pH values are near the critical acidity threshold of < 4.5, below which accelerated degradation is expected.

The margins and inner parts of the paper, particularly in the binding area, had been fully exposed to a humid environment. This is concluded by the appearance of tidelines resulting from the movement of moisture through the paper to the point of evaporation. These areas are extremely fragile and disintegrate into dust upon contact, which is why they will be reinforced during the restoration process using thin Japanese paper *Tosa Tengujo, 1.6 g/m², 100% Kozo fiber*.

4. Manuscript Conservation and Restoration

4.1. Fumigation Treatment

Fumigation is a conservation procedure in which manuscripts are placed in a hermetically sealed chamber, where volatile substances evaporate and act to inhibit the activity of spores, mold and pests without direct contact with the paper (Sequeira et al., 2012; 2016). Due to suspicious stains and the potential presence of spores, preventive fumigation was carried out using butanol (80–96%), which evaporates more slowly and provides longer-lasting effects compared to ethanol (Karbowska-Berent et al., 2016). Traditionally, ethanol or methanol has been used for similar purposes, but butanol has proven to be more effective due to its prolonged action time and reduced risk of directly damaging the paper (Sequeira et al., 2012). Manuscript was disbound into bifolios to allow for even exposure and the process lasted 48 hours per quire, followed by post-treatment microclimate control. Upon evaporation, butanol effectively destroys spores and fungi at 25°C (Sequeira et al., 2012).

4.2. Alkalizacija papira

Deacidifikacija je postupak kojim se nastoji smanjiti kiselost papira povećavanjem njegove pH vrijednosti pomoću kalcijevog bikarbonata ($Ca(HCO_3)_2$) ili kalcijevog hidroksida ($Ca(OH)_2$). Postupak deacidifikacije papira implicirao bi povećanje pH vrijednosti papira. Penetracija karbonata u papiru stvara alkalne rezerve koje sprečavaju apsorpciju kiselina iz okoliša. Budući da je papir već kiseo, bilo je neophodno izvršiti neutralizaciju i alkalizaciju kiselina. Uzimajući u obzir da su na rukopisu korištene vodotopive tinte, papir je bilo potrebno tretirati rastvorom koji umjesto vode kao rastvarača koristi neki od organskih rastvarača poput acetona, etanola, toluena i sl. Takav rastvor najčešće se nanosi prskanjem, premazivanjem četkama ili potapanjem. U ovom slučaju, zbog izuzetno niske pH vrijednosti papira, pojedinačne dvolisnice rukopisa tretirane su prskanjem ravnomjerno po površini papira i potapanjem (samo nekoliko najugroženijih listova) u *Bookkeeper* rastvor, koji sadrži magnezijev metoksid rastvoren u metanolu. Vrijednost pH papira nakon neutralizacije i alkalizacije kiselina na rukopisu *Al-Qāmūs al-Muḥīṭ* iznosila je 7,7, što upućuje na to da je ovim tretmanom efikasno smanjena kiselost, a time se i povećala stabilnost papira. Pri potapanju, pH vrijednost papira mjerena je do maksimalno 7,7, kako bi se izbjegle previsoke alkalne vrijednosti koje mogu dovesti do alkalne depolimerizacije (Hubbe et al., 2017; He et al., 2019; Chen et al., 2025).

4.3. Mehaničko čišćenje papira

Mehaničko čišćenje rukopisa *Al-Qāmūs al-Muḥīṭ* obuhvatilo je uklanjanje površinske prljavštine i prašine. Nakon numeracije stranica i rastavljanja rukopisa na pojedinačne forme, izvršeno je detaljno usisavanje pomoću aparata s HEPA filterima, koji uklanjaju do 99,97% čestica veličine 0,3 μm, uključujući spore plijesni, prašinu i biološke agense. Tvrdi ostaci, poput izmeta insekata, uklonjeni su skalpelom i mikrospatulom, dok je prljavština očišćena vulkaniziranom spužvom. Po potrebi su uklonjena i stara ljepila te tragovi prethodnih reparacija.

