*Ф А 2.2.1-32-367*

**MINISTRY OF HEALTH OF UKRAINE**
**NATIONAL UNIVERSITY OF PHARMACY**
**faculty for foreign citizens' education**
**department drug technology**

# QUALIFICATION WORK

on the topic: **« DEVELOPMENT OF TOPICAL GEL ANALGESIC ACTIVITIES»**

**Prepared by**: higher education graduate of group Фм18(5,0д) англ-06
specialty 226 Pharmacy, industrial pharmacy
educational program Pharmacy
Imane BENDIJOUR
**Supervisor**: assistant professor of department drug technology, PhD
Anna KRIUKOVA
**Reviewer**: associate professor of higher education institution of department of drugs technology, PhD, associate professor
Marina BURYAK

**Kharkiv – 2023 year**

## ANNOTATION

Studies of the physicochemical and pharmaco-technological properties of the Devil's claw dry extract have been conducted. The composition and technology for the production of a gel based on Devil's claw dry extract have been developed. For the medicinal product, quality indicators were studied in accordance with the current regulatory documentation of Ukraine. The developed gel is recommended for use in diseases of the musculoskeletal system.

The work consists of an introduction, three chapters, general conclusions and literature. The content of the work is set out on 45 pages of typewritten text, containing 8 tables, 10 figures.

*Key words*: Devil's claw, gel, analgesic effect

## АНОТАЦІЯ

Проведені дослідження фізико-хімічних та фармакотехнологічних властивостей гарпагофітуму лежачого екстракту сухого. Розроблено склад і технологію виробництва гелю на основі гарпагофітуму лежачого екстракту сухого. Для лікарського засобу досліджені показники якості відповідно до діючої нормативної документації України. Розроблений гель рекомендовано застосовувати при захворюваннях опорно-рухового апарату.

Робота складається зі вступу, трьох розділів, загальних висновків та списку використаної літератури. Зміст роботи викладений на 45 сторінках машинописного тексту, що містить 8 таблиць, 10 рисунків.

*Ключові слова*: гарпагофітум лежачий, гель, знеболююча дія

**CONTENT**

## LIST OF CONVENTIONAL ABBREVIATIONS

| | | |
|---|---|---|
| API | – | active pharmaceutical ingredient |
| BAS | – | biologically active substances |
| MSS | – | musculoskeletal system |
| NSAIDs | – | nonsteroidal anti-inflammatory drugs |
| pH | – | hydrogen index |
| SPhU | – | State Pharmacopoeia of Ukraine |
| WHO | – | World Health Organization |

# INTRODUCTION

**Actuality of subject.** In the structure of the causes of temporary disability, the pathology of the musculoskeletal system takes the second place after respiratory diseases. In Ukraine, joint diseases in the structure of non-infectious pathology occupies the third place after the pathology of the circulatory system and tumor neoplasms. Up to 2 % of the world's population suffers from such articular pathology as arthritis, about 10 % of the world's population is affected by arthrosis [9, 10].

Diseases of the musculoskeletal system include more than 150 nosology that affect the musculoskeletal system: muscles, bones, joints, connective tissues such as tendons and ligaments. They range widely, from acute and short-term states – fractures, sprains, and dislocations – to lifelong impairments accompanied by chronic pain and disability. Currently, non-steroidal anti-inflammatory drugs are widely used in the pharmacotherapy of diseases of the musculoskeletal system, in particular, to eliminate the inflammatory process and alleviate pain. However, today the question of undesirable side effects of drugs in this group remains unresolved. An alternative is herbal medicines, the advantages of which are low toxicity, mildness of action, which makes it possible to use these drugs for a long time without significant side effects.

However, today the question of undesirable side effects of drugs in this group remains unresolved. An alternative is herbal medicines, the advantages of which are low toxicity, mildness of action, which makes it possible to use these drugs for a long time without significant side effects.

**The aim of the work** – is the development of the composition and technology of the topical gel analgesic activities.

**Tasks of work.** For this objective, the following tasks were supplied:

- to study the literature data of the characteristics of diseases of the musculoskeletal system;

- to analyze the main approaches to the pharmacotherapy of diseases of the musculoskeletal system;
- to conduct an analytical examination of medicines used locally for joint and muscle pain, presented on the pharmaceutical market of Ukraine;
- to conduct a study of the physicochemical and pharmaco-technological properties of the Devil's claw dry extract;
- to develop the composition and technology of the gel based on the Devil's claw dry extract;
- to establish and study the quality indicators of the obtained gel.

**The object of the research –** active ingredients: Devil's claw dry extract; other ingredients: carbomer Ultrez 21, xanthan gum; experimental samples of gel bases, the process of obtaining a gel.

**The subject of the research** is the experimental substantiation of the composition and technology of the gel based on the Devil's claw dry extract.

**Methods of the research:** general scientific (analysis and structuring of scientific literature data), organoleptic (homogeneity, smell, color), physicochemical (solubility, hydrogen index), pharmaco-technological (colloidal stability, thermal stability), and mathematical (statistical processing of results).

**The practical value of the results.** The composition and technology of the production of a gel analgesic activity have been developed. Gel for the treatment of diseases of the musculoskeletal system.

**Approbation of research results and publication.** The research results of the qualifying work were discussed at the scientific-practical conference and published in the form of abstracts (see Appendices A):

Bendijour I., Kriukova A., Konovalenko I. Marketing analysis of the assortment of topical medicines of the treatment of musculoskeletal diseases in Ukraine/ Соціальна фармація: стан, проблеми та перспективи: матер. VIII Міжнар. наук.-

практ. дистанційної конференції (27 кв. 2023 р., м. Харків) / ред. кол.: А. А. Котвіцька та ін. – Х.: НФаУ, 2023. – С.413-415.

**The structure of the work.** The work consists of an introduction, three chapters, general conclusions and literature. The content of the work is set out on 45 pages of typewritten text, containing 8 tables, 10 figure.

# CHAPTER I
# DEVIL'S CLAW AS A PROMISING RAW MATERIAL FOR DEVELOPING MEDICINES (REVIEW OF LITERATURE)

## 1.1. General of diseases of the musculoskeletal system

The musculoskeletal system is the body's framework of bones, muscles, tendons, ligaments, and other connective tissues that work together to support the body's weight, protect internal organs, and enable movement.

Bones provide the rigid structure of the musculoskeletal system, while muscles contract and relax to produce movement. Tendons and ligaments connect muscles to bones and bone to bone, respectively, helping to stabilize joints and prevent injuries.

The musculoskeletal system also includes other important structures, such as cartilage, which provides cushioning between bones, and synovial fluid, which lubricates joints and helps to reduce friction during movement.

The musculoskeletal system is essential for maintaining posture, balance, and coordination, as well as for performing activities of daily living, such as walking, running, lifting, and carrying. It also plays a critical role in protecting the body from external forces and impacts, such as falls or collisions [11].

Diseases and conditions that affect the musculoskeletal system can have a significant impact on a person's quality of life, causing pain, stiffness, and limited mobility. Treatment options vary depending on the specific condition but may include medication, physical therapy, surgery, or lifestyle modifications. Maintaining a healthy musculoskeletal system through regular exercise, a balanced diet, and proper posture and body mechanics can help prevent many musculoskeletal conditions and improve overall health and well-being [41].

There are many diseases and conditions that can affect this system, including:

- Osteoarthritis – degenerative joint disease that causes the breakdown of cartilage, resulting in pain, stiffness, and loss of mobility. Symptoms include joint pain, stiffness, tenderness, and swelling, especially after periods of inactivity or overuse.
- Rheumatoid arthritis – autoimmune disease that causes chronic inflammation of the joints, leading to joint damage, pain, and stiffness. Symptoms include joint pain, stiffness, swelling, and redness, and may be accompanied by fatigue, fever, and weight loss.
- Osteoporosis – condition characterized by a loss of bone density, making bones fragile and more susceptible to fractures. Symptoms may include back pain, loss of height, and a stooped posture.
- Fibromyalgia – chronic condition that causes widespread pain, fatigue, and tender points in muscles and joints. Symptoms may include muscle pain and stiffness, fatigue, sleep disturbances, headaches, and depression.
- Gout – form of arthritis caused by the buildup of uric acid crystals in the joints, resulting in severe pain, swelling, and stiffness.
- Scoliosis – abnormal curvature of the spine that can cause back pain and affect posture and mobility.
- Tendinitis – inflammation of a tendon, usually caused by overuse or repetitive strain, resulting in pain and restricted movement.
- Bursitis – inflammation of a bursa, a small fluid-filled sac that cushions and lubricates joints, resulting in pain and limited mobility. Symptoms may include joint pain, stiffness, and swelling.
- Carpal tunnel syndrome – condition caused by compression of the median nerve in the wrist, resulting in pain, numbness, and weakness in the hand and wrist.
- Muscular dystrophy – group of genetic disorders that cause progressive muscle weakness and loss of muscle mass.

Articular syndrome is one of the main clinical symptoms that unites almost all diseases musculoskeletal system. Articular syndrome is a medical term used to describe a set of symptoms that affect the joints of the musculoskeletal system. The syndrome can result from a variety of causes, including injuries, infections, autoimmune diseases, and degenerative conditions.

Symptoms of articular syndrome may include joint pain, stiffness, swelling, redness, and warmth. Movement of the affected joint may be limited, and there may be a loss of joint function.

Drug treatment for articular syndrome depends on the underlying cause and severity of the symptoms. Here are some common types of medications used to treat articular syndrome:

- Nonsteroidal anti-inflammatory drugs (NSAIDs) – these medications help to reduce pain and inflammation associated with articular syndrome. Examples include ibuprofen, naproxen, and aspirin;
- Corticosteroids – these medications work by reducing inflammation and can be taken orally or injected directly into the affected joint. Examples include prednisone and methylprednisolone;
- Disease-modifying antirheumatic drugs (DMARDs): these medications help to slow down the progression of certain types of articular syndrome, such as rheumatoid arthritis. Examples include methotrexate and sulfasalazine;
- Biologic response modifiers (biologics): these medications work by targeting specific components of the immune system that contribute to inflammation in articular syndrome. Examples include adalimumab and etanercept;
- Colchicine – This medication is used to treat gout, a type of articular syndrome caused by the buildup of uric acid crystals in the joints. Colchicine helps to reduce pain and inflammation during gout attacks.

The main drugs used to treat diseases of the musculoskeletal system are analgesic and anti-inflammatory drugs [32, 33]. Clinical experience proves that the plant products

are a worthy alternative to synthetic drugs [35]. Some of the advantages of herbal remedies over synthetic drugs include: natural and safe, affordable, fewer side effects: while all medications have the potential to cause side effects, herbal remedies are generally less likely to cause adverse reactions than synthetic drugs [23, 41].

## 1.2. Analysis of the assortment of topical medicines of the treatment of musculoskeletal diseases at the pharmaceutical market of Ukraine

Chapter 1 provides information about the etiology, pathogenesis and main directions of treatment tactics for diseases of the musculoskeletal system. At the next stage of work, we analyzed the range of topical preparations registered in Ukraine for the treatment of these pathologies, their composition, dosage forms, and manufacturers [13, 18].

According to the anatomical therapeutic chemical classification system, drugs that affect the musculoskeletal system, are divided into the following groups:

M01 – anti-inflammatory and antirheumatic medicines;
M02 – topical medicines for joint and muscle pain;
M03 – muscle relaxers;
M04 – medicines used to treat gout;
M05 – medicines used to treat bone diseases;
M09 – other medicines that used in case of pathology of the musculoskeletal system.

We have studied group M02 – drugs used topically for joint and muscle pain, marketing analysis data are given in table. 3.1. [7, 12].

