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# Development of a base formula for a medical stick intended for the treatment of skin warts

## *Opracowanie formuły bazowej sztyftu medycznego przeznaczonego do usuwania brodawek skórnych*

ABSTRACT

**Introduction**: Warts are common, benign skin and mucosal lesions caused by the human papillomavirus (HPV). Their high prevalence and tendency to recur make them a significant medical and social issue.

**Aim**: The study aimed to develop and optimize the composition of a wax-lipid base for a stick-form product intended for the topical treatment of cutaneous warts, based on an evaluation of its physicochemical, technological, and biopharmaceutical properties.

**Materials and methods**: Six model wax-lipid bases were developed. Samples were prepared by sequentially melting the ingredients and subsequently evaluated for organoleptic properties, homogeneity, melting point, spreadability, and adhesion. Statistical analysis was performed using one-way analysis of variance (ANOVA).

**Results**: The resulting bases exhibited melting points in the range of 38.0-69.5°C, with samples no. 3 and 4 showing optimal values close to human body temperature. Spreadability and adhesion varied depending on the structuring agents used. For salicylic acid, the diffusion zone increased from 21-22 mm to 34-39 mm over 24 hours, with the highest release rate in formulation no. 4.

**Conclusions**: Based on a multicriteria assessment, the formulation containing almond oil, cetyl alcohol, soy wax, and cocoa butter was optimal.

**Keywords**: human papillomavirus, HPV, cutaneous warts, medical stick, wax-lipid base, pharmaceutical technology, keratolytic agents.

STRESZCZENIE

**Wstęp:** Brodawki to częste, łagodne zmiany skórne i śluzówkowe wywoływane przez ludzki wirus brodawczaka (HPV). Ich duża powszechność oraz skłonność do nawrotów czynią je istotnym problemem medycznym i społecznym.

**Cel:** Celem pracy było opracowanie i optymalizacja składu podłoża woskowo-lipidowego dla sztyftu przeznaczonego do miejscowego leczenia brodawek skórnych, w oparciu o ocenę jego właściwości fizykochemicznych, technologicznych i biofarmaceutycznych.

**Materiały i metody:** Opracowano sześć modelowych podłoży woskowo-lipidowych. Próbki przygotowano poprzez sekwencyjne stapianie składników, a następnie poddano ocenie pod kątem właściwości organoleptycznych, jednorodności, temperatury topnienia, rozsmarowywalności oraz adhezji. Analizę statystyczną przeprowadzono za pomocą jednoczynnikowej analizy wariancji (ANOVA).

**Wyniki**: Uzyskane podłoża charakteryzowały się temperaturą topnienia w zakresie 38,0-69,5°C, przy czym próbki nr 3 i 4 wykazywały wartości optymalne, zbliżone do temperatury ciała. Rozsmarowywalność i adhezja różniły się w zależności od zastosowanych substancji strukturyzujących. W przypadku kwasu salicylowego zaobserwowano zwiększenie strefy dyfuzji z 21-22 mm do 34-39 mm w ciągu 24 godzin, przy czym najwyższy stopień uwalniania odnotowano dla formulacji nr 4.

**Wnioski:** Na podstawie przeprowadzonej oceny wielokryterialnej za optymalną uznano formulację zawierającą olej migdałowy, alkohol cetylowy, wosk sojowy oraz masło kakaowe.

**Słowa kluczowe:** ludzki wirus brodawczaka, HPV, brodawki skórne, sztyft medyczny, podłoże woskowo-lipidowe, technologia farmaceutyczna, środki keratolityczne.

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## INTRODUCTION

Warts are among the most common viral lesions of the skin and mucous membranes and remain an important medical, biological, and social issue in modern dermatology. They are benign proliferative epithelial neoplasms that arise from infection with the human papillomavirus (HPV). According to international epidemiological studies, the prevalence of warts in the general population averages 7-12%; however, in certain age groups, particularly among children, adolescents, and young adults, this figure can exceed 20% [1-8].

Recent reviews in dermatological therapy emphasize the need for the development of topical, minimally invasive, and user-friendly dosage forms that ensure accurate dosing and minimal contact with healthy tissues [9, 10]. In this context, solid topical systems such as dermatological sticks and pencils are considered promising carriers for the delivery of active substances due to their stability, portability, and ability to provide localized application [10].

