



IPAK FIBROINIGA IMMOBILLANGAN NITROZO-R TUZI YORDAMIDA CO(II) IONLARINI SORBSION-SPEKTROFOTOMETRIK ANIQLASH

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Annotatsiya. Ipak fibroiniga immobillangan nitrozo-R tuzining Co(II) ionlari bilan kompleks hosil qilish xususiyatlari o'rganildi. Kompleksning maksimal analitik signali 510 nm da kuzatilib, Co(II) ionini aniqlash uchun optimal sharoitlar belgilandi. Darajalash grafigida 2,7-54,3 mkg/25 ml oralig'ida chiziqli bog'liqlik kuzatildi. Regressiya tenglamasi $R^2 = 0,99862$ ni tashkil etib, kompleksning molyar so'ndirish koeffitsienti $2,663 \cdot 10^4 \text{ L} \cdot \text{mol}^{-1} \cdot \text{cm}^{-1}$ ga teng bo'ldi. Olingan natijalar ipak fibroiniga immobillangan nitrozo-R tuzidan Co(II) ionlarini sorbsion-spektrofotometrik aniqlashda foydalanish imkoniyatini ko'rsatdi.

Kalit so'zlar: kobalt(II), nitrozo-R tuzi, ipak fibroin, immobillash, sorbsion-spektrofotometriya, qattiq faza.

Аннотация. Изучены особенности комплексообразования ионов Co(II) с нитрозо-R-солью, иммобилизованной на фиброине шёлка. Максимальный аналитический сигнал комплекса наблюдался при длине волны 510 нм, были установлены оптимальные условия определения ионов Co(II). На градуировочном графике наблюдалась линейная зависимость в диапазоне 2,7–54,3 мкг/25 мл. Коэффициент детерминации регрессионной зависимости составил $R^2 = 0,99862$, а молярный коэффициент поглощения комплекса — $2,663 \cdot 10^4 \text{ л} \cdot \text{моль}^{-1} \cdot \text{см}^{-1}$. Полученные результаты показали возможность использования нитрозо-R-соли, иммобилизованной на фиброине шёлка, для сорбционно-спектрофотометрического определения ионов Co(II).

Ключевые слова: кобальт(II), нитрозо-R-соль, фиброин шёлка, иммобилизация, сорбционно-спектрофотометрический метод, твёрдая фаза.

Abstract. The complex-forming properties of Co(II) ions with Nitroso-R salt immobilized on silk fibroin were investigated. The maximum analytical signal of the complex was observed at 510 nm, and the optimal conditions for the determination of Co(II) ions were established. A linear relationship was observed in the calibration curve over the concentration range of 2.7–54.3 µg/25 mL. The coefficient of determination for the regression was $R^2 = 0.99862$, while the molar extinction coefficient of the complex was $2.663 \times 10^4 \text{ L} \cdot \text{mol}^{-1} \cdot \text{cm}^{-1}$. The obtained results demonstrate the potential of Nitroso-R salt immobilized on silk fibroin for the sorption-spectrophotometric determination of Co(II) ions.

Keywords: cobalt(II), Nitroso-R salt, silk fibroin, immobilization, sorption-spectrophotometry, solid phase.

Kirish. Og‘ir metall ionlarini atrof-muhit obyektlarida nazorat qilish zamonaviy analitik kimyoning muhim yo‘nalishlaridan biridir. Kobalt biologik tizimlarda mikroelement sifatida muhim ahamiyatga ega bo‘lishiga qaramasdan, uning yuqori miqdorlari tirik organizmlarga salbiy ta‘sir ko‘rsatishi mumkin. Shu sababli tabiiy va texnogen obyektlarda kobaltning kichik miqdorlarini aniqlash uchun sezgir, selektiv, tezkor va iqtisodiy jihatdan samarali analitik usullar ishlab chiqish dolzarb hisoblanadi [1].

Kobalt ionlarini aniqlash uchun atom-absorbtsion, atom-emission, elektrokimyoviy va spektrofotometrik usullardan keng foydalaniladi. Yuqori instrumental imkoniyatlarga ega usullar sezgirliги bilan ajralib tursa-da, ko‘pincha murakkab va qimmat asbob-uskunalarini talab qiladi. Spektrofotometrik usullar esa bajarilishining soddaligi, nisbatan arzonligi hamda organik reagentlar yordamida analitik signalni tezkor aniqlash imkoniyati bilan ajralib turadi [2].