*Table. 3.1.*

**A range of topical medicines for joint and muscle pain**

| № | Name of the drug, manufacturer, country of manufacture | Dosage forms | Active ingredients |
|---|---|---|---|
| **1** | **2** | **3** | **4** |
| 1. | Artrokol. *World Medicine, Great Britain* | Gel | Ketoprofen |

| 1 | 2 | 3 | 4 |
|---|---|---|---|
| 2. | Algozan. *PJSC «Chervona zirka «Chemical & Pharmaceutical Plant»,Ukraine.* | Gel | Diclofenac diethylamine, chestnut seed extract dry |
| 3. | Aertal. *Gedeon Richter, Hungary* | Cream | Aceclofenac |
| 4. | Butadion. *Gedeon Richter, Hungary* | Ointment | Phenylbutazone |
| 5. | Viprotoks. *LLC «DKP «Farmatsevtychna fabryka», Ukraine.* | Liniment | Viper poison, salicylic acid, racemic camphor, siberian fir oil |
| 6. | Diclofenac Sodium - Zdorovye Ultra. *TOV «Pharmaceutical Company Zdorovye», Ukraine.* | Spray for local application, gel | Sodium diclofenac |
| 7. | Diklak. *Sandoz, Switzerland.* | Gel | Sodium diclofenac |
| 8. | Diclosafe. *Kusum Healthcare Pvt., India.* | Gel | Sodium diclofenac |
| 9. | Sodium diclofenac натрію. *JSC «Farmak», Ukraine.* | Gel | Sodium diclofenac |
| 10. | Dimexide. *JSC «Galychpharm», Ukraine* | Solution for local application | Dimethyl sulfoxide |
| 11. | Dolobene. *Merkle GmbH, Germany.* | Gel | Heparin sodium, dimethyl sulfoxide, dexpanthenol |
| 12. | Zhivokost-viola. *PJSC «Pharmaceutical factory Viola», Ukraine.* | Ointment | Comfrey tincture (1:5), tocopherol acetate |
| 13. | Ketonal. *Sandoz, Switzerland.* | Cream | Ketoprofen |
| 14. | Clodifen. *S.C. Slavia Pharm S.R.L., Romania* | Gel | Sodium diclofenac |

| 1 | 2 | 3 | 4 |
|---|---|---|---|
| 15. | Menovazin. *TOV «Ternopharm», Ukraine.* | Solution for local application | Racemic menthol, procaine hydrochloride, benzocaine |
| 16. | Traumeel C. *Heel, Germany.* | Ointment | Homeopathic complex remedy |
| 17. | Fastofen. *PJSC «Chervona zirka «Chemical & Pharmaceutical Plant» Ukraine.* | Gel | Ketoprofen |
| 18. | Finalgon. *PJSC «Sanofi», France.* | Ointment | Nonivamide, nicoboxyl |
| 19. | Flamidez Gel. *Organosyn Life Sciences, India.* | Gel | Sodium diclofenac, methyl salicylate, levomenthol |
| 20. | Zeel T. *Heel, Germany.* | Ointment | Homeopathic complex remedy |
| 21. | Nimid. *Kusum Healthcare Pvt., India.* | Gel | Nimesulide |
| 22. | Nobi gel. *JSC «Farmak», Ukraine*. | Gel | Ketoprofen |
| 23. | Olfen. *Teva, Israel.* | Gel, transdermal patch | Sodium diclofenac |
| 24. | Rewma-Gel. *Deutsche Homoopathie-Union, Germany.* | Gel | Homeopathic complex remedy |
| 25. | Fanigan Fast. *Kusum Healthcare Pvt., India.* | Gel | Sodium diclofenac, menthol, methyl salicylate, linseed oil |
| 26. | Fastum Gel. *AG «Berlin-Chemie», Germany.* | Gel | Ketoprofen |
| 27. | Chondra-sila. *JSC «Farmak», Ukraine.* | Ointment | Chondroitin sodium sulfate |

| 1 | 2 | 3 | 4 |
|---|---|---|---|
| 28. | Viprosal V .<br>*Grindeks, Latvia.* | Ointment | Dry venom of the common viper, racemic camphor, turpentine oil, salicylic acid. |
| 29. | Deep relief.<br>*Delta Medical Promotions AG, Switzerland.* | Gel | Levomenthol |
| 30. | Capsicam.<br>*Grindeks, Latvia.* | Ointment | Dimethyl sulfoxide, racemic camphor, turpentine oil, benzyl nicotinate, nonivamide. |
| 31. | Nimedar.<br>*PRJSC «Pharmaceutical firm Darnitsa», Ukraine* | Gel | Nimesulide |
| 32. | Remisid.<br>*PRJSC «Pharmaceutical firm Darnitsa», Ukraine* | Gel | Nimesulide, levomenthol |
| 33. | Reparil gel H.<br>*Meda Pharma, Sweden.* | Gel | Escin, diethylamine salicylate, lavender oil, neroli oil |
| 34. | F-gel.<br>*PRJSC «Pharmaceutical firm Darnitsa», Ukraine.* | Gel | Ketoprofen, lavender oil, neroli oil |
| 35. | Deep hit.<br>*Mentholatum Company, Inc., USA.* | Cream | Eucalyptus oil, turpentine oil, menthol, methyl salicylate |
| 36. | Apizartron.<br>*Passauer Pharma GmbH, Germany.* | Ointment | Bee venom, methyl salicylate, allyl isothiocyanate |
| 37. | Bengay.<br>*McNeil Products Limited , USA.* | Cream | Methyl salicylate, racemic menthol |
| 38. | Dicloran plus.<br>*Johnson & Johnson, USA*. | Gel | Diclofenac diethylamine, methyl salicylate, linseed oil |
| 39. | Ketorolgel.<br>*Dr. Reddy's Laboratories Ltd, India.* | Gel | Ketorolac |
| 40. | Raptengel.<br>*STADA Arzneimittel AG*, *Germany.* | Gel | Sodium diclofenac |

| 1 | 2 | 3 | 4 |
|---|---|---|---|
| 41. | Ultrafastin. *Polpharma S.A., Poland.* | Gel | Ketoprofen lysine salt, ketoprofen |
| 42. | Bainvel ointment intensive. *«Homburg», Germany.* | Ointment | Camphor, purified turpentine, eucalyptus oil, racemic menthol, pine needle oil |
| 43. | Valusal. *Grindeks, Latvia.* | Gel | Ketoprofen |
| 44. | Ketum-gel. *M-Invest Limited, Cyprus.* | Gel | Ketoprofen |
| 45. | Voltaren emulgel. *Novartis Consumer Health SA, Switzerland.* | Emulgel | Sodium diclofenac |
| 46. | Dolgitgel *DOLORGIET GmbH & Co. KG., Germany.* | Cream | Ibuprofen |
| 47. | Фітобене. *PJSC «Fitopharm», Ukraine* | Gel | Dexpanthenol, sodium heparin, dimethyl sulfoxide |
| 48. | Diklofen-gel. *PJSC SIC «Borshchahivskiy CPP», Ukraine.* | Gel | Sodium diclofenac Levomenthol |
| 49. | Menovazin. *LLC «DKP «Farmatsevtychna fabryka», Ukraine.* | Solution for local application | Racemic camphor, прокаїн, бензокаїн |
| 50. | Alorom. *PJSC «Lubnyfarm», Ukraine.* | Liniment | Chamomile extract liquid aloe juice, liquid calendula extract, racemic menthol, eucalyptus oil |
| 51. | Bom bengue. *LLC «Ternopharm», Ukraine*. | Ointment | Levomenthol, methyl salicylate |
| 52. | Bom bengue ointment. *PJSC «Pharmaceutical factory Viola», Ukraine.* | Ointment | Levomenthol, methyl salicylate |
| 53. | Gevkamen. *PJSC «Pharmaceutical factory Viola», Ukraine.* | Ointment | Menthol, racemic camphor, eucalyptus oil, clove oil |

| 1 | 2 | 3 | 4 |
|---|---|---|---|
| 54. | Gevkamen. *LLC «Ternopharm», Ukraine.* | Ointment | Racemic menthol, racemic camphor, eucalyptus oil, clove oil |
| 55. | Diclosan. *PJSC «Lubnyfarm», Ukraine.* | Gel | Diclofenac sodium, nicotinic acid, ammonia solution 15 % formaldehyde solution |
| 56. | Sodium diclofenac. *PJSC "Chervona zirka «Chemical & Pharmaceutical Plant» Ukraine.* | Gel | Sodium diclofenac |
| 57. | Sodium diclofenac- Viola. *PJSC «Pharmaceutical factory Viola», Ukraine.* | Gel | Sodium diclofenac |
| 58. | Bile medical canned. *JSC «Infuzia», Ukraine.* | Solution for local application | Cattle bile and pig |
| 59. | Indomethacin plus. *PJSC «Chervona zirka «Chemical & Pharmaceutical Plant» Ukraine.* | Ointment | Indomethacin, dimethyl sulfoxide |
| 60. | Camphor oil. *PJSC «Pharmaceutical factory Viola», Ukraine.* | Oil for local application | Racemic camphor |
| 61. | Menovazin. *PJSC «Lubnyfarm», Ukraine.* | Solution for local application | Racemic menthol, procaine hydrochloride, benzocaine |
| 62. | Menovazin. *PJSC «Pharmaceutical factory Viola», Ukraine.* | Solution for local application | Racemic menthol, procaine hydrochloride, benzocaine |
| 63. | Nimulid. *Panacea Biotec, India.* | Gel | Nimesulide |
| 64. | Rosenthal paste. *LLC «Ternopharm», Ukraine.* | Solution for local application | Iodine, ethanol, chloroform |
| 65. | Capsicum tincture. *PJSC «Pharmaceutical factory "Viola"», Ukraine.* | Tincture for local application | Pepper fruit tincture |

| 1 | 2 | 3 | 4 |
|---|---|---|---|
| 66. | Turpentine Ointment. *LLC «Ternopharm», Ukraine.* | Ointment | Purified turpentine oil |
| 67. | Camphor alcohol. *LLC «Unipharma», Ukraine.* | Solution for local application | Racemic camphor, ethanol 70 % |
| 68. | Camphor alcohol. *PJSC «Pharmaceutical factory Viola», Ukraine.* | Solution for local application | Racemic camphor, ethanol 70 % |
| 69. | Camphor alcohol. *LLC «DKP «Farmatsevtychna fabryka», Ukraine.* | Solution for local application | Racemic camphor, ethanol 70% |
| 70. | Chondroitin Ointment. *LLC «DKP «Farmatsevtychna fabryka», Ukraine.* | Ointment | Sodium chondroitin sulfate |
| 71. | Espol. *PJSC «Chervona zirka «Chemical & Pharmaceutical Plant» Ukraine.* | Ointment | Екстракт перцю стручкового Dimethyl sulfoxide |
| 72. | Diclosafe forte. *Kusum Healthcare Pvt Ltd., India.* | Emulgel | Sodium diclofenac |
| 73. | Argett. *Delta Medical Promotions AG, Switzerland.* | Spray for local application | Sodium diclofenac |
| 74. | Voltaren forte. *Novartis Consumer Health SA, Switzerland.* | Emulgel | Diclofenac diethylamine |
| 75. | Sodium diclofenac- здоров'я. *LLC «DKP «Farmatsevtychna fabryka», Ukraine.* | Gel | Sodium diclofenac |
| 76. | Dolgit mountain pine. *Naturwaren, Germany.* | Solution for local application | Mountain pine oil, racemic camphor, levomenthol |

| 1 | 2 | 3 | 4 |
|---|---|---|---|
| 77. | Doloxen fast.<br>*Euro Lifecare, Great Britain.* | Ointment | Methyl salicylate |
| 78. | Comfrey ointment.<br>*PJSC «Fitopharm», Ukraine.* | Ointment | Comfrey tincture |
| 79. | Ibument.<br>*PJSC "Chervona zirka «Chemical & Pharmaceutical Plant» Ukraine.* | Gel | Ibuprofen, levomenthol |
| 80. | Ketogel - zdorovye.<br>*TOV «Pharmaceutical Company Zdorovye», Ukraine.* | Gel | Ketoprofen |
| 81. | Neofen plus.<br>*Belupo, Croatia.* | Gel | Ibuprofen |
| 82. | Ketoprofen.<br>*American Norton Corporation, USA.* | Gel | Ketoprofen |
| 83. | Menovazin-wishfa.<br>*LLC «DKP «Farmatsevtychna fabryka», Ukraine.* | Solution for local application | Menthol, novocaine (procaine hydrochloride), anestezin (benzocaine) |
| 84. | Olfen Hydrogel.<br>*Merkle GmbH, Germany.* | Gel | Sodium diclofenac |
| 85. | Flamiar.<br>*Pekana Naturheilmittel, Germany.* | Ointment | Homeopathic complex remedy |
| 86. | Gevkamen.<br>*LLC «Ternopharm», Ukraine.* | Ointment | Menthol, camphor, eucalyptus oil, clove oil |
| 87. | Indomethacin.<br>*Sopharma, Bulgaria.* | Ointment | Indomethacin |
| 88. | Nicoflex.<br>*Medimpex, Republic of Kyrgyzstan.* | Ointment | Capsaicin, ethyl nicotinate, glycol salicylate, lavender oil. |

| 1 | 2 | 3 | 4 |
|---|---|---|---|
| 89. | Denebol.<br>*Mili Healthcare, Great Britain.* | Gel | Rofecoxib |
| 90. | Northafien.<br>*M-Invest Limited, Cyprus.* | Gel | Ibuprofen |
| 91. | Finalgel.<br>*Sanofi, France.* | Gel | Piroxicam |

According to table 1.1., in group M02 – topical medicines for joint and muscle pain, there are 91 trade names [34]. The researched range of drugs indicates that drugs on the pharmaceutical market of Ukraine are represented by foreign production (51 %) and Ukrainian (49 %) in almost equal proportions (fig. 1.1).

Among foreign manufacturers, the largest market share is occupied by German manufacturers (27 %). Also, a significant market share is occupied by India – 16 %, USA – 9 %, Switzerland – 9 %, Great Britain 7 %, Latvia 7 % (fig. 1.2).