Despite the availability of topical wart treatments, medical pencils (MPs) specifically designed for this purpose remain unavailable in modern pharmaceutical practice. Most products are formulated as solutions, gels, or patches, which may limit application precision. International practice primarily uses keratolytic and destructive agents such as salicylic, lactic, and trichloroacetic acids. While conventional dosage forms predominate, innovative localized systems, including solid sticks and pen-like applicators, are increasingly used to improve precision, protect healthy tissue, and enhance patient compliance [9-16].

According to the State Register of Medicinal Products of Ukraine, as of December 2025, five medicinal products have been registered to treat skin lesions caused by viral warts [14]. According to the Anatomical Therapeutic Chemical Classification System (ATC), the investigated medicinal products belong to group "D – Dermatologicals," in particular:

- D02A – Preparations with softening and protective action, subclass D02AF – Salicylic acid preparations: SALICYLIC OINTMENT – a 10% ointment, 25 g in containers; 20 g or 25 g in tubes; 1 g of ointment contains 100 mg of salicylic acid (PJSC Pharmaceutical Factory "Viola," Ukraine);
- D11A – Other dermatological products, subclass D11A F – Agents used for the removal of warts and corns: COLLOMAK® M - a topical solution 167.0 mg/g, 10 ml vial; 1 g of solution contains 167.0 mg of salicylic acid (Medinfar Manufacturing S.A., Portugal); FEREZOL – a topical liquid, 15 g vial; 1 g of liquid contains 600 mg of phenol and 400 mg of tricresol (JSC "Lubnyfarm", Ukraine); VERRUCUTAN – a topical solution, 13 ml vial; 1 g of solution contains 5 mg of fluorouracil and 100 mg of salicylic acid (Mibe GmbH Arzneimittel, Germany); DUOFILM - a topical solution, 15 ml vial; 1 g of solution contains 167 mg of salicylic acid and 167 mg of lactic acid (Stiefel Laboratories Ltd., Ireland) [14].

Analyzing the listed medicines by dosage form (DF), country of origin, and composition of active pharmaceutical ingredients (APIs), the distribution is as follows: 1 drug is formulated as an ointment, and 4 products are in the form of a liquid/solution for topical use; 2 drugs are domestically produced, and 3 are of foreign origin; 2 medicines are single-component preparations containing salicylic acid at concentrations of 10% or 16.7%; 2 products, in addition to salicylic acid, also contain either 5% fluorouracil or 16.7% lactic acid; 1 medicine is a eutectic mixture of 60% phenol and 40% tricresol.

Additionally, dermatocosmetics for wart removal are available on the market, such as: Lapis pencil 1 g, containing 97% silver nitrate and 3% potassium nitrate (Salus-International, Poland); Antipapilloma gel for papillomas and warts, 10 ml bottle (LLC Eliksir, Ukraine); Collo gel for the removal of warts and calluses, 5 ml (JSC "HFZ Chervona Zirka," Ukraine); PapiloStop solution, 4 ml (LLC ARMIC GROUP, Ukraine); Superchistotel Dias wart removal product, 1.2 ml vial (LLC Dias-Gold, Ukraine); Papillek wart removal product, 2 ml vial (individual entrepreneur Tishchenko T.M., Ukraine), and others. The mentioned medicines in the form of topical liquids or gels contain keratolytic active substances, such as salicylic, lactic, acetic, and citric acids, while the latter two products also contain celandine extract. Except for the Lapis pencil, all the medicinal products are of domestic origin. Analysis of the pharmaceutical and dermatocosmetic markets showed that most products are produced as topical liquids, less frequently as soft dosage forms such as gels or ointments, and only one dermatocosmetic product is available as a medical pencil (MP), which contains only API. Given the current state of registered medicinal products and marketed dermatocosmetics, a relevant research direction is developing a medical pencil for removing skin warts, based on a hydrophobic base and containing keratolytic APIs.

MPs are primarily wax-based sticks intended for topical application. Their melting point depends on their composition and typically ranges from 34°C to 62°C. Fatty alcohols, waxes, paraffin or ceresin, and vegetable oils and fats ensure a solid consistency at room temperature and melt or soften upon contact with the skin [14]. The MP is a convenient dosage form for individual single- or multiple-use and can be easily carried in a pocket or first-aid kit.