Adabiyotlar tahlili. So‘nggi yillarda organik reagentlarni qattiq tashuvchilar yuzasiga immobillashga asoslangan sorbsion-spektrofotometrik yondashuvlar keng rivojlanmoqda. Bunday tizimlarda aniqlanayotgan ionni sorbsiya qilish va rangli kompleks hosil qilish jarayonlari bir bosqichda amalga oshishi mumkin. Natijada aniqlanayotgan komponentning qattiq fazada konsentrlanishi kuzatiladi, reagent sarfi kamayadi va analitik signalning kontrastligi ortadi [3].

Tabiiy polimerlar, jumladan ipak fibroin, funksional guruhlariga boyliги, g‘ovak-amorf tuzilishi, ekologik xavfsizliги va sorbsion xususiyatlari sababli organik reagentlarni immobillash uchun istiqbolli material hisoblanadi [4]. Tadqiqotda qo‘llanilgan ipak fibroin “Urganchtex” korxonasida ikkilamchi chiqindi sifatida hosil bo‘ladigan tolalardan olingan bo‘lib, uning tarkibida serin, glitsin, alanin va valin kabi aminokislotalarning mavjudliги aniqlangan [5]. Rentgenofazaviy tadqiqotlarga ko‘ra, tolaning 78,25 % qismini amorf va 21,75 % qismini kristall faza tashkil qiladi. Sorbsion jarayonlarning asosan amorf sohada sodir bo‘lishi ipak fibroindan tashuvchi sifatida foydalanish imkoniyatini oshiradi [6].

Mazkur ishning maqsadi nitrozo-R tuzini ipak fibroin tolasiga immobillashning optimal sharoitlarini aniqlash, immobillangan reagentning Co(II) ionlari bilan kompleks hosil qilish qonuniyatlarini o‘rganish hamda hosil bo‘lgan analitik tizimning spektral va strukturaviy xususiyatlarini baholashdan iborat [7].

Usullar

Reaktivlar va asbob-uskunalar

Tadqiqotlarda analitik tozalik darajasidagi nitrozo-R tuzi reagenti va Co(II) ionining standart eritmalaridan foydalanildi. Nitrozo-R tuzining ishchi eritmasi $1,0 \cdot 10^{-4}$ mol/L konsentratsiyada tayyorlandi.

Organik reagentni immobillash uchun tabiiy ipak fibroin tolasi qo‘llanildi. Tajribalarda tolaning 0,2000 g miqdordagi namunalaridan foydalanildi.

Eritmalarning optik zichligi EMC-30PC UV-1800 spektrofotometrida o‘lchandi. Muhit kislotaliligi Mettler-Toledo pH-metri yordamida nazorat qilindi. Qattiq fazadagi analitik signal nur qaytarish spektrofotometriyasi yordamida baholandi. Immobillash va kompleks hosil bo‘lish jarayonini tasdiqlash uchun IQ-spektroskopik va elektron-mikroskopik tadqiqotlar amalga oshirildi.

Ipak fibroinni tayyorlash va nitrozo-R tuzini immobillash. Tolali sorbentdan 0,2000 g miqdorda tortib olinib, xlorid shaklga o‘tkazish maqsadida 0,05 M HCl eritmasi bilan faollashtirildi. So‘ngra tola distillangan suv bilan yuvildi.

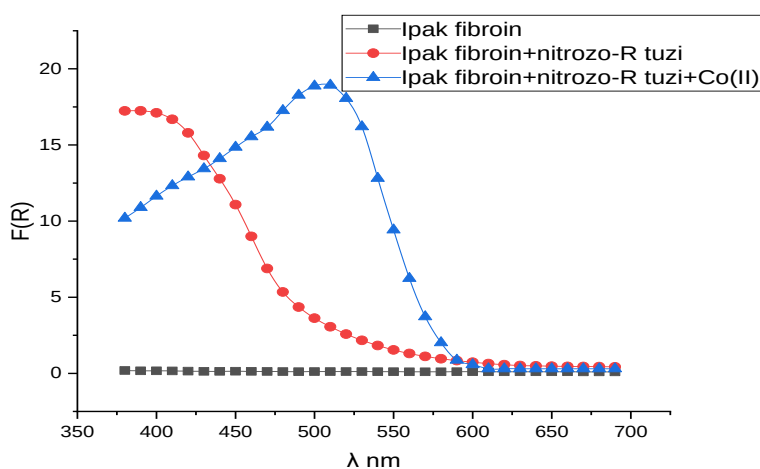
Immobillash uchun 0,2000 g tayyorlangan sorbentga 30 ml $1,0 \cdot 10^{-4}$ M nitrozo-R tuzi eritmasi qo‘shildi va aralashma statik sharoitda ushlab turildi. Jarayon davomida eritmaning rangsizlanishi va sorbentning reagent rangiga kirishi reagentning eritmadan qattiq fazaga o‘tishini ko‘rsatdi.