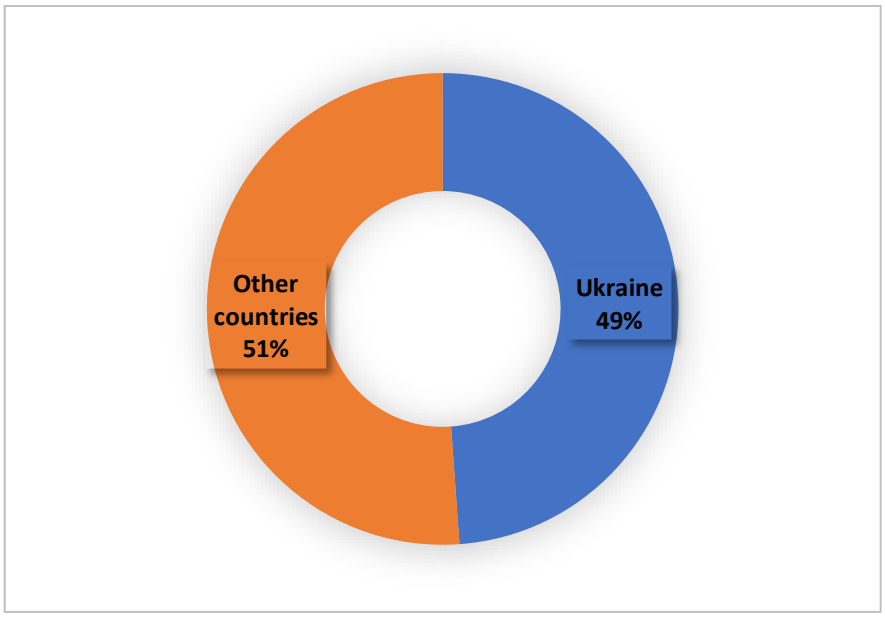



Fig. 1.1. Distribution of researched group of drugs by manufacturer countries

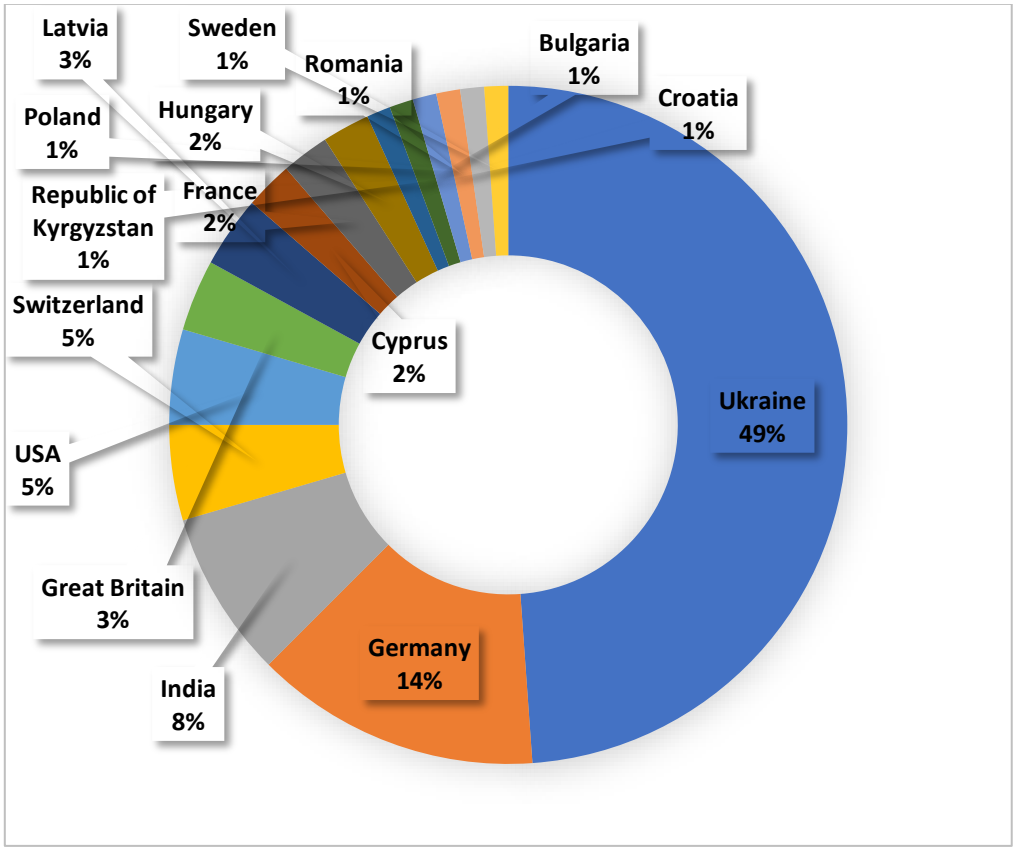



Fig. 1.2. Distribution of researched group of drugs of foreign manufacturers

The analysis conducted of the range of drugs by dosage form, it was found that the majority of drugs are produced in the form of a gel – 47 %, ointments are in second place – 24 %, skin solutions make up 19 % of the range (Fig. 1.3.).

The popularity of the dosage form of gels is due to a number of advantages of this dosage form: ease of application to the surface, prolonged action, the possibility of including chemically incompatible substances in the composition. Therefore, despite the large range of drugs in the form of gels, this dosage form is relevant in the development of new drugs [18].

Analysis of the product range by component composition, found that the main part of the drugs contains in own composition (65 %) the active component of the

synthetic origin, herbal medicines store only 20 % of the entire range, homeopathic medicines – 5 %, complex medicines – 10 %.

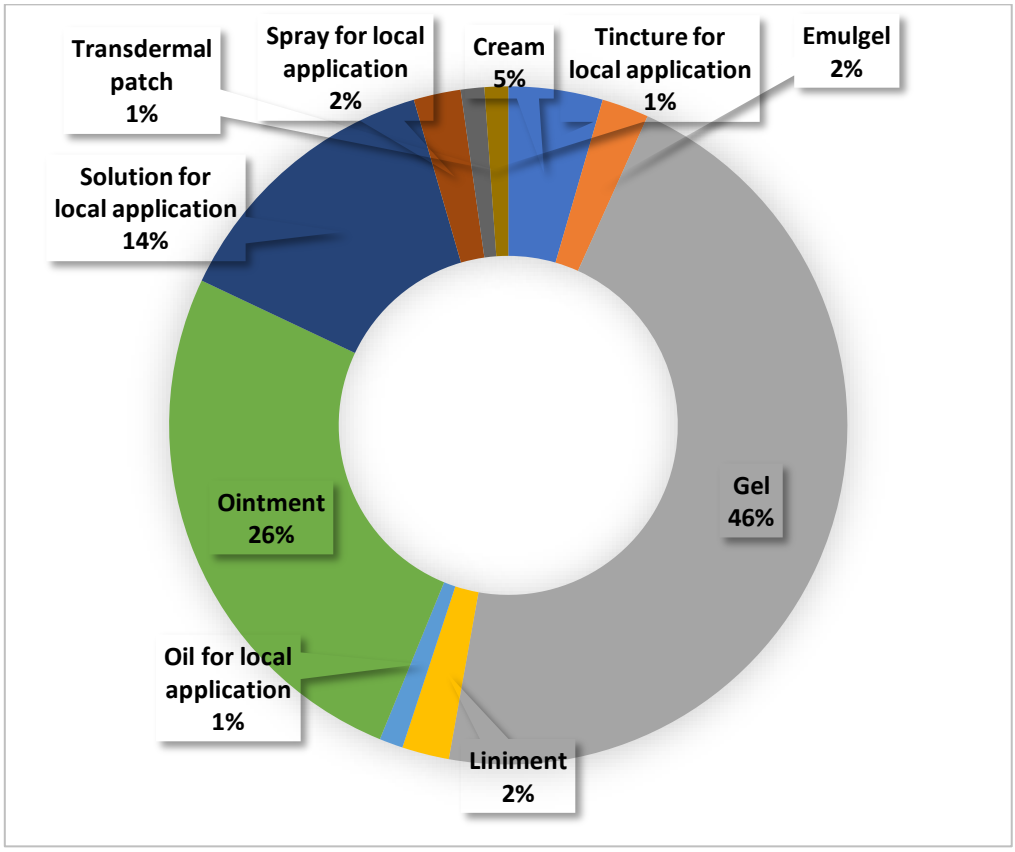



Fig. 1.3. Distribution of researched group of drugs by dosage form

Based on the results of the research, it should be noted that the range of herbal remedies is insufficient. That is, the development of new herbal remedies is a relevant task [34].

### 1.3. The use of raw materials of Devil's claw in pharmacy

Devil's Claw is native to the southern regions of Africa and gets its name from the hooks which cover its fruit. It has been traditionally used by tribal African peoples and more recently by Europeans and North Americans [22].

Roots are used as medicinal plant material. Figure 1.4. depicts the appearance of the plant and crushed roots.

Fig. 1.4.a. Image of a Devil's claw

Fig. 1.4.b. Devil's claw root minced

Devil's claw has been used to treat conditions such as arthritis, lower back pain, and digestive disorders. It is believed to work by reducing inflammation and pain in the body.

Devil's Claw is abundant in naturally occurring bioactive compounds including harpagoside, phytosterols, phenolic acids and flavonoids (kaempferol) [24, 28]. Structural formulas of the main biologically active substances (BAS) are shown in figure 1.5. [37]. Some studies suggest that these compounds may help to support joint comfort through their ability to promote a healthy response to typical everyday joint stress [19, 21].

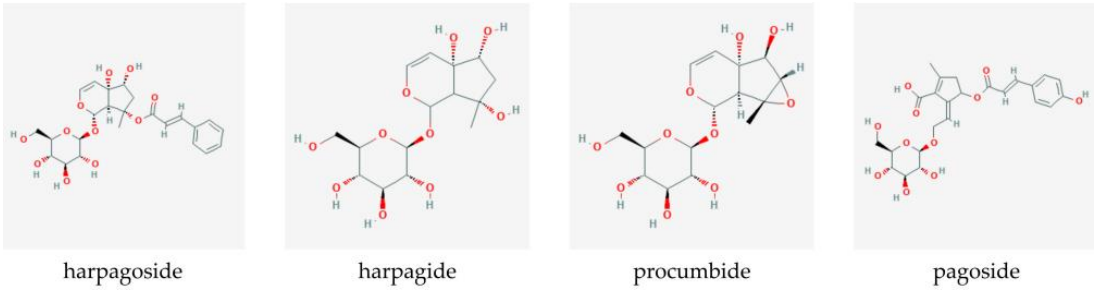



Fig. 1.5 Main BAS of Devil's Claw *(Harpagophytum procumbens)*

## CONCLUSIONS TO THE 1ST CHAPTER

1. The data of literary sources on clinical manifestations and classification of diseases of the musculoskeletal system have been analyzed. The main directions of treatment of articular syndrome are characterized.

2. The range of drugs used locally for joint and muscle pain, registered in Ukraine, was studied according to the indicators: «dosage form», «producing country», «component composition».

3. It has been established that the most expedient is the use of medicinal plant materials that exhibit analgesic and anti-inflammatory activity, in particular, Devil's claw *(Harpagophytum procumbens)*.

# CHAPTER II
# OBJECT AND METHODS OF RESEARCH

## 2.1. Object of the research

*Active ingredients:*

*Devil's claw dry extract (Harpagophyti extractum siccum)*, supplier Starwest Botanicals, USA – fine hygroscopic powder. From light brown to dark brown. Specific smell. Lumps allowed. Standardized according to the content of harpagoside (not less than 1.2%) [4, 27].

*Excipients:*

*Purified water (Aqua purificata)* – clear, colorless liquid without taste or smell. Butto formula: H2O; molecular weight: 18.02; pH - 5.0 - 7.0. The production method is distillation from drinking water.

*Xanthan gum (Xanthani gummi)* – white or yellowish white free flowing powder. Gross formula: $(C_{35}H_{49}O_{29})n$, belongs to the group of stabilizers. Xanthan has a double or multi-turn structure model, which ensures the stability of the bases in a wide temperature range and pH value. Chemically, xanthan gum is a polysaccharide produced by fermentation using the bacterium Xanthomonas campestris.

*Carbomer Ultrez 21 (Carbopol Ultrez 21)* – white or almost white, friable, hygroscopic powders, high molecular weight cross-linked polymers of acrylic acid with polyalkenylethers of sugars or polyalcohols. Contain not less than 56 % and not more than 68 % carboxyl groups (COOH) in terms of dry matter. When dispersed, they swell in water and other polar solvents. To obtain a viscous transparent gel, carbomer solutions require neutralization, for example, with a solution of triethanolamine.

*Triethanolamine* – clear, viscous, colorless or slightly yellowish liquid, very hygroscopic, with a faint smell of ammonia. Gross formula: $C_6H_{15}NO_3$. It is used in the production of medicines in the form of gels, creams as a carbopol neutralizer.

## 2.2. Methods of research

*Method 1.* Determination of the quantitative content of harpagoside. Carried out in accordance with the requirements of the article SPhU 2.0 *«Liquid chromatography» (2.2.29)*, according to the method given in the monograph DFU 2.0 "Harpagophytum recumbent root", SPhU 2.2 «Harpagophyti extractum siccum». The procedure was adapted to work using a Prostar chromatograph (Viran).