4.2. Paper alkalization

Deacidification is a process aimed at reducing the acidity of paper by increasing its pH value using calcium bicarbonate ($Ca(HCO_3)_2$) or calcium hydroxide ($Ca(OH)_2$). The deacidification treatment implies raising the papers' pH. Carbonates penetrate the paper, forming alkaline reserves that inhibit acid absorption from the surroundings. Since the paper was already acidic, neutralization and alkalization of the acids were necessary. Considering the use of water-soluble inks in the manuscript, the paper needed to be treated with a solution that uses organic solvents instead of water as a medium, such as acetone, ethanol, toluene, etc. Such solutions are typically applied by spraying, brushing, or immersion. In this case, due to the extremely low pH of the paper, individual bifolia of the manuscript were treated by spraying evenly over the paper surface and immersion (only a few of the most damaged leaves) in a Bookkeeper solution, which contains magnesium methoxide dissolved in methanol. After neutralization and alkalization of the acids, the pH value of the paper in the *Al-Qāmūs al-Muḥīṭ* manuscript reached 7.7, indicating that this treatment effectively reduced acidity and thus increased the paper's stability. During immersion, the papers' pH was measured up to a maximum of 7.7 to avoid excessively high alkaline values that could lead to alkaline depolymerization (Hubbe et al., 2017; He et al., 2019; Chen et al., 2025).

4.3. Mechanical Cleaning of Paper

Mechanical cleaning of the *Al-Qāmūs al-Muḥīṭ* manuscript involved the removal of surface dirt and dust. After numbering the pages and disbinding the manuscript into individual quires, a thorough vacuuming was carried out using equipment with HEPA filters, which remove up to 99.97% of particles as small as 0.3 μm, including mold spores, dust, and biological agents. Solid residues, such as insect excretions, were removed with a scalpel and microspatula, while dirt was cleaned using a vulcanized sponge. As required, old adhesives and traces of previous repairs were also removed.

Slika 2. Mehaničko čišćenje papira rukopisa: A) Usisavanje dvolisnica pomoću usisivača s HEPA filterima; B) Čišćenje inkrustrirane prljavštine vulkaniziranom spužvom; C) Uklanjanje rezidua prethodnih reparacija skalpelom
Figure 2. Mechanical cleaning of the paper in the manuscript: A) Vacuuming of bifolio with a HEPA-filter vacuum cleaner; B) Removal of encrusted dirt using a vulcanized sponge; C) Mechanical removal of previous repair residues with a scalpel

4.4. Impregnacija papira

Nakon mehaničkog čišćenja rukopisa i uklanjanja starih traka i neadekvatnih reparacija, sprovedena je impregnacija papira radi stabilizacije oslabljenih vlakana. Impregnaciju je veoma važno izvršiti radi stabilizacije papira nakon pranja i alkalizacije, jer se time smanjuje njegova krhkost. Izvedena je lokalna impregnacija 2% metilcelulozom koja poboljšava mehaničku stabilnost bez utjecaja na optička svojstva papira (Borges et al., 2018; Müller et al., 2022). Škrob, koji se tradicionalno koristio kao impregnant, podložan je biološkoj razgradnji i može poticati rast mikroorganizama, dok je metilceluloza hemijski stabilnija, reverzibilna i otpornija na degradaciju, čime predstavlja sigurniju i učinkovitiju alternativu za očuvanje vrijednih rukopisa (Borges et al., 2018; Müller et al., 2022).

4.5. Nadomještanje nedostajućih dijelova

Dopunjavanje oštećenih dijelova, spajanje pocijepanih listova i povezivanje singlica ključni su konzervatorsko-restauratorski zahvati za vraćanje funkcionalnosti i estetske cjelovitosti rukopisa. Korišteno je škrobno ljepilo i ručno izrađeni japanski papir *Kinugawa ivory* (22 g/m², 100% Kozo vlakna), identične debljine i boje kao izvorni papir. Japanski papir oblikovan je pomoću vodenog kista na svijetlećem stolu kako bi se precizno ispratile konture. Lijepljen je s obje strane lista, a zbog svoje čvrstoće i adekvatnog izbora boje papira, dopune su neprimjetne (Artal-Isbrand, 2018). Kako bi se ojačali dijelovi papira koji su oslabili uslijed djelovanja vlage, korišten je *Tosa Tengujo NAJ* (1,6 g/m², 100% Kozo), najtanji japanski papir, koji, iako neprimjetan, pruža dodatno ojačanje papiru. Nakon restauracije, listovi su spojeni u dvolisnice, složeni u "sendvič" od holiteksa i upijača te sušeni pod pri-