Natijalar. Organik reagentlarni qattiq tashuvchiga immobillashda sorbentning kimyoviy tabiati va sirt xususiyatlari muhim ahamiyatga ega. Shu sababli nitrozo-R tuzini immobillashda turli tolali sorbentlarning samaradorligi taqqoslandi [8].

Tajribalar davomida sorbentlar bir xil massada 0,2000 g olinib, ularga bir xil hajm va konsentratsiyadagi nitrozo-R tuzi eritmasi ta’sir ettirildi. Olingan nur qaytarish spektrlari sorbentlarning reagentga nisbatan turlicha sorbsion faollikka ega ekanligini ko‘rsatdi [9].

Tabiiy ipak fibroin yuqori sorbsion faolligi hamda qattiq fazada yetarlicha intensiv analitik signal hosil qilishi bilan ajralib turdi. Bundan tashqari, materialning tabiiyligi, foydalanish qulayligi va mahalliy ikkilamchi xomashyo asosida olinishi uni keyingi tajribalar uchun tashuvchi sifatida tanlashga asos bo‘ldi [10].

Co(II)–nitrozo-R kompleksining spektral xususiyatlari. Nitrozo-R tuzining o‘ziga xos yutilish maksimumi 380 nm atrofida kuzatildi. Reagent ipak fibroinga immobillangandan so‘ng Co(II) ionlari bilan o‘zaro ta’sirlashdi, hosil bo‘lgan kompleksning maksimal analitik signali 510 nm da qayd etildi [11].



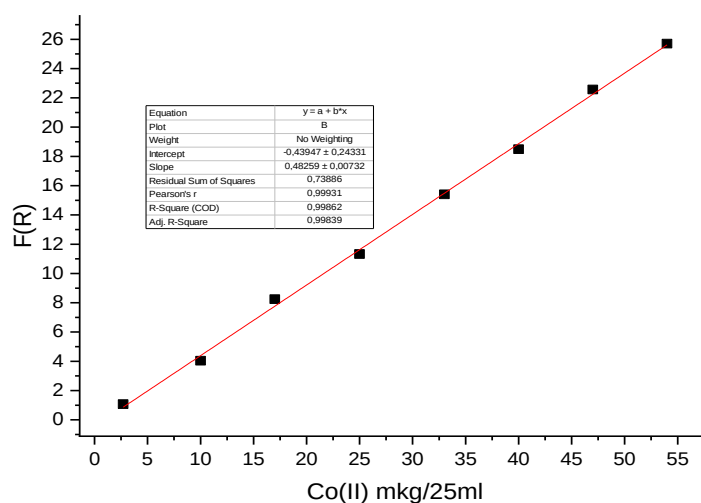
1-rasm. Ipak fibroin, unga immobillangan nitrozo-R tuzi va kobalt(II) ionlari bilan kompleksining nur qaytarish spektrlarini Kubelka-Munk funksiyasidagi ifodasi

Muhokama

Shunday qilib,

$\Delta\lambda = 130 \text{ nm}$ ga teng batoxrom siljish kompleks hosil bo‘lish jarayonida xromofor tizimdagi elektron taqsimotining sezilarli o‘zgarishini ko‘rsatadi. Bunday katta spektral farq reagent va kompleks signallarini bir-biridan aniq ajratish imkonini beradi va reaksiyaning yuqori kontrastligini ta‘minlaydi [12].