*Method 2.* Description. The appearance and characteristic organoleptic properties of the obtained samples are controlled, namely, color, smell, consistency, etc. For this, the creams deposited on the glass slide with a layer of (2–4) mm are viewed using color standards.

*Method 3.* Determination of the pH of aqueous solutions (according to the requirements of the SPhU 2.2, *«Potentiometric determination of pH» (2.2.3)).* 5.0 g of the cream (accurately weighed) was added to a 100 ml beaker and dissolved in 50 ml of water purified with stirring with a glass rod, left for 10 minutes for sedimentation of insoluble components, after which the pH value of the resulting aqueous dispersion was determined potentiometrically.

*Method 4.* Determination of structural-mechanical (rheological) parameters. According to the SPhU article 2.0. *«Rotational viscometry method» (2.2.10).*

*Method 5.* Statistical processing of results. The results of the studies were processed by the method of mathematical statistics in accordance with the requirements of the SFU monograph 5.3 «Statistical analysis of the results of biological tests and tests» and 5.3.N.1 «Statistical analysis of the results of a chemical experiment», the Statistica 8.0 program was used to process the results.

## CONCLUSIONS TO THE 2ND CHAPTER

1. The physicochemical properties of active and excipients used in the development of a soft dosage form based on Devil's claw dry extract are characterized.
2. Methods of physicochemical, pharmaco-technological, biopharmaceutical methods used in the development, as well as quality control of the resulting soft dosage form in the form of a gel, are described.

# CHAPTER III
# DEVELOPMENT OF A COMPOSITION AND TECHNOLOGY OF A GEL BASED ON DEVIL'S CLAW DRY EXTRACT

## 3.1. Study of physicochemical and pharmaco-technological properties of Devil's claw dry extract

Standardization of plant extracts is one of the main factors influencing the quality of the medicines obtained. Extracts used for the preparation of herbal remedies must be standardized, that is meet the requirements of regulatory documentation [4, 5, 6]. State Pharmacopoeia of Ukraine (SPhU) 2.2. monographs «Harpagophyti extractum siccum» regulates such quality indicators as *«Appearance»*, identification by *«Thin-layer chromatography» (2.2.27)*, assay by «*Liquid Chromatography» (2.2.29)*. Additional indicators were also investigated: *«Loss on drying» (2.2.27), «Total ash» (2.4.16).*

*Appearance.* Light brown uniform powder.

*Loss on drying.* Maximum 10.0 percent, determined on 1.000 g by drying in an oven at 105 °C.

*Total ash.* Maximum 5.0 percent, determined on 1.0 g.

*Assay.* Determination of the content of harpagoside in Devil's claw dry extract was carried out by liquid chromatography according to the method given in the monograph SPhU 2.2 «Harpagophyti extractum siccum». Under the conditions of this methods, the time of maintenance of the main peak of harpagoside was about 9 min. On fig. 3.4 and 3.5 show the chromatograms of the standard solution of *harpagoside P* and the test sample solutions of devil's claw dry extract, respectively.

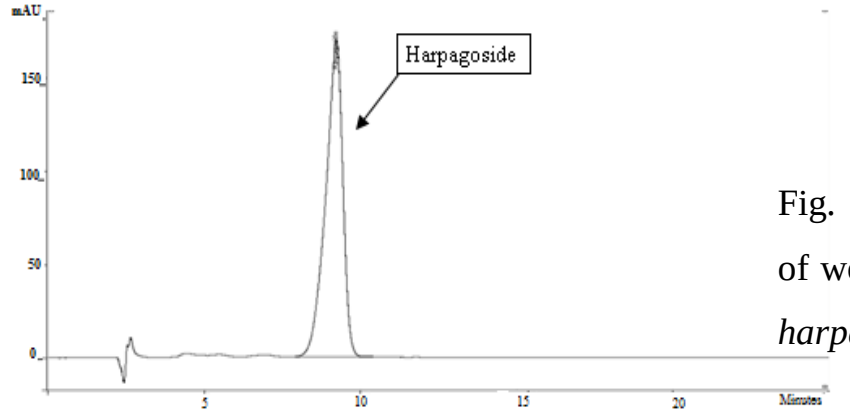



Fig. 3.1. HPLC chromatogram of working standard solution of *harpagoside P*

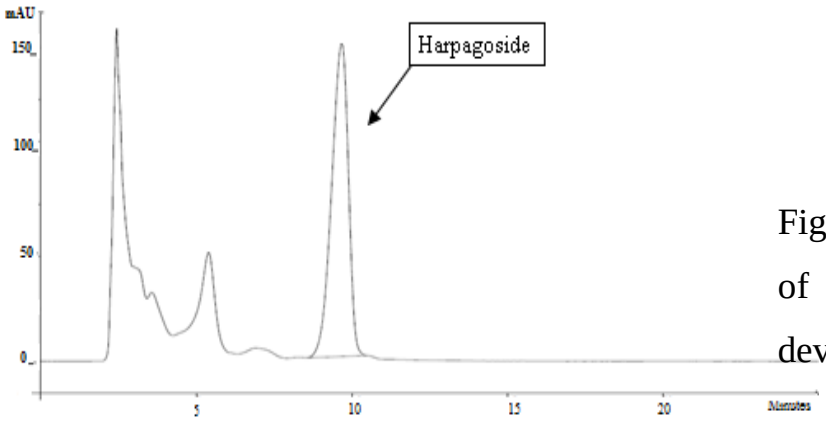



Fig. 3.2. HPLC chromatogram of a test sample solutions of devil's claw dry extract

According to the results obtained, the researched sample of the extract sample solutions of devil's claw dry extract meets the specified requirements (table 3.1).

*Table. 3.1.*

**The results of the research of Devil's claw roots dry extract for compliance with the requirements of the monograph SPhU 2.2 «Harpagophyti extractum siccum»**

| **Parameter** | **Requirements** | **Result** |
|---|---|---|
| **1** | **2** | **3** |
| Appearance | Light brown uniform powder. | + |
| Identification by «Thin-layer chromatography» | The chromatogram should show chromatography separated spots that compliance to *harpagoside P* and *fructose P* | + |

| 1 | 2 | 3 |
|---|---|---|
| *Loss on drying* | Maximum 10.0 percent | 7.96±0.28 |
| *Total ash* | Maximum 5.0 percent | 2.9±0.31 |
| Quantitation | Not less than 1.5% harpagoside calculated with reference to the dried extract. | 2.6±0.02 |

Due to the fact that the Devil's claw dry extract is supposed to be used to create a soft dosage form in the form of a gel, necessary to study its pharmaco-technological properties [15, 16]. The results obtained will be used in determining excipients in the process of substantiating the composition and technology for development the drug (table 3.2).

*Table. 3.2.*

**Pharmaceutical and technological properties of Devil's claw roots dry extract (n = 5)**

| Parameter under examination | Measuring unit | Result |
|---|---|---|
| **1** | **2** | **3** |
| Fluidity (fixed funnel method) | c/100 g | eternally |
| Fluidity (funnel method with the shaker) | c/100 g | 9.58±0.32 |
| Bulk density | g/ml | 0.754±0,004 |
| Tapped density | g/ml | 0,842±0,007 |
| Bulk volume before shrinkage ($V_0$) | g/ml | 94.31±1.17 |
| Bulk volume after shrinkage ($V_{10}$) | g/ml | 87.14±1.34 |

| 1 | 2 | 3 |
|---|---|---|
| Bulk volume after shrinkage ($V_{500}$) | g/ml | 82.41±1.41 |
| Bulk volume after shrinkage ($V_{1250}$) | g/ml | 82.41±1.54 |
| Natural slope angle degree | град | 33.06±0.41 |
| Compressibility degree | % | 10.12±0.52 |
| Gausner coefficient | – | 1.16±0.02 |

The powder natural slope angle is another characterizing parameter of its fluidity as it is connected with the interparticle friction or movement resistance between particles. The natural slope angle of Burnet is 33.06±0.41degrees and is within the satisfactory range acceptable for production.

The results of crystallographic examination of Devil's claw roots dry extract are given in Fig. 3.3.

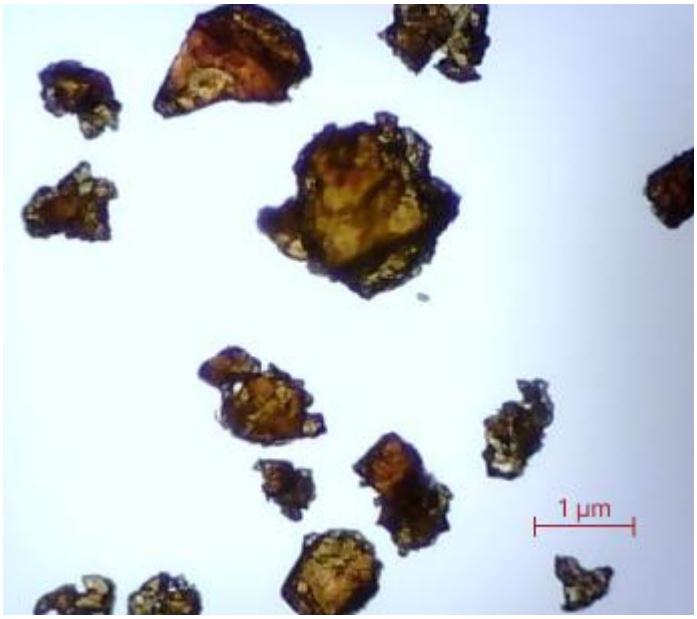



Fig. 3.3. Microphotography of Devil's claw roots dry extract

The solubility of a dry extract depends on several factors, such as the nature of the extract, the solvent used, and the temperature and pH of the solution. Some dry extracts are soluble in water, while others may require organic solvents such as ethanol or methanol. In general, polar solvents such as water and ethanol tend to be more effective at dissolving polar compounds, while nonpolar solvents such as hexane and chloroform tend to be more effective at dissolving nonpolar compounds.

To determine the solubility of a dry extract, it is typically necessary to perform experiments under controlled conditions, such as by adding the extract to a known quantity of solvent and measuring the concentration of the resulting solution over time. The solubility of the extract can then be calculated based on the amount of extract that dissolves in the solvent [29].

The solubility of a dry extract can be influenced by its particle size and morphology. Finely ground powders tend to dissolve more readily than coarse powders, and extracts that form amorphous or small crystalline particles may have higher solubility than those that form large crystalline particles [3].

In general, it's important to determine the solubility of a dry extract in various solvents in order to optimize its formulation and ensure that it can be effectively incorporated into a product. Solubility testing can be performed using a variety of methods, including visual observation of the extract in the solvent, gravimetric analysis, or spectrophotometric analysis.

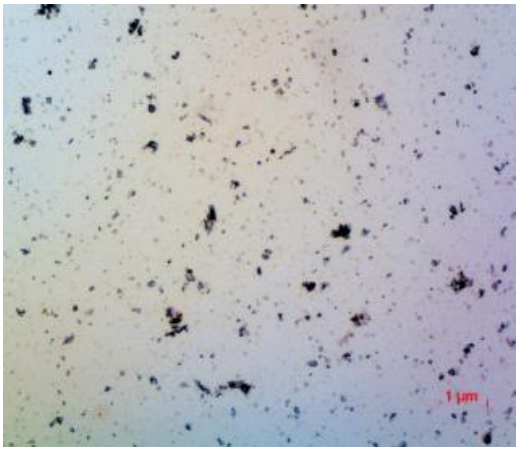
Therefore, the next stage of our research was to study the solubility of active pharmaceutical ingredients in the following solvents: water purified, propylene glycol, ethanol 96 %. Solubility and microscopy are carried out according to the methods of the State Pharmacopoeia of Ukraine. Research results are shown in table 3.3. and fig. 3.4. [6, 30].

*Table. 3.3.*

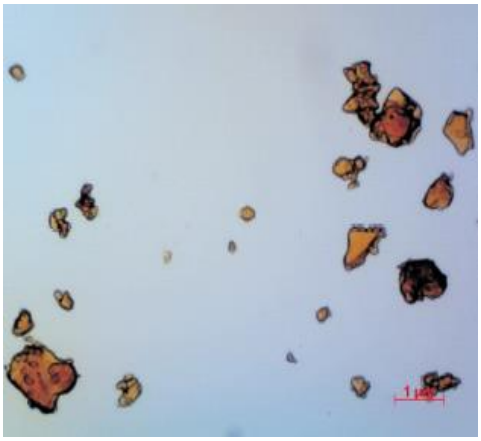
**Solubility research of Devil's claw dry extract**

| Solvent | Devil's claw dry extract |
|---|---|
| Purified water | Readily soluble |
| Propylene glycol | Practically insoluble |
| Ethanol | Slightly soluble |
| Glycerin | Readily soluble |

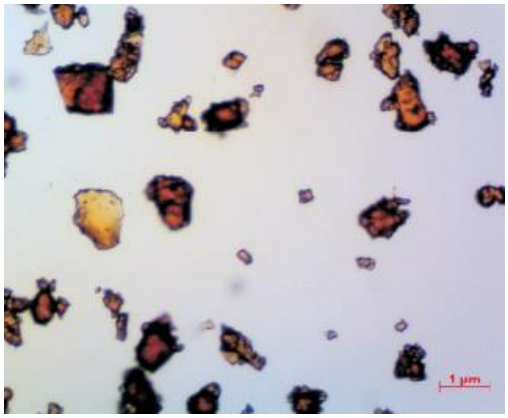
The data in Table 3.4. indicate that the dry extract is soluble in purified water and completely insoluble in propylene glycol and ethanol 96 %.