4.4. Paper resizing

After the mechanical cleaning of the manuscript and the removal of old tapes and inadequate repairs, paper resizing was carried out to stabilize weakened fibers. Resizing is essential after washing and alkalization, as it reduces the brittleness of the paper. Localized resizing was performed using 2% methylcellulose, which improves mechanical stability without affecting the optical properties of the paper (Borges et al., 2018; Müller et al., 2022). Starch, traditionally used as an impregnating agent, is susceptible to biological degradation and may promote microbial growth, whereas methylcellulose is chemically more stable, reversible, and more resistant to degradation—making it a safer and more effective alternative for the preservation of valuable manuscripts (Borges et al., 2018; Müller et al., 2022).

4.5. Replacement of Missing Parts

The infilling of missing areas, the repair of torn bifolios, and the reintegration of single leaves are essential conservation-restoration interventions designed to restore both the functionality and aesthetic integrity of the manuscript. Starch paste and handmade Japanese paper *Kinugawa Ivory* (22 g/m², 100% Kozo fibers), matching the original paper in thickness and color were used. The Japanese paper was shaped using a water brush on a light table to precisely follow the contours. It was applied on both sides of the leaf and due to its strength and the appropriate color match, the infills are nearly invisible (Artal-Isbrand, 2018). To reinforce areas of the paper weakened by moisture, *Tosa Tengujo NAJ* (1.6 g/m², 100% Kozo), the thinnest Japanese paper, was used. Though barely visible, it provides additional support to the original material. After restoration, the single leaves were joined into bifolios, placed between

tiskom u knjigoveškoj presi. Višak papira je ručno odstranjen bez mijenjanja dimenzija, a listovi složeni prema originalnoj paginaciji.

layers of Holitex and blotting paper ("sandwich" structure) and dried under pressure in a bookbinding press. Excess paper was manually trimmed without altering the original dimensions so the leaves can be arranged according to the original pagination.

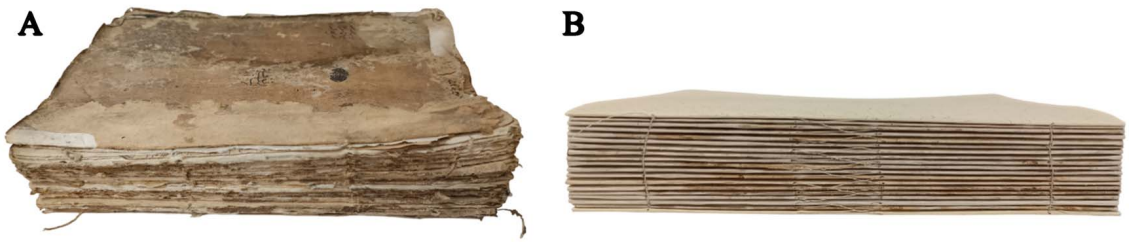
Slika 3. Dopuna nedostajućih dijelova izvornog papira rukopisa: A) Dvolisnica prije dopune japanskim papirom; B) Oblikovanje kontura nedostajućeg dijela vodenim kistom; C) Izgled japanskog papira za nadopunu
Figure 3. Infilling of missing areas of the manuscript's original paper: A) Bifolio prior to Japanese paper infill; B) Contouring the missing part with a water brush; C) Visual aspect of the Japanese paper for infilling