Co(II) ionining darajalash grafigi. Nitrozo-R tuzi immobillangan sorbent yordamida Co(II) ionini aniqlashda analitik signalning metall ion miqdoriga bog‘liqligi o‘rganildi. O‘lchashlar 510 nm to‘lqin uzunligida amalga oshirildi. Olingan darajalash grafigida Co(II) ionining **2,7–54,3 mkg/25 ml** miqdorlar oralig‘ida chiziqli bog‘liqlik kuzatildi. Chiziqli regressiya tenglamasi $y = 0,48259x - 0,43947$ bo‘lib, korrelyatsiya koeffitsienti $r = 0,99931$ teng, determinatsiya koeffitsienti esa $R^2 = 0,99862$ ni tashkil etdi. Olingan yuqori korrelyatsiya qiymati analitik signal va Co(II) ionining miqdori o‘rtasida kuchli chiziqli bog‘liqlik mavjudligini ko‘rsatadi [13].



2-rasm. Co(II) aniqlashning darajalash grafigi

Kompleksning molyar so‘ndirish koeffitsienti: Optimal sharoitda Co(II)–nitrozo-R kompleksining maksimal optik zichligidan foydalanib molyar so‘ndirish koeffitsienti hisoblandi:

$$\varepsilon = A/(C \cdot l)$$

Tajribada:

$$A = 0,49; C = 1,83 \cdot 10^{-5} \text{ mol/L}; l = 1 \text{ cm.}$$

Shundan:

$$\varepsilon = 0,49/(1,83 \cdot 10^{-5} \cdot 1) = 2,663 \cdot 10^4 \text{ L} \cdot \text{mol}^{-1} \cdot \text{cm}^{-1}.$$

Molyar so‘ndirish koeffitsientining nisbatan yuqori qiymati hosil bo‘lgan kompleksning intensiv rangli ekanligi va spektrofotometrik aniqlash uchun qulayligini ko‘rsatadi.

1-jadval

Co(II) ionini aniqlashning optimal shartlari

Analitik reagent	Ipak fibroin matritsada immobillangan nitrozo-R tuzi
λ nitrozo-R tuzi (nm)	380
λ kompleks (nm)	510

Immobillash vaqti (min)	30
Kompleks hosil bo‘lishining pH muhiti	6,0±0,3
Molyar so‘ndirish koeffitsientining	2,663·10 ⁴
To‘g‘ri chiziqli bog‘lanish diapazon (mg l ⁻¹)	0,1-2,17
Aniqlash quyi chegarasi (mg l ⁻¹)	0,018

1-jadvalda Co(II) ionlarini nitrozo-R tuzi yordamida aniqlashning asosiy analitik shartlari umumlashtirilgan [14]. Kompleks hosil bo‘lishi pH=6,0±0,3 muhitida optimal kechib, uning maksimal analitik signali 510 nm to‘lqin uzunligida qayd etildi. Co(II) ionlari uchun 0,1–2,17 mg/L oralig‘ida chiziqli bog‘lanish kuzatilib, aniqlash quyi chegarasi 0,018 mg/L ga teng bo‘ldi. Ushbu natijalar ipak fibroiniga immobillangan nitrozo-R tuzi asosidagi analitik tizimning Co(II) ionlarini sorbsion-spektrofotometrik aniqlash uchun yetarli analitik imkoniyatga ega ekanligini ko‘rsatadi [15].

Xulosa. Tadqiqot natijasida tabiiy ipak fibroini nitrozo-R tuzini immobillash uchun samarali qattiq tashuvchi sifatida tanlandi. Immobillangan reagentning Co(II) ionlari bilan o‘zaro ta’siri natijasida intensiv analitik signal beruvchi kompleks hosil bo‘lishi aniqlandi. Reagent va kompleks signallari orasidagi sezilarli spektral farq kompleks hosil bo‘lish jarayonini qattiq fazada qayd etish imkonini berdi.

Aniqlangan optimal sharoitlar va analitik tavsiflar ipak fibroiniga immobillangan nitrozo-R tuzi asosidagi tizimning Co(II) ionlarini aniqlash uchun yaroqli ekanligini ko‘rsatdi. Tizimning tabiiy ipak fibroini asosida yaratilgani, mahalliy ikkilamchi xomashyodan foydalanish imkoniyati va sorbsion-spektrofotometrik yondashuvning soddaligi ushbu usulni analitik amaliyotda qo‘llash uchun istiqbolli qiladi.

Foydalanilgan adabiyotlar

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