When selecting the dosage form, it was guided by the fact that MPs have several key advantages compared to topical liquids, ointments, and gels, namely [17, 18]:

- localized action: the MP enables precise application of the API directly to the area affected by warts, minimizing contact with healthy skin; in contrast, topical liquids may spread beyond the affected area; likewise, ointments packaged in jars are not always applied accurately to the pathological focus when using fingers or auxiliary devices (cotton pads, swabs, sticks, spatulas, etc.).

– hygiene: there is no need to touch the product with fingers, which reduces the risk of infection contamination both of the dosage form itself and of the affected skin area;
– cost-effectiveness: due to point (localized) application, the dosage form is used economically, in the required amount on a localized area;
– storage stability: compared with gels, the dosage forms do not require the addition of preservatives;
– ease of application: the dosage forms have a solid form, which ensures convenient application and storage without the risk of spillage, as is the case with liquid formulations.

## AIM

The study aimed to develop and compare several formulations of a wax-lipid base for an MP intended for the removal of skin warts, to investigate their physicochemical properties (including hardness, melting behaviour, and stability), and to select the optimal composition based on defined quality and performance parameters, ensuring localized and precise application as well as compatibility with active pharmaceutical ingredients.

## MATERIALS AND METHODS

The initial component proportions in the wax-lipid base were selected based on literature data and preliminary experimental results. According to pharmaceutical technology data, these ranges of ratios between waxes, paraffins, and lipid components ensure an optimal balance between hardness, plasticity, and melting temperature in dermatological bases, as supported by both classical references and recent reviews on the development of topical dosage forms.

In addition, preliminary pilot tests made it possible to establish technologically acceptable limits of system stability and to exclude formulations characterized by insufficient mechanical strength or excessive brittleness. These results formed the basis for six model compositions with fixed component ratios.

It should be emphasized that this study has a staged character and is primarily aimed at developing a basic platform composition of a wax–lipid base with reproducible physicochemical properties, which can serve as a foundation for subsequent incorporation of APIs and the development of the final dosage form.

As the object of the study, experimental samples of bases were used, which contained 50% almond oil, Italy, Sharon) and 50% of a mixture of structuring agents such as the emulsifier cetyl alcohol (5%) (Germany, Evonik); vegetable solid fats (butters) – cocoa butter and shea butter (15%) (Cargill, the Netherlands); and vegetable waxes – sunflower wax, rice bran wax, and soy wax (30%) (France, Natura-Tec). The base samples differed in butter and wax composition (Tab. 1). The ingredient proportions were selected based on literature data [18, 19]. This ingredient combination provides the base samples with the necessary properties, such as hardness, spreadability, and elasticity.

**Tab. 1.** Samples of model base formulations (per 10.0 g). **Source:** Own elaboration.

| № | Ingredient | Quantity [g] | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 |
| 1 | Almond oil | 5 | 5 | 5 | 5 | 5 | 5 |
| 2 | Cetyl alcohol | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| 3 | Sunflower wax | 3 | 3 | | | | |
| 4 | Soy wax | | | 3 | 3 | | |
| 5 | Rice bran wax | | | | | 3 | 3 |
| 6 | Shea butter | 1.5 | | 1.5 | | 1.5 | |
| 7 | Cocoa butter | | 1.5 | | 1.5 | | 1.5 |

The base was prepared by melting the ingredients while taking into account their melting temperatures, in order from higher to lower. The molten mass was poured into stick molds (pencils) for lipsticks. The obtained samples were evaluated according to the following parameters: organoleptic assessment (appearance, color, odor), homogeneity of mixing, melting temperature, spreadability, adhesion, and efficiency of API release.

### Organoleptic control

Appearance: the studied samples of MP bases were transferred to a glass slide and examined with the naked eye. Color: should be characteristic of the components of the test sample; samples were transferred to a sheet of white paper or a glass slide and examined with the naked eye. Odor: pleasant, characteristic of the odor of the ingredients of the test sample.

### Determination of mixing uniformity

Samples of each sample were taken in the amount of 0.3-0.5 g, placed on a glass slide, covered with a second glass slide and pressed firmly until spots with a diameter of about 2 cm were formed. The obtained samples were examined with the naked eye. The sample was considered homogeneous if no visible particles, foreign inclusions and signs of physical instability were detected in the samples [1, 19].

### The melting point

The melting temperatures of MP bases were determined by the open capillary method according to the State Pharmacopoeia of Ukraine 2.2.15 [19].