4.6. Ušivanje formi u knjižni blok

Ušivanje formi u knjižni blok ključno je za dugotrajnu stabilnost knjige. Islamski rukopisi koriste različite formate uveza, uključujući nevezane, što pokazuje fleksibilnost očuvanja (Scheper, 2023). Orijentalni stil ušivanja razlikuje se od zapadnog time što se izvodi bez užadi, što omogućava ravan hrbat bez prostora između korica, dok zaobljeni hrbat dodatno povećava fleksibilnost i trajnost. Forme su ušivene tehnikom *link-stitch* svilenim, voštanim koncem i šavovima koji oblikuju znak "X" u sredini, kao i oblik lanca na krajevima. Hrbat je ojačan s dva sloja tankog japanskog papira i jednim slojem organtina, pružajući stabilnost i fleksibilnost (Ljubuškić, 2023; Scheper, 2023; Ganović, 2025). Predlist i zalist zalijepljeni su mješavinom škrobnog i PVA ljepila, koristeći *Hahnemühle Bugra* papir (130 g/m², antique boja). Nova kapitalna traka nije ušivana, budući da rukopis izvorno nije posjedovao kapitalnu traku, te se njen izvorni izgled ne može pouzdano utvrditi.

4.6. Sewing the Quires into the Text Block

Sewing the quires into the text block is crucial for the long-term stability of the book. Islamic manuscripts employ various binding formats, including unsupported bindings, which demonstrate conservation flexibility (Scheper, 2023). The Oriental sewing style differs from the Western one in that it is executed without cords, allowing for a flat spine without gaps between the covers, while a rounded spine further enhances flexibility and durability. The quires were sewn using the link-stitch technique with silk waxed thread and stitches forming an "X" shape in the center, as well as chain-like stitches at the ends. The spine was reinforced with two layers of thin Japanese paper and one layer of mull, providing both stability and flexibility (Ljubuškić, 2023; Scheper, 2023; Ganović, 2025). The front and back endpapers were adhered with a mixture of starch and PVA glue, using *Hahnemühle Bugra* paper (130 g/m², antique color). The new endband was not sewn, as the manuscript originally did not have one, and its original appearance cannot be reliably determined.



Slika 4. A) Izgled knjižnog bloka prije konzervatorsko-restauratorskih zahvata; B) Knjižni blok nakon zahvata i šivanja
Figure 4. A) Appearance of the book block prior to conservation and restoration interventions; B) Text block post-restoration and stitching

5. Konzervacija i restauracija originalnih korica

Mehaničko čišćenje obuhvatilo je usisavanje usisivačem s *HEPA* filterom i uklanjanje mrlja vulkaniziranom spužvom, dok je mokro čišćenje rađeno mješavinom destilirane vode i etanola (3 ml/100 ml). Prilikom konzervatorskih radova identificirana je originalna koža ispod sekundarnog sloja, s očuvanim elementima slijepog tiska i pozlate. Sekundarne korice su pažljivo odvojene od originalnih mikrorestauratorskom špatulom nakon kratkog potapanja u rastvor vode i etanola, a originalni predlist i zalist sušeni su u knjigoveškoj presi 24 sata. Nedostatak hrpta, preklopa i klapne na originalnoj koži ukazuje na to da je novi sloj kože zalijepljen radi nadomještanja oštećenja ili namjernog prekrivanja pozlaćenih korica. Originalna koža impregnirana je 2% rastvorom *Klucel G* u etanolu radi očuvanja stabilnosti i fleksibilnosti. *Klucel G* prodire u materijal bez stvaranja filma, čuvajući prirodnu teksturu i elastičnost (Kite & Thomson, 2020).

5. Conservation and Restoration of the Original Covers

Surface cleaning included vacuuming with a HEPA filter and stain removal using a vulcanized sponge, while wet cleaning was performed with a mixture of distilled water and ethanol (3 ml/100 ml). During the conservation work, the original leather beneath the secondary layer was identified, with preserved elements of blind tooling and gilding. The secondary covers were carefully separated from the original ones using a micro-spatula after brief immersion in a water and ethanol solution. The original leather front and back endpaper were dried in a bookbinding press for 24 hours. The absence of the spine, turn-ins, and flap on the original leather indicates that the new leather layer was adhered to compensate for damage or to deliberately cover the gilded covers. The original leather was impregnated with a 2% *Klucel G* solution in ethanol to preserve its stability and flexibility. *Klucel G* penetrates the material without leaving a coating, preserving the natural texture and elasticity (Kite & Thomson, 2020).