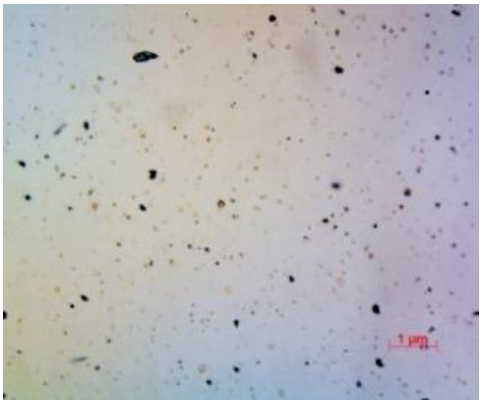
A – purified water



B – propylene glycol



C – ethanol



D – glycerin

Fig. 3.4. Devil's claw dry extract in various solvents

The results of the studies of particle distribution indicate that the most uniform distribution can be traced in purified water. Thus, the introduction of active ingredients into the composition of the gel is justified: it is rational to introduce the dry extract as a solution in water purified at temperature 20 °C.

### 3.2. Substantiation of the composition of the analgesic gel

Soft dosage forms have a local and resorptive effect, due to which they provide a longer concentration of active substances directly at the location at which the drug is applied. The gel form is easy to use, promotes the penetration of the active substance through the skin, additionally causing a cooling effect [14].

In the technology of soft drugs, formative substances are the bases that provide the necessary consistent properties of the dosage form and affect the release of active substances [1].

The basis of the criteria for choosing the optimal gelling agent are:

• features of physical and chemical properties;

• concentration that provides the necessary viscosity and stability of the gel;

• possibility of regulation of structural and mechanical properties;

• lack of toxicity, chemical compatibility;

• technological convenience and the possibility of obtaining the gel on existing equipment;

• stability of the developed drug during storage;

• providing satisfactory sensory properties [2].

There are several gelling agents used in the preparation of soft dosage form, but some of the most popular ones include [17]:

Carbomer – a synthetic polymer that can absorb large amounts of water and create a gel-like consistency. It is commonly used in lotions, creams, and gels [31];

Xanthan gum – a natural gum produced by fermenting sugar with a specific strain of bacteria. It is often used in soft dosage form to thicken and stabilize the formulation;

Hydroxyethylcellulose – a water-soluble cellulose derivative that can create a clear gel when added to water. It is commonly used in hair care products like shampoos and conditioners;

Agar – a natural gelling agent derived from seaweed that is often used in natural and organic cosmetics. It can create a firm, jelly-like texture in formulations [36];

Also added to the composition glycerin – a humectant that can also act as a gelling agent in some formulations. It is often used in skincare products to help retain moisture and create a thicker, more emollient texture. Glycerin can be used to dissolve dry herbal extracts and cand uniform distribution of plant extract in the base [8].

Based on the accessed data, at the first stage, studies were carried out on the compatibility of the obtained Devil's claw root dry extract with various gelling agents: carbomer Ultrez-27, carbomer - 940, xanthan gum in various concentrations [38]. The compositions and production technology of experimental samples are shown in Table 3.4. and 3.5. respectively.

*Table. 3.4.*

**Composition of experimental gel samples**

| Substance | Substance concentration, %/sample number | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| Carbomer Ultrez-27 | 0.5 | 1.0 | 1.5 | – | – | – |
| Carbomer - 940 | – | – | – | – | – | – |
| Xanthan gum | – | – | – | 1.0 | 2.0 | 3.0 |
| Triethanolamine | q.s. | | | – | | |
| Devil's claw root dry extract | 1.0 % | | | | | |
| Glycerin | 5.0 % | | | | | |
| Purified water | up to 100 % | | | | | |

*Table. 3.5.*

**Technology of experimental gel samples**

| № | Gelling agents | Technological process |
|---|---|---|
| **1** | **2** | **3** |
| 1. | Samples of gels with Carbopol Ultrez-27 | Prepared as follows: the gelling agent was carefully poured into a thin layer on the surface of purified water (to prevent the formation of lumps) and left at rest for twenty minutes. Then, in several steps, a solution of triethanolamine was added to a certain pit value and slowly stirred until a gel was formed. |
| 2. | Samples of gels with xanthan gum | Prepared as follows: the calculated amount of xanthan gum was moistened with a non-aqueous solvent, glycerin, and purified water was added, the mixture was stirred at medium speed of the stirrer (10-15 min). |

After complete structuring of the system (after 24 h) and during the storage (3 months), physicochemical studies of the base samples obtained were carried out (appearance, color, uniformity, odor, colloidal stability, thermal stability and pH). Studies of the characteristics of model samples are presented in table 3.6.

Based on the results of the studies, it was found that samples № 1 (sample of gel with Carbopol Ultrez-27) and № 4 (sample of gel with xanthan gum) had a liquid gel-like consistency and did not pass the thermal stability test. Xanthan gum sample № 6 formed a sticky film when applied to the skin.

After 3 months, repeated studies were carried out with stable samples № 2, № 3, № 5. However, sample № 2. failed the test. Therefore, these samples (№ 1, 2, 4, 6) were excluded from further studies.

*Table. 3.6.*

**Result physicochemical research of experimental gel samples**

**($n$ = 5, P = 95 %)**

| № | Colloidal stability | Thermal stability | Appearance | pH (10 % solution) |
|---|---|---|---|---|
| **After 24 h** | | | | |
| 1.1. | Unstable | Unstable | Liquid gel-like uniform consistency | – |
| 1.2. | Stable | Stable | Viscous gel-like homogeneous consistency, absorbed fast | 5.04±0.03 |
| 1.3. | Stable | Stable | Viscous gel-like homogeneous consistency, absorbed fast | 5.09±0.03 |
| 1.4. | Unstable | Unstable | Viscous gel-like heterogeneous consistency | – |
| 1.5 | Stable | Stable | Viscous gel-like heterogeneous consistency | 5.05±0.02 |
| 1.6 | Stable | Stable | Viscous gel-like homogeneous consistency, sticky when applied | 5.03±0.04 |
| **3 months storage** | | | | |
| 2.2 | Unstable | Unstable | Viscous gel-like heterogeneous consistency, sticky when applied | – |
| 2.3 | Stable | Stable | Viscous gel-like homogeneous consistency, absorbed fast | 5.04±0.03 |
| 2.5. | Stable | Stable | Viscous gel-like homogeneous consistency, sticky when applied | 5.06±0.02 |

Sample gels No. 2 with the use of carbomers had good consumer characteristics – they were well and easily distributed, they were not sticky. Sample gels No. 5 had a non-uniform consistency, sticky when applied.

Therefore, sample № 3 was chosen to create a soft dosage form.

At the next stage, studies were carried out to select the optimal preservative for the preparation of a soft dosage form. Preservatives are essential ingredients in many cosmetic and personal care products to prevent the growth of bacteria, yeast, and mold that can spoil the product and potentially cause harm to consumers. Some of the most popular preservatives used in the preparation of cosmetics include [39]:

Parabens –parabens are a class of preservatives that have been used in cosmetics and personal care products for decades. They are effective against a broad spectrum of bacteria and fungi, but have come under scrutiny due to their potential hormone-disrupting properties.

*Phenoxyethanol* – phenoxyethanol is a broad-spectrum preservative that is often used as an alternative to parabens. It has low toxicity and is effective against bacteria, yeast, and mold.

*Benzyl alcohol* – benzyl alcohol is a natural preservative that is derived from various plants and fruits. It is effective against bacteria and some fungi but may not be as effective against mold.

*Potassium sorbate* – potassium sorbate is a salt derived from sorbic acid, which is found in berries and other fruits. It is effective against fungi and some bacteria but may not be as effective against gram-negative bacteria.

*Sodium benzoate* – sodium benzoate is a salt derived from benzoic acid, which is found naturally in many fruits and vegetables. It is effective against bacteria and fungi but may not be as effective against mold.

*Ethylhexylglycerin* – ethylhexylglycerin is a synthetic preservative that is often used in combination with other preservatives to enhance their effectiveness. It is effective against bacteria and some fungi.

The choice of preservative will depend on a number of factors, including the type of product being formulated, its pH, and the specific microorganisms that need to be controlled. It's important to use preservatives at the correct concentrations and follow recommended usage levels to ensure product safety and efficacy.

The optimal pH value for a skin gel can vary depending on the specific formulation and ingredients used, but generally, the ideal pH range for a skin gel is between 4.5 to 6.5. The results obtained are within the normal range [25].

Based on the results of structural and mechanical studies, the optimal composition of the gel based on the Devil's claw dry extract was selected:

| | |
|---|---|
| ***Active component:*** | |
| Devil's claw root dry extract | 1.5 % |
| ***Excipients:*** | |
| Carbopol Ultrez-27 | 1.5 % |
| Triethanolamine | q.s. |
| Phenoxyethanol | 0.5 % |
| Euxyl K 903 | 1.0 % |
| Glycerin | 5.0 % |
| Purified water | up to 100 % |

### 3.3. Development of scheme of processes of technological preparation of analgesic gel

Based on the data obtained in the study of the influence of various factors, on the structural and mechanical parameters of the gel bases with carbopol and the rheological characteristics of the gel based on the Devil's claw root dry extract, using the traditional approach, we proposed the following rational technology for the production of the drug [20, 26].

The flowchart for manufacturing the gel under conditions of the commercial production is given in Fig. 3.5.

*Stage 1. Preparation of the gel components.*

The all ingredients for the gel (Devil's claw root dry extract, carbopol Ultrez-27, triethanolamine, phenoxyethanol, euxyl K 903, glycerin, purified water) preparation after the input control are delivered to the site with the help of a cart.

*Stage 2. Obtaining of the gel base.*

The necessary amount of purified water is measured into the reactor and the powder of carbopol is weighted gradually by small portions and allowed to stand for an hour (for the full powder swelling of gel-forming carbopol). After swelling of carbopol the dispersed water solution is mixed with the help of switched-on reactor mixers till the formation of a homogenous water dispersion. Homogeneity of dispersion is controlled visually.

It should be homogenous, without any lumps. Then at the mixer's rotation (not more than 700 rps) the solution of triethanolamine prepared is loaded to the reactor. With the help of vacuum after the full loading of the neutralizer solution the mass is mixed for 20 min till the formation of homogenous gel base under the following conditions: the rotation speed of the spade mixer is 42 rpm, speed of the anchored mixer is 20 rpm, the vacuum depth is (0.6-0.7 bar). The turbo mixer is switched off. The gel mass obtained is checked for homogeneity and pH value of the gel.

*Stage 3. Obtaining of the gel.*

In the reactor with the gel base preliminary prepared the necessary amount of solution of Devil's claw root dry extract and a preservative are consistently added. Then the frame mixer is switched on and the substance is mixed till formation of a homogenous mass. The gel is checked for homogeneity and pH value.