### Determination of spreadability

Spreadability was determined according to the method proposed by Jonescus S. in 1974. MP samples weighing 0.5 g with an initial diameter of 10 mm were placed in the centre of a 10 × 10 cm lower glass plate, covered with the upper

**Tab. 2.** Organoleptic control of experimental MP base samples. **Source:** Own elaboration.

| № bases | Organoleptic properties | | | |
|---|---|---|---|---|
| | Appearance | Homogeneity | Color | Odor |
| 1 | Compact mass with inclusions | Heterogeneous structure, inclusions in the form of small grains | White | Neutral, characteristic of the base ingredients |
| 2 | Compact mass without inclusions | Homogeneous structure, without inclusions | Light yellow | Neutral, characteristic of the base ingredients |
| 3 | Compact mass without inclusions | Homogeneous structure, without inclusions | White | Neutral, characteristic of the base ingredients |
| 4 | Compact mass without inclusions | Homogeneous structure, without inclusions | White with a yellowish tint | Neutral, characteristic of the base ingredients |
| 5 | Compact mass with grains, easily deformed | Heterogeneous structure, inclusions in the form of small grains | White | Neutral, characteristic of the base ingredients |
| 6 | Compact mass with grains, easily deformed | Heterogeneous structure, inclusions in the form of small grains | Light yellow | Neutral, characteristic of the base ingredients |

plate, after which a 500 g weight was carefully placed. The results were recorded by the diameter of the spot formed after the weight was applied for 15 minutes. Measurements were performed 3 times, and the average value was calculated [17].

### Determination of adhesion

The adhesion index was determined by the mass of a MP smear applied to a pre-weighed glass plate 2 cm wide and 7 cm long. The coating (applied layer) was inspected for uniformity, crumbs, and irregularities, and weighed on an analytical balance. Measurements were performed three times for each sample, and the average value was calculated [17].

### Biopharmaceutical studies

To 2% agar gel, an aqueous solution of 10% iron (III) chloride (Ukraine, CAS) was added at 5% relative to the gel mass. The agar gel was poured into Petri dishes in two portions of 15 ml, using cylinders to form wells (3 in each cup) with a diameter of 10 mm. MPs with bases no. 3 and 4 were prepared separately, to which 10% salicylic acid was added. 0.5 g of a sample of the base with API was placed in each well, and the cups were transferred to a thermostat at a temperature of 37°C. API, when released from the base, interacted with the reagent, forming purple zones, which were measured every 30 min; the last measurement was 24 h [20].

### Statistical analysis

The experimental data were analyzed as the mean ± SEM for five samples for each base (n = 5). The data from the biopharmaceutical studies were analyzed as the mean ± SEM for six colored zones (n = 6). The normality of data distribution was assessed using the Shapiro–Wilk test. As the data did not significantly deviate from a normal distribution ($p > 0.05$), one-way analysis of variance (ANOVA) was used for statistical analysis. Differences were considered statistically significant at $p < 0.05$. All statistical analyses were performed using MS Excel [21].

## RESULTS

The results of the organoleptic control evaluation of experimental MP base samples are given in tab. 2.

The base samples had a color from white to white with a yellowish tint or light yellow; in terms of structural uniformity, samples no. 2-4 showed the best results, since they were characterized by a homogeneous consistency; samples no. 1, 5 and 6 were brittle and easily deformed (Tab. 2).

Determination of the melting point is a mandatory quality indicator for fat-based compact medicines. This indicator ranges from 34 to 62°C. The melting point cannot be lower than 30°C, which corresponds to the hardening temperature of the compact mass. Usually, a low melting point range of 37-40°C, which resembles or is close to body temperature, is optimal for convenient application of the product to the skin and effective release of the API, with simultaneous stability of the shape in the packaging during storage. As shown in tab. 3, all studied MP bases had melting points ranging from 37.5°C to 70°C. Samples no. 1, 2, 5, and 6 demonstrated high melting-point indicators (58-70°C), which can complicate application to the skin due to excessive hardness at room temperature. Instead, samples no. 3 and 4 had melting points of 39.0 ± 0.5°C and 38 ± 0.6°C, which corresponds to the optimal values of this parameter.