Slika 5. A) Izgled korica rukopisa prije konzervatorsko-restauratorskih zahvata; B) Identifikacija originalne kože ispod sekundarnog sloja; C) Primarni sloj kože korica prije čišćenja; D) Primarni sloj kože korica nakon mehaničkog čišćenja, presovanja i ravnanja

Figure 5. A) Condition of the manuscript covers prior to conservation and restoration interventions; B) Recognition of the original leather beneath the secondary covering; C) Original leather layer of the book covers prior to cleaning; D) Primary leather layer of the covers after mechanical cleaning, pressing, and flattening

Nova koža, tamnosmeđa goveđa, ručno stanjena na 0,2 mm, korištena je isključivo za nadomještanje dijelova na kojima je izvorna koža nedostajala – poput hrbata, preklopa i klapne na licu korica. Zalijepljena je mješavinom škrobnog i PVA ljepila na kar-

Exclusively for replacing missing sections like the spine, turn-ins, and fore-edge on the front of the covers, new dark brown cowhide leather, hand-thinned to 0.2 mm, was employed. It was adhered with a mixture of starch and PVA glue onto 2 mm thick

ton debljine 2 mm. Rubovi su pažljivo presavijeni, a korice su sušene u ručnoj presi 24 sata. Originalna (primarna) koža je reintegrirana na korice, a sekundarni sloj je nakon stabilizacije pohranjen u beskiselinsku kutiju radi trajnog čuvanja i dokumentacije. Nakon završetka uvezivanja, originalni predlist i zalist pažljivo su vraćeni na svoje mjesto. Rukopis je potom smješten u beskiselinsku zaštitnu kutiju s jasno istaknutom oznakom, u svrhu dugoročne zaštite i lakše identifikacije. Prema Kite i Thomson, (2020), završno premazivanje kože u svrhu zaštite se više ne preporučuje, jer su mnogi takvi tretmani na starim kožnim koricama uzrokovali oksidaciju, gubitak fleksibilnosti, kao i ljuštenja kože, te povećali osjetljivost kože na plijesan. Stoga je odlučeno da se koža neće dodatno tretirati, već će se održavati redovnim čišćenjem i nježnom njegom.

board. The edges were carefully folded and the covers were dried in a bookbinding press for 24 hours. The original leather was reintegrated onto the covers and the secondary leather was stored in an acid-free box for long-term preservation and documentation after stabilization. After the binding was finalized, the original leather endpapers at the front and back were carefully restored to their original positions. Finally, the manuscript was placed inside an acid-free box with a clearly visible label to provide long-term protection and simplify identification. According to Kite and Thomson (2020), final leather coatings for protection are no longer recommended, as many such treatments on old leather covers have caused oxidation, loss of flexibility and peeling, as well as increased sensitivity to mold. Consequently, no additional treatments were applied to the leather, with regular cleaning and careful care chosen as the preferred approach.

Slika 6. Rukopis nakon konzervatorsko-restauratorskih zahvata: A) Korice rukopisa s dodatom i originalnom kožom; B) Naličje preklopa i klapne s izvornom kožom; C) Izgled originalnog, kožnog predlista rukopisa
Figure 6. Manuscript after conservation-restoration treatments: A) Manuscript covers with added and original leather; B) Reverse side of the fore-edge and envelope flap showing original leather; C) Appearance of the original leather front endpaper of the manuscript

6. Preporuke za dugoročno očuvanje rukopisa

Za dugoročno očuvanje rukopisa preporučuje se čuvanje u prostoriji sa stabilnim mikroklimatskim uslovima: konstantna temperatura između 17 i 19°C i relativna vlaga između 40% i 55%, bez velikih oscilacija. Kako je rukopis digitalizovan, fizički primjerak više nije izložen čestom rukovanju ni direktnom uticaju svjetlosti, što značajno doprinosi njegovoj zaštiti. Ukoliko dođe do izlaganja, neophodno je izbjegavati izlaganje rukopisa direktnoj IC i UV svjetlosti, a intenzitet vidljive svjetlosti treba biti manji od 50 luksa. Rukopis zahtijeva kontinuiranu stručnu brigu – preporučuje se godišnji pregled uveza i mehaničko čišćenje.