*Stage 4. Homogenization of the gel.*

Homogenization is conducted inside the reactor with the frame mixer for 20 min along with vacuolization to prevent the process of aeration. After homogenization the control samples from the different zones of the reactor are taken and the analysis of the intermediate product – the finished gel is carried out. This gel should be a homogeneous

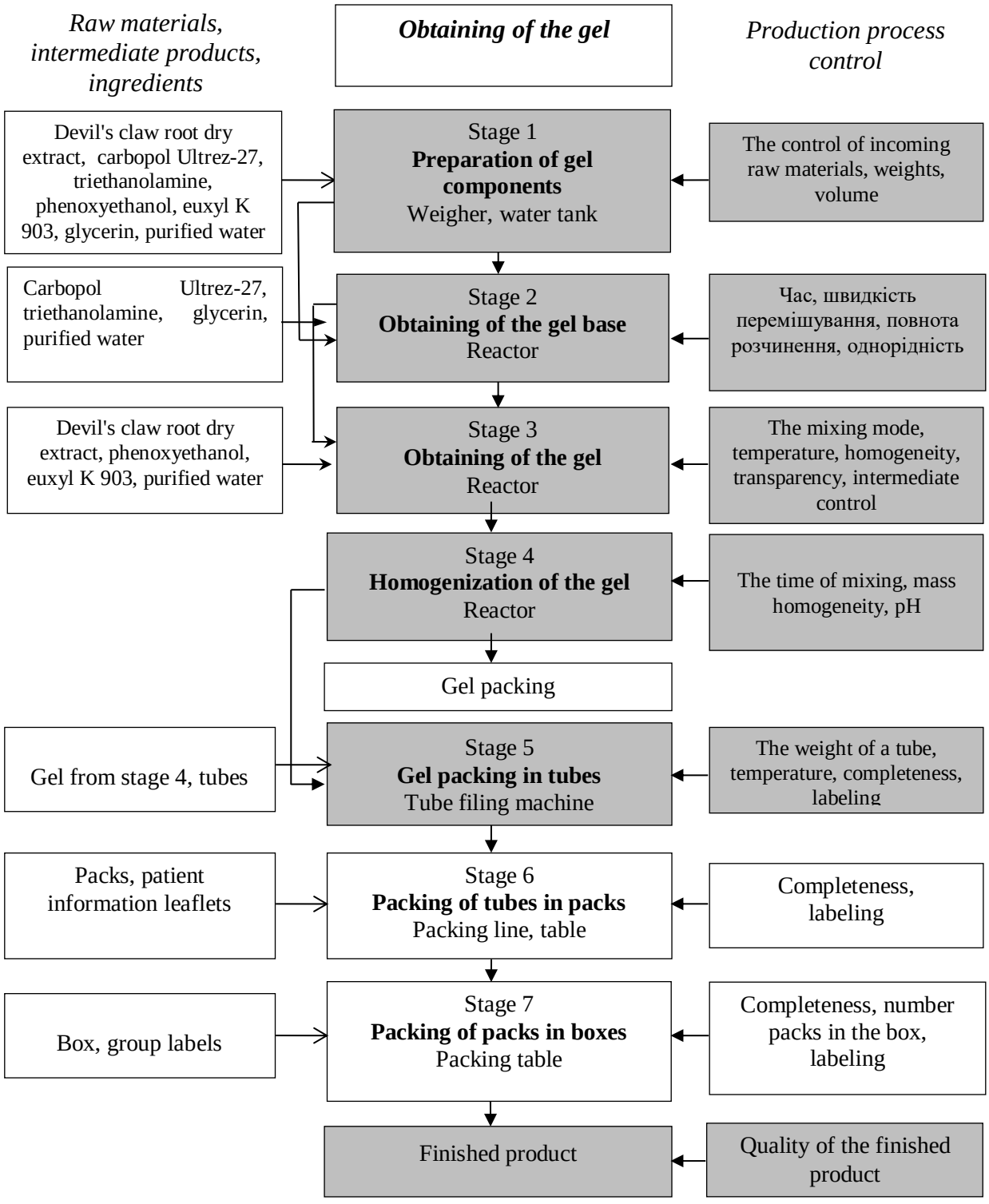



Fig. 3.5. The technological process flowchart for manufacturing of the analgesic gel in the industrial conditions

and opaque mass of the light brown color with the specific herbal odor and must meet the requirements of the normative documentation. The gel is checked for homogeneity and pH value.

*Stage 5. Gel packing in tubes.*

The gel obtained is pumped into the bunker of the tube filling machine, with its help the gel is packed in 50.0 g aluminum tubes. The precise dosing and the machine productivity and accuracy of the tube packing (batch number and shelf life) are controlled.

*Stage 6. Packing of tubes in packs.*

Tubes with the patient information leaflet are packed into packs. The completeness of packing is controlled (tube, patient information leaflet, bouchon).

*Stage 7. Packing of packs in boxes.*

Perform packing of packs in boxes on the automatic packing line. Form the batch of the finished product on the basis of one loading of the reactor-homogenizer.

### 3.4. Quality control of the topical gel based on devil's claw dry extract

The final stage of this scientific work is the study of the quality indicators of the obtained gel. To assess the quality in accordance with the requirements of the current regulatory documentation of Ukraine, we have determined the following indicators: appearance, color, smell, hydrogen index (pH), colloidal stability, thermal stability, the content of the amount of biologically active substances (table 3.7).

The obtained results of studies of the series of the obtained gel according to the established quality parameters are presented in the table. 3.7.

*Appearance.* Gel of light cream color without visible inclusions without a characteristic smell.

*Homogeneity.* The gel is a homogeneous mass without signs of physical instability (particle aggregation, separation, coagulation).

*Table. 3.7.*

**Quality indicators of the gel based on devil's claw dry extract**

| № | **Parameter under examination** | **Basic requirements** | **Result** |
|---|---|---|---|
| 1 | Appearance | Homogeneous mass without foreign impurities | Homogeneous mass without foreign impurities |
| 2 | Color | Inherent color specified in specifications | Light cream color |
| 3 | Smell | Own smell, set in the technical requirements | Pleasant specific smell |
| 4 | pH (10 % solution) | 4.5 to 6.5 | 5.3±0.2 |
| 5 | Colloidal stability | Stable | Stable |
| 6 | Thermal stability | Stable | Stable |

*Stability.* The studied gel samples were colloidal and thermal stability.

*Hydrogen index (pH).* The pH values for the studied samples of the obtained gel corresponded to the established criteria and were within the physiological norm 5.3±0.2.

## CONCLUSIONS TO THE 3RD CHAPTER

1. Standardization of on devil's claw dry extract was carried out according to the requirements established by the State Pharmacopoeia of Ukraine: «Appearance», identification by the method of «Thin-layer chromatography» (2.2.27), quantitative determination by the method of «Liquid Chromatography» (2.2.29). Additional indicators were also investigated: «Loss on drying», «Total ash». The pharmaco-technological properties of the Devil's claw dry extract were also studied.
2. Based on a theoretical analysis of the literature data and the results of a patent search, the composition of the active components of the analgesic gel and the effective concentration of the Devil's claw dry extract are substantiated – 1.0%.
3. Solubility studies of active pharmaceutical ingredients in the following solvents were performed: purified water, propylene glycol, ethanol 96 %. Established that Devil's claw dry extract in water purified dissolves best of all.
4. A number of pharmaco-technological studies were carried out aimed at determining the optimal gelling agent for creating a gel based on dry harpagophytum extract – Carbapol Ultrez 21 at a concentration of 1.5 %.
5. An optimal technology for obtaining a gel based on Devil's claw dry extract has been developed.
6. The quality parameters of the gel were determined: description, thermos and colloidal stability, pH value. Based on the results of examination the researched gel complies with the requirements of the regulatory documentation of Ukraine.

# GENERAL CONCLUSIONS

1. The data of literary sources on clinical manifestations and classification of diseases of the musculoskeletal system have been analyzed. The main directions of treatment of articular syndrome are characterized.
2. The range of drugs used locally for joint and muscle pain, registered in Ukraine, was studied according to the indicators: «dosage form», «producing country», «component composition».
3. It has been established that the most expedient is the use of medicinal plant materials that exhibit analgesic and anti-inflammatory activity, in particular, Devil's claw *(Harpagophytum procumbens)*.
4. The physicochemical properties of active and excipients used in the development of a soft dosage form based on Devil's claw dry extract are characterized.
5. Methods of physicochemical, pharmaco-technological, biopharmaceutical methods used in the development, as well as quality control of the resulting soft dosage form in the form of a gel, are described.
6. Standardization of on devil's claw dry extract was carried out according to the requirements established by the State Pharmacopoeia of Ukraine: «Appearance», identification by the method of «Thin-layer chromatography» (2.2.27), quantitative determination by the method of «Liquid Chromatography» (2.2.29). Additional indicators were also investigated: «Loss on drying», «Total ash». The pharmaco-technological properties of the Devil's claw dry extract were also studied.
7. Based on a theoretical analysis of the literature data and the results of a patent search, the composition of the active components of the analgesic gel and the effective concentration of the Devil’s claw dry extract are substantiated – 1.0 %.
8. Solubility studies of active pharmaceutical ingredients in the following solvents were performed: purified water, propylene glycol, ethanol 96 %. Established that Devil’s claw dry extract in water purified dissolves best of all.

9. A number of pharmaco-technological studies were carried out aimed at determining the optimal gelling agent for creating a gel based on dry harpagophytum extract – Carbapol Ultrez 21 at a concentration of 1.5 %.
10. An optimal technology for obtaining a gel based on Devil's claw dry extract has been developed.
11. The quality parameters of the gel were determined: description, thermos and colloidal stability, pH value. Based on the results of examination the researched gel complies with the requirements of the regulatory documentation of Ukraine.

# REFERENCES


1. Баранова, И. И. Изучение реологических параметров гелей на основе модифицированного крахмала/ И. И. Баранова, А. Г. Башура// Запорожский медицинский журнал– 2010. – №2. – С. 81–84.
2. Баранова, І. І. Порівняльне вивчення реологічних та фізико-хімічних властивостей гелевої композиції комплексу ксантан/модифікований крохмаль/ І. І. Баранова, О. Г. Башура// Український вісник психонев-рології. – 2009. – Т. 17, вип. 2 (59). – С. 165−166.
3. Вплив пропіленгліколю на реологічні та біофармацевтичні властивості гелів / Воловик Н.В., Ляпунов М.О., Зінченко О.А. // Фармаком. . – 2001. – № 4. – С. 18-23.
4. Державна Фармакопея України / Державне підприємство «Український науковий фармакопейний центр якості лікарських засобів». — 2-е вид. — Доповнення 2. — Харків: Державне підприємство «Український науковий фармакопейний центр якості лікарських засобів», 2018. — 336 с.
5. Державна Фармакопея України : в 3 т. / ДП «Український науковий фармакопейний центр якості лікарських засобів». 2–е вид. Харків : Державне підприємство «Український науковий фармакопейний центр якості лікарських засобів», 2014. Т. 3. 732 с.
6. Державна Фармакопея України: в 3 т. / ДП «Український науковий фармакопейний центр якості лікарських засобів». 2–е вид. Харків: Державне підприємство «Український науковий фармакопейний центр як ості лікарських засобів», 2015. Т. 1. 1128 с.
7. Державний реєстр лікарських засобів України 2023 рік. URL: http://www.drlz.kiev.ua/ (дата звернення: 09.03.2023).

8. Допоміжні речовини у виробництві ліків: навч. посіб. для студентів вищ. фармац. навч. закл. / О. А. Рубан, І. М. Перцев, С. А. Куценко, Ю. С. Маслій; за ред. І. М. Перцева. Харків: Золоті сторінки, 2016. 720 с.
9. Індекс здоров'я. Ukraine – 2020: Результати загальнонаціонального дослідження /Укл. Степурко Т.Г. та ін. Київ, 2020.
10. Коваленко В. М. Динаміка стану здоров'я народу України та регіональні особливості / В. М. Коваленко, В. М. Корнацький // Аналітично-статистичний посібник. – 2012. – Київ, 211
11. Коваленко В. М. Ревматичні захворювання в Україні: стан проблеми та шляхи вирішення / В. М. Коваленко // Український ревматологічний журнал. – 2012. – № 3 (49). – С. 84-86.
12. Компендіум on line. URL: http://compendium.com.ua (дата звернення: 24.02.2023).
13. Крюкова А. І., Владимирова І. М. Аналітичний огляд сучасних засобів рослинного походження, що застосовуються при захворюваннях опорно-рухового апарату. ScienceRise. 2015. № 10/4 (15). С. 24–31.
14. Ляпунов, А.Н. Создание мягких лекарственных средств на различных основах. Исследование реологических свойств гелей, образованных карбомерами / А.Н. Ляпунов, Н.В. Воловик // Фармаком. - 2001. -№ 2. - С. 52-61.
15. Методический подход к фармацевтической разработке гелей и крем-гелей противовоспалительного действия/ Н. А. Ляпунов, Е. П. Безуг-лая, А. Н. Яцюк и др. // Сьогодення та майбутнє фармації: тез. доп. Всеукр. конгр., м. Харків, 16–19 квіт. 2008 р. – Х: НФаУ, 2008. – С. 645.
16. Некоторые аспекты технологии получения биологически активных веществ из лекарственного растительного сырья/ В. И. Литвиненко, Т. П. Попова, А. С. Амосов, В. Г. Воловик// Фармаком. – 2003. – №4. – С. 27–32.
17. Перцев І.М., Дмитрієвський Д. І., Рибачук В. Д. та ін. Допоміжні речовини в технології ліків:вплив на технологічні, споживчі, економічні характеристики і

терапевтичну ефективність : навч. посіб. для студ. вищ. фар мац. навч. закл. – Харків: Золоті сторінки, 2010. – 600 с

18. Пивень Е. П., Дихтярев С. И., Тихомирова Е. В. Анализ структуры украинского рынка препаратов по лекарственным формам и перспективы расширения их использования при формировании отечественного ассортимента лекарственных средств. Фармаком. 2008. № 1. С. 94–101.
19. Abdelouahab N., Heard C. Effect of the major glycosides of Harpagophytum procumbens (Devil's Claw) on epidermal cyclooxygenase–2 (COX–2) in vitro. J Nat Prod. 2008. Vol. 71, № 5. P. 746 – 749.
20. Aulton, M.E.; Taylor, K.M. Aulton’s Pharmaceutics—The Design and Manufacture of Medicine, 5th ed.; Churchill Livingstone Elsevier: Edinburgh, UK, 2013.
21. Baghdikian B, Lanhers M.C, Fleurentin J, Olivier E, Maillard C, Balansard G, Mortier F. An analytical study: anti-inflammatory and analgesic effects of Harpagophytum procumbens and Harpagophytum zeyheri. Planta Med 2007;63(2):171-6.
22. Brendler, T., Eloff, J.N., Gurib-Fakim, A., Phillips, L.D. Harpagophytum procumbens in African herbal Pharmacopoeia; Association for African Medicinal Plants Standards Port Louis: Port Louis, Mauritius, 2010; pp. 127–134, ISBN 9990389098.
23. Cameron M., Gagnier J.J., Little C.V., Parsons T.J., Blumle A., Chrubasik S. (2009). Evidence of effectiveness of herbal medicinal products in the treatment of arthritis. Part I: Osteoarthritis. Phytotherapy Research, 23, 1497–1515. https://doi.org/10.1002/ptr.3007
24. Chrubasik S, Zimpfer Ch, Schutz U, Ziegler R. Effectiveness of Harpagophytum procumbens in treatment of acute low back pain. Phytomedicine 2006;3(1):1-10.
25. Das S, Samanta A, Bose A. Design, development and evaluation of fluconazole topical gel. Asian J Pharm Clin Res. 2015;8(2):132-5.
26. Encyclopedia of pharmaceutical technology / ed. by J. Swarbrick. [3–rd ed.] N.Y. : Informa Healthcare USA, Inc., 2007. – 4372 p.

27. European Pharmacopoeia. 8.0 th ed. Strasbourg: European Department for the Quality of Medicines, 2014. P. 1126–1227
28. Grant L., McBean D., Fyfe L. A review of the biological and potential therapeutic actions of Harpagophytum procumbens. Phytother. Res. 2007. Vol. 21. P. 199 – 209.
29. J. Van der Merwe, J. Steenekamp, D. Steyn, J. Hamman. The role of functional excipients in solid oral dosage forms to overcome poor drug dissolution and bioavailability, Pharmaceutics 12 (2020) 1-17.
30. Jagtap P., Jain S.S., Dand N., Jadhav K., Kadam V.J. Hot Melt. Extrusion Technology, Approach of Solubility Enhancement: A Brief Review. Pharm. Lett. 2012; 4:42–53.
31. Jantrawut P, Ruksiriwanich W. Carbopol-guar gum gel as a vehicle for topical gel formulation of pectin beads loaded with rutin. Asian J Pharm Clin Res. 2019;8(4):231-236.
32. Kimmatkar N., Thawani V., Hingorani L. Efficacy and tolerability of Boswellia serrata extract in treatment of osteoarthritis of knee – a randomized double blind, placebo controlled trial. Phytomedicine. 2003. Vol. 10. P. 3–7.
33. Leblan D, Chantre P, Fournie B. Harpagophytum procumbens in the treatment of knee and hip osteo-arthritis. Four-month results of a prospective, multicenter, double-blind trial versus diacer-hein. Joint Bone Spine 2010;67(5):462-7.
34. Mobasheri A. (2012). Intersection of inflammation and herbal medicine in the treatment of osteoarthritis. Current Rheumatology Reports, 604-616. https://doi.org/10.1007/s11926-012-0288-9.
№ 3. С. 63–65.
35. Oral herbal therapies for treating osteoarthritis URL: https://www.cochrane.org/CD002947/MUSKEL_oral–herbal–therapies–treating–osteoarthritis (data of access: 12.05.2020)
36. Prashant K, Vivek R, Dixit D, Pranav P. Hydrogels as a drug delivery system and applications: A review. International Journal of Pharmacy and Pharmaceutical Sciences 2012; 4(1):1-7.

37. Qi J. Iridoid glycosides from Harpagophytum procumbens D.C. (devil's claw). Phytochemistry. 2016. Vol. 67 (13). P. 372–377.
38. Tanwar YS, Jain AK. Formulation and evaluation of topical diclofenac sodium gel using different gelling agent. Asian J. Pharm Res Healthc. 2018;4(1):1-6.
39. Wanga, Y. Liub, W. R. Kamb, Y. Lia and D. A. Sullivan (2020). Toxicity of the cosmetic preservatives parabens, phenoxyethanol and chlorphenamineon human meibomian gland epithelial cells. Experimental Eye Research. 196-204.
40. Wink M. (2015). Modes of Action of Herbal Medicines and Plant Secondary Metabolites. Medicines, 2015; 2, 251-286. doi:10.3390/medicines2030251
41. Yoshimura N. Epidemiology of osteoarthritis in Japan: the ROAD study // Clin. Calcium. 2011. Vol. 21(6). P.821-825.

# APPENDICES

*Appendix A*

МІНІСТЕРСТВО ОХОРОНИ ЗДОРОВ'Я УКРАЇНИ
НАЦІОНАЛЬНИЙ ФАРМАЦЕВТИЧНИЙ УНІВЕРСИТЕТ
КАФЕДРА СОЦІАЛЬНОЇ ФАРМАЦІЇ

# СОЦІАЛЬНА ФАРМАЦІЯ: СТАН, ПРОБЛЕМИ ТА ПЕРСПЕКТИВИ

МАТЕРІАЛИ
VIII МІЖНАРОДНОЇ НАУКОВО-ПРАКТИЧНОЇ
ДИСТАНЦІЙНОЇ КОНФЕРЕНЦІЇ

27 квітня 2023 року

Харків
НФаУ
2023

*Appendix A (continued)*

*Appendix A (continued)*



## MARKETING ANALYSIS OF THE ASSORTMENT OF TOPICAL MEDICINES OF THE TREATMENT OF MUSCULOSKELETAL DISEASES IN UKRAINE

Bendijour I., Kriukova A., Konovalenko I.
National University of Pharmacy, Kharkiv, Ukraine
kriukova92@gmail.com

In the structure of the causes of temporary disability, the pathology of the musculoskeletal system takes the second place after respiratory diseases. In Ukraine, joint diseases in the structure of non-infectious pathology occupies the third place after the pathology of the circulatory system and tumor neoplasms. Up to 2 % of the world's population suffers from articular pathology such as arthritis, about 10 % of the world's population is affected by arthrosis.

The main drugs used to treat diseases of the musculoskeletal system are analgesic and anti-inflammatory drugs. Clinical experience proves that the plant products are a worthy alternative to synthetic drugs. Some of the advantages of herbal remedies over synthetic drugs include: natural and safe, affordable, fewer side effects: while all medications have the potential to cause side effects, herbal remedies are generally less likely to cause adverse reactions than synthetic drugs.

The aim of our work the analyze the range of topical medicines for the treatment of musculoskeletal diseases at the pharmaceutical market of Ukraine. Analyze their composition, dosage forms, and manufacturers preparations.

According to the anatomical therapeutic chemical classification system, drugs that affect the musculoskeletal system, are divided into the following groups:

- M01 – anti-inflammatory and antirheumatic medicines;
- M02 – topical medicines for joint and muscle pain;
- M03 – muscle relaxers;
- M04 – medicines used to treat gout;
- M05 – medicines used to treat bone diseases;
- M09 – other medicines that used in case of pathology of the musculoskeletal system.

*Appendix A (continued)*



In group M02 – topical medicines for joint and muscle pain, there are 91 trade names. The researched range of drugs indicates that drugs on the pharmaceutical market of Ukraine are represented by foreign production (51 %) and Ukrainian (49 %) in almost equal proportions. Among foreign manufacturers, the largest market share is occupied by German manufacturers (27 %). Also, a significant market share is occupied by India – 16 %, USA – 9 %, Switzerland – 9 %, Great Britain 7 %, Latvia 7 % (fig. 1).

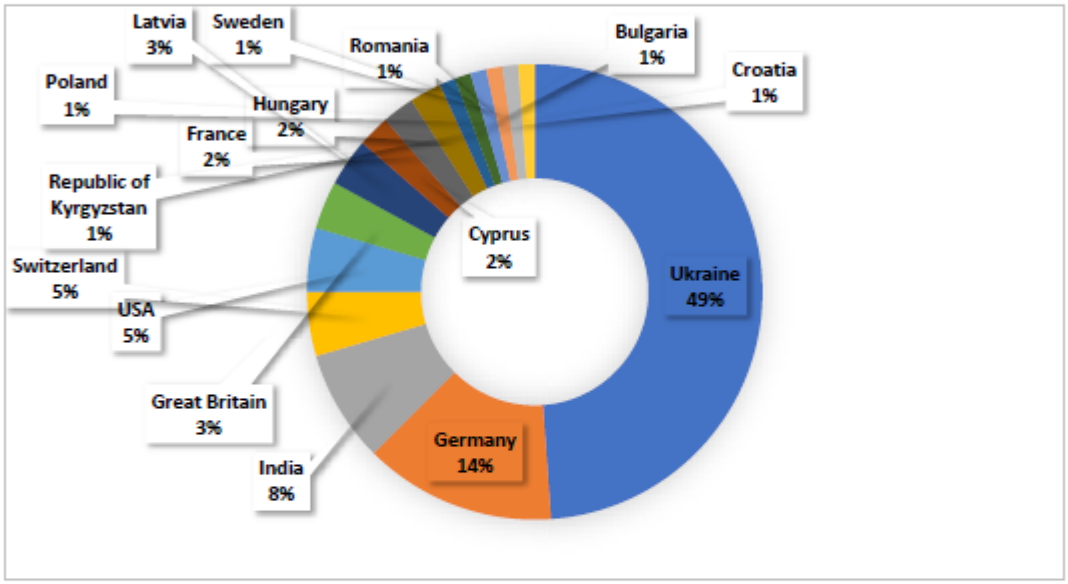



Fig. 1. Distribution of researched group of drugs of foreign manufacturers

The analysis conducted of the range of drugs by dosage form, it was found that the majority of drugs are produced in the form of a gel – 46 %, ointments are in second place – 26 %, skin solutions for local application 14 % of the range (Fig. 2).

The popularity of the dosage form of gels is due to a number of advantages of this dosage form: ease of application to the surface, prolonged action, the possibility of including chemically incompatible substances in the composition. Therefore, despite the large range of drugs in the form of gels, this dosage form is relevant in the development of new drugs [18].

*Appendix A (continued)*



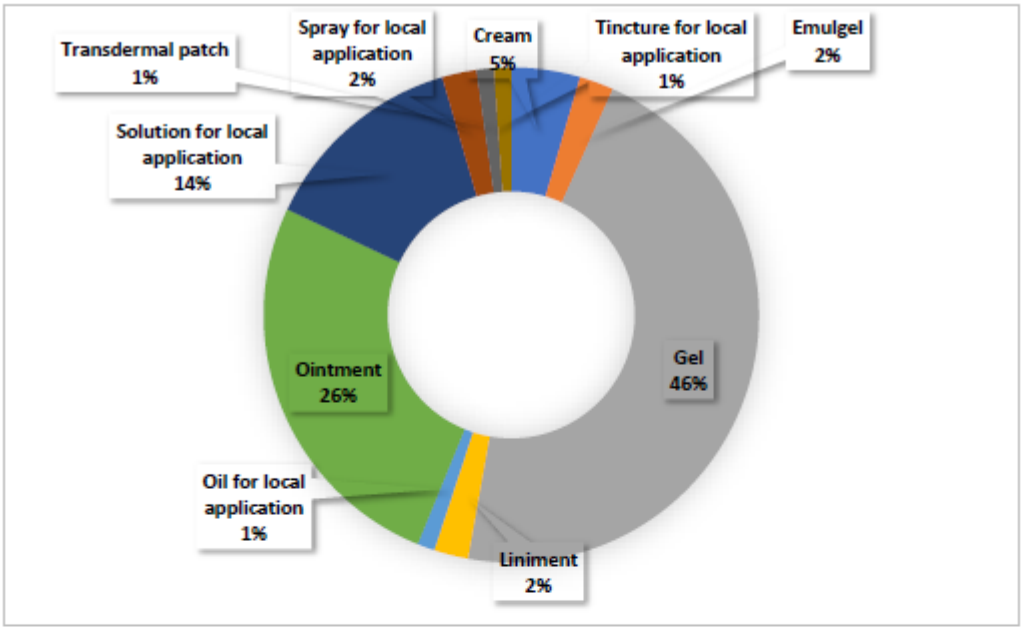



Fig. 2. Distribution of researched group of drugs by dosage form

Analysis of the product range by component composition, found that the main part of the drugs contains in own composition (65 %) the active component of the synthetic origin, herbal preparations store only 20 % of the entire range, homeopathic preparations – 5 %, complex preparations – 10 %.

As the study showed, the total assortment of topical medicines for joint and muscle pain 91 trade names. Among the medicinal forms almost half (46 %) falls on the share of gels. Among topical medicines there are also medicinal herbal remedies in the form of ointment, skin solutions for local application and etc. Based on the results of the research compositions this group of drugs, it should be noted that the range of herbal medicines is insufficient. That is, the development of new herbal remedies for the treatment of musculoskeletal diseases is a relevant task.