6. Recommendations for the Long-Term Preservation of the Manuscript

For the long-term preservation of the manuscript, it is recommended to store it in an environment with stable microclimatic conditions: a constant temperature between 17 and 19°C and relative humidity between 40% and 55%, without significant fluctuations. Since the manuscript has been digitized, the physical transcript is no longer subjected to frequent handling or direct light exposure, which greatly contributes to its protection. If exposure does occur, it is essential to avoid direct infrared (IR) and ultraviolet (UV) light and the intensity of visible light should remain below 50 lux. The manuscript requires continuous professional care—an annual inspection of the binding and mechanical cleaning are recommended.

7. Zaključak

Rukopis *Al-Qāmūs al-Muḥīṭ* iz zbirke Nacionalne i univerzitetske biblioteke Bosne i Hercegovine predstavlja vrijedan dio orijentalne kulturne baštine ne samo Bosne i Hercegovine već i regije.

Ispitivanja mikrohemijskim testovima i detaljna analiza materijala papira rukopisa *Al-Qāmūs al-Muḥīṭ* otkrila su složenost i raznovrsnost tradicionalnih tehnika izrade i obrade papira. Prisutnost lignina, tragova škroba i proteinskih materijala ukazuje na upotrebu različitih organskih komponenti u pripremi papira, što je u skladu s arapskom tradicijom i varijacijama u historijskoj proizvodnji papira.

Proces konzervacije i restauracije obuhvatio je pažljivo mehaničko čišćenje, lokalnu impregnaciju metilcelulozom, kao i preciznu dopunu i ojačanje oštećenih dijelova japanskim papirom, što je značajno doprinijelo očuvanju strukturalne i estetske cjelovitosti rukopisa. Konzervacija i restauracija korica, uključujući odvajanje slojeva primarne i sekundarne kože, konzervaciju originalne kože i njeno vraćanje na rukopis, provedeni su u skladu sa savremenim konzervatorsko-restauratorskim standardima, čime je osigurana dugotrajna stabilnost i očuvanje historijske vrijednosti dokumenta.

Primijenjene konzervatorsko-restauratorske metode i materijali pokazali su se efikasnim i prikladnim za očuvanje osjetljivih rukopisnih predmeta. Poseban značaj dat je pažljivoj identifikaciji originalnih gradivnih materijala, čija je identifikacija omogućila prilagođenu primjenu modernih impregnacijskih sredstava. Ovakav multidisciplinarni pristup omogućava očuvanje kulturnog naslijeđa uz poštivanje njegove izvornosti i autentičnosti te predstavlja vrijedan primjer konzervatorsko-restauratorske prakse u području zaštite vrijednih islamskih rukopisa.

7. Conclusion

The manuscript *Al-Qāmūs al-Muḥīṭ* from the collection of the National and University Library of Bosnia and Herzegovina represents a valuable part of the Oriental cultural heritage not only of Bosnia and Herzegovina but of the entire region.

Microchemical testing and detailed material analysis of the paper in the *Al-Qāmūs al-Muḥīṭ* manuscript revealed the complexity and diversity of traditional paper-making and processing techniques. The presence of lignin, traces of starch, and proteinaceous materials indicates the use of various organic components in paper preparation, consistent with Arabic traditions and historical variations in paper production.

The conservation and restoration process included careful surface cleaning, localized resizing with methylcellulose, precise infilling and reinforcement of damaged areas using Japanese paper. These interventions significantly contributed to the preservation of the manuscripts' structural and aesthetic integrity. Conservation and restoration of the covers, including the separation of primary and secondary leather layers, conservation of the original leather, and its reattachment to the manuscript, were carried out following modern conservation-restoration standards, ensuring long-term stability and preservation of the manuscripts' historical value.

Applied conservation-restoration methods and materials proved effective and appropriate for the preservation of delicate manuscript items. Particular importance was given to the careful identification of original constituent materials, which enabled the tailored use of modern impregnation agents. This multidisciplinary approach enabels the preservation of cultural heritage while respecting its originality and authenticity, representing a valuable example of conservation-restoration practice in the field of safeguarding precious Islamic manuscripts.

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