*Appendix A (continued)*

MINISTRY OF HEALTH OF UKRAINE
NATIONAL UNIVERSITY OF PHARMACY
DEPARTMENT OF SOCIAL PHARMACY

VIII INTERNATIONAL SCIENTIFIC AND PRACTICAL DISTANCE CONFERENCE "SOCIAL PHARMACY: STATE, PROBLEMS AND PROSPECTS"

# CERTIFICATE OF PARTICIPATION №180

Imane BENDIJOUR

**participated in the roundtable "Current issues of social pharmacy"**
**according to the program of 7 hours / 0.2 ECTS credits**

**Achieved learning outcomes:**
**the use in professional activity of knowledge of the basic principles of the concept of social pharmacy as a component of the effective sphere of health care, as well as the peculiarities of the regulatory and legal regulation of pharmaceutical provision of the population**

Acting rector of the National University of Pharmacy, Doctor of Pharmaceutical Sciences, Professor, Honored Worker of Science and Technology of Ukraine — Alla KOTVITSKA

Vice-Rector for scientific and pedagogical work, Doctor of Pharmaceutical Sciences, professor — Inna VLADYMYROVA

Head of the department of Social Pharmacy, Candidate of Pharmaceutical Sciences, Associate Professor — Alina VOLKOVA

Kharkiv,
April 27, 2023

*Appendix B*


МІНІСТЕРСТВО ОХОРОНИ ЗДОРОВ'Я УКРАЇНИ
НАЦІОНАЛЬНИЙ ФАРМАЦЕВТИЧНИЙ УНІВЕРСИТЕТ

# ГРАМОТА

нагороджується

## Бендіжур Іман

у секційному засіданні студентського наукового товариства кафедри аптечної технології ліків

XXIX Міжнародна науково-практична конференція молодих вчених та студентів

**«Актуальні питання створення нових лікарських засобів»**

В.о. ректора
Національного фармацевтичного університету

Алла КОТВІЦЬКА

19-21 квітня 2023 р.
м. Харків

*Ф А 2.2.1–32-366*

**National University of Pharmacy**

Faculty for foreign citizens' education
Department drug technology

Level of higher education master

Specialty 226 Pharmacy, industrial pharmacy
Educational program Pharmacy

**APPROVED**
**The Head of Department**
**department drug technology**

_____
**Liliia VYSHNEVSKA**
«_28__» _September_ 2022

**ASSIGNMENT**
**FOR QUALIFICATION WORK**
**OF AN APPLICANT FOR HIGHER EDUCATION**

**Imane BENDIJOUR**

1. Topic of qualification work: «Development of topical gel analgesic activities»,
supervisor of qualification work: Anna KRIUKOVA, PhD,

approved by order of NUPh from "6th" of February 2023 № 35

2. Deadline for submission of qualification work by the applicant for higher education: april 2023.

3. Outgoing data for qualification work: proposed composition of a new topical gel analgesic activities.

4. Contents of the settlement and explanatory note (list of questions that need to be developed):
- to study the literature data of the characteristics of diseases of the musculoskeletal system;
- to analyze the main approaches to the pharmacotherapy of diseases of the musculoskeletal system;
- to conduct an analytical examination of medicines used locally for joint and muscle pain, presented on the pharmaceutical market of Ukraine;
- to conduct a study of the physicochemical and pharmaco-technological properties of the Devil's claw dry extract;
- to develop the composition and technology of the gel based on the Devil's claw dry extract.

5. List of graphic material (with exact indication of the required drawings):
10 tables, 6 figures.

6. Consultants of chapters of qualification work

| Chapters | Name, SURNAME, position of consultant | Signature, date | |
|---|---|---|---|
| | | assignment was issued | assignment was received |
| 1 | Anna KRIUKOVA, assistant professor of department drug technology | 20.10.2022 | 20.10.2022 |
| 2 | Anna KRIUKOVA, assistant professor of department drug technology | 17.11.2022 | 17.11.2022 |
| 3 | Anna KRIUKOVA, assistant professor of department drug technology | 19.12.2022 | 19.12.2022 |

7. Date of issue of the assignment: «_28_» September 2022.

**CALENDAR PLAN**

| № | Name of stages of qualification work | Deadline for the stages of qualification work | Notes |
|---|---|---|---|
| 1 | Topic selection | September 2022 | **done** |
| 2 | Study and analysis of reference data | October - November 2022 | **done** |
| 3 | Conducting experimental studies | December 2022-January 2023 | **done** |
| 4 | Summing up, preparation for defense | February–March 2023 | **done** |
| 5 | Submission of finished work to the commission | April 2023 | **done** |

**An applicant of higher education** _____ Imane BENDIJOUR

**Supervisor of qualification work** _____ Anna KRIUKOVA

**ВИТЯГ З НАКАЗУ № 35**
**По Національному фармацевтичному університету**
**від 06 лютого 2023 року**

нижченаведеним студентам 5-го курсу 2022-2023 навчального року, навчання за освітнім ступенем «магістр», галузь знань 22 охорона здоров'я, спеціальності 226 – фармація, промислова фармація, освітня програма – фармація, денна форма здобуття освіти (термін навчання 4 роки 10 місяців та 3 роки 10 місяців), які навчаються за контрактом, затвердити теми кваліфікаційних робіт:

| Прізвище студента | Тема кваліфікаційної роботи | | Посада, прізвище та ініціали керівника | Рецензент кваліфікаційної роботи |
|---|---|---|---|---|
| • **по кафедрі аптечної технології ліків** | | | | |
| Бендіжур Іман | Розробка топічного гелю знеболювальної дії | Development of topical gel analgesic activities | ас. Крюкова А. І. | доц. Буряк М. В. |

Підстава: подання деканату, згода ректора

Ректор

**Вірно**. Секретар

Національний фармацевтичний університет
Факультет з підготовки іноземних громадян
№02109936

*Ф А2.8-47-110*

# ВИСНОВОК

**Комісії з академічної доброчесності про проведену експертизу щодо академічного плагіату у кваліфікаційній роботі здобувача вищої освіти**

№ 112184 від «6 » квітня 2023 р.

Проаналізувавши випускну кваліфікаційну роботу за магістерським рівнем здобувача вищої освіти денної форми навчання Бендіжур Іман, 5 курсу, англ-06 групи, спеціальності 226 Фармація, промислова фармація, на тему: «Розробка топічного гелю знеболювальної дії / Development of topical gel analgesic activities», Комісія з академічної доброчесності дійшла висновку, що робота, представлена до Екзаменаційної комісії для захисту, виконана самостійно і не містить елементів академічного плагіату (компіляції).

**Голова комісії,**
**професор** **Інна ВЛАДИМИРОВА**

**1%**

**28%**

*Ф А 2.2.1-32-353*

**REVIEW**

**of scientific supervisor for the qualification work of the master's level of higher education of the specialty 226 Pharmacy, industrial pharmacy**

**Imane BENDIJOUR**

**on the topic: « Development of topical gel analgesic activities »**

**Relevance of the topic.** Disease of the musculoskeletal system is one of the most common groups of human pathologies. Functional limitations and an increased risk of developing associated diseases lead to disability over time. Thus, the development of the composition and technology of anti-inflammatory and analgesic drugs in the treatment of diseases of the musculoskeletal system is an actual goal in pharmacy.

**Practical value of conclusions, recommendations and their validity.** In the process of research work, a technology and composition of a new anesthetic gel for the treatment of diseases of the musculoskeletal system was developed. The results of this work can be used in further studies to expand the range of drugs.

**Assessment of work**. The work was done at a high scientific level; in terms of the volume of theoretical and practical research, it fully meets the requirements for the design of qualifying works.

**General conclusion and recommendations on admission to defend.** The qualification work, completed by the applicant for higher education Imane Bendijour, can be submitted for official defense to the Examination Commission of the National University of Pharmacy.

Scientific supervisor _____ Anna KRIUKOVA

« 12th » of April 2023

*Ф А 2.2.1-32-356*

**REVIEW**

**for qualification work of the master's level of higher education, specialty 226 Pharmacy, industrial pharmacy**

**Imane BENDIJOUR**

**on the topic: «Development of topical gel analgesic activities»**

**Relevance of the topic.** The prevalence of diseases of the musculoskeletal system (MSS) among the world population is constantly growing. Analgesic drugs are used to treat this group of diseases. Numerous studies confirm that herbal remedies are a worthy alternative to synthetic drugs. The main advantages of which are low toxicity, mildness of action, which makes it possible to use drugs for a longer time.

**Theoretical level of work.** The literature data on the characteristics of diseases of the MSS are presented. Proved the prospect of using medicinal plant materials in the treatment of MSS. An analytical examination of drugs used topically for joint and muscle pain, presented on the pharmaceutical market of Ukraine, was carried out.

**Author's suggestions on the research topic.** The author proposed the composition of the gel based on the Devil's claw dry extract. Based on the results of pharmaco-technological studies, the choice of the gel base was substantiated.

**Practical value of conclusions, recommendations and their validity.** The composition of the drug in the form of a gel for the treatment of MSS diseases has been developed.

**Disadvantages of work.** The work submitted for review does not have any significant shortcomings or disadvantages that affect compliance with the requirements of qualifying works.

**General conclusion and assessment of the work.** The qualification work of Imane Bendijour can be submitted for defense to the Examination Commission of the National Pharmaceutical University for the assignment of the master's educational qualification level.

Reviewer _____ as. prof. Marina BURYAK

« 19 th » of April 2023

**МІНІСТЕРСТВО ОХОРОНИ ЗДОРОВ'Я УКРАЇНИ**
**НАЦІОНАЛЬНИЙ ФАРМАЦЕВТИЧНИЙ УНІВЕРСИТЕТ**

**ВИТЯГ З ПРОТОКОЛУ № _9_**
«26» квітня 2023 року
м. Харків

**засідання кафедри**
**___ *аптечної технології ліків* _____**
(назва кафедри)

**Голова:** завідувачка кафедри, професор Вишневська Л.І.
**Секретар:** докт. філ., асистент Коноваленко І. С.

**ПРИСУТНІ:**

Богуцька О. Є., Зуйкіна С. С., Ковальова Т. М., Крюкова А. І., Марченко М. В., Половко Н. П., Семченко К. В.

**ПОРЯДОК ДЕННИЙ:**

1. Про представлення до захисту кваліфікаційних робіт здобувачів вищої освіти.

**СЛУХАЛИ: проф. Вишневську Л. І. –** про представлення до захисту до Екзаменаційної комісії кваліфікаційних робіт здобувачів вищої освіти.

**ВИСТУПИЛИ:** Здобувач вищої освіти групи Фм18(5,0д)-англ 06 спеціальності 226 Фармація, промислова фармація Іман БЕНДІЖУР – з доповіддю на тему «Розробка гелю місцевої знеболювальної дії/Development of topical gel analgesic activities» (науковий керівник, ас. Анна КРЮКОВА).

**УХВАЛИЛИ:** Рекомендувати до захисту кваліфікаційну роботу.

**Голова**
Завідувачка кафедри, проф. _____ **Лілія ВИШНЕВСЬКА**
(підпис)

**Секретар**
асистент _____ **Ілона КОНОВАЛЕНКО**
(підпис)

*Ф А2.2.1-32-042*

**НАЦІОНАЛЬНИЙ ФАРМАЦЕВТИЧНИЙ УНІВЕРСИТЕТ**

**ПОДАННЯ**
**ГОЛОВІ ЕКЗАМЕНАЦІЙНОЇ КОМІСІЇ**
**ЩОДО ЗАХИСТУ КВАЛІФІКАЦІЙНОЇ РОБОТИ**

Направляється здобувач вищої освіти Іман БЕНДІЖУР до захисту кваліфікаційної роботи
за галуззю знань 22 Охорона здоров'я
спеціальністю 226 Фармація, промислова фармація
освітньою програмою Фармація
на тему: «Розробка гелю місцевої знеболювальної дії».

Кваліфікаційна робота і рецензія додаються.

Декан факультету _____ / Світлана КАЛАЙЧЕВА /

**Висновок керівника кваліфікаційної роботи**

Здобувач вищої освіти Іман БЕНДІЖУР представила кваліфікаційну роботу, яка за об'ємом теоретичних та практичних досліджень повністю відповідає вимогам до оформлення, що висуваються до кваліфікаційних робіт магістерського рівня і може бути рекомендована до захисту в Екзаменаційній комісії НФаУ.

Керівник кваліфікаційної роботи

_____ Анна КРЮКОВА

«12» квітня 2023 р.

**Висновок кафедри про кваліфікаційну роботу**

Кваліфікаційну роботу розглянуто. Здобувачка вищої освіти Іман БЕНДІЖУР допускається до захисту даної кваліфікаційної роботи в Екзаменаційній комісії.

Завідувачка кафедри
фармацевтичної хімії

_____ Лілія ВИШНЕВСЬКА

«26» квітня 2023 року

Qualification work was defended

of Examination commission on

«  »  June  2023

With the grade _____

Head of the State Examination commission,

DPharmSc, Professor

_____ / Oleh SHPYCHAK /