Determining smearing and adhesion indicators is not mandatory for quality control of MPs, but the quality of applying a drug to the skin or mucous membrane depends on them. When determining the smearing ability, the diameter value is directly correlated with the ease of applying the drug to the body surface - the larger the diameter of the imprint, the softer the consistency of the medical pencil and the easier

**Tab. 3.** Properties of experimental samples of MPs. **Source:** Own elaboration.

| Indicator | Sample base number/parameters under study | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| Melting point [°C] | 69.5 ± 0.8 | 68.0 ± 1.0 | 39.0 ± 0.5 | 38.0 ± 0.6 | 59.5 ± 0.3 | 58.0 ± 0.5 |
| Determination of spreadability [mm] | 17.7 ± 1.8 | 17.3 ± 1.8 | 27.3 ± 1.8 | 24.7 ± 1.1 | 16.0 ± 0.7 | 15.3 ± 0.4 |
| Determination of adhesion ability – mass of sample on glass [g] | 0.007 ± 0.0010 | 0.008 ± 0.0006 | 0.072 ± 0.0013 | 0.021 ± 0.0013 | 0.004 ± 0.0008 | 0.020 ± 0.0011 |
| Sensory properties, generalized assessment | 5.5 | 6.3 | 8.7 | 9.4 | 6.8 | 7.2 |

and more uniform distribution. According to tab. 2, the best smearing ability is characterized by samples no. 3 and 4, with average imprint diameters of 27.3 ± 1.8 mm and 24.7 ± 1.1 mm, respectively. Other samples – no. 1, 2, 5 and 6 – demonstrated smaller diameter values (from 15.3 ± 0.4 mm to 17.7 ± 1.8 mm), which indicates a worse smearing ability and a harder consistency of the bases.

Adhesion describes the ability of MPs to distribute evenly on the body surface. A uniform smear of a thin layer should remain on the slide; therefore, it is important to ensure an optimal application mass. According to the data in tab. 3, the experimental base compositions for samples 1, 2, and 5 range from 0.004 to 0.008 g, indicating low adhesion and, accordingly, unsatisfactory results. The highest values were recorded for samples no. 3, 4, and 6, indicating better application efficiency and the formation of a uniform smear.

When evaluating the sensory properties of the MP bases on a 10-point scale by volunteers, it was found that for samples no. 1, 2 and 5 the indicators were average (5.0-7.0), for sample no. 6 – moderately high (7.0-8.0), and for samples no. 3 and 4 - high (> 8.0). Bases no. 3 and 4 were easy to apply, had high adhesion, and formed a stable film on the skin surface.

Thus, taking into account the results of comprehensive tests, the compositions of experimental samples of MPs no. 3 and 4 were selected for the following biopharmaceutical study. As a result of the interaction of the API released from the base with the reagent in the agar gel, the formation of a purple color was observed (Fig. 1). The size of the diameter of the colored zones, which increased during the study, indicated the penetration rate and the efficiency of the release of the API.

Based on the data obtained, a graph was constructed of the dependence of the diameters of the colored zones on the time of the experiment (Fig. 2).

The diameter of the colored zones from the beginning to the end of the study changed for base no. 3 from 21 mm to 34 mm, and for base no. 4 – from 22 mm to 39 mm. The results obtained indicate a high ability of both samples to release API, however, the combination of soybean wax and cocoa butter in base no. 4 provides more effective release of API.

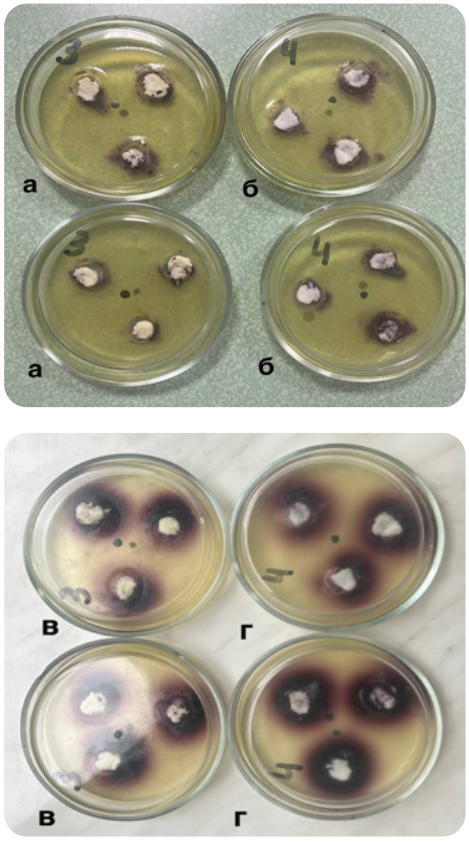



**Fig. 1.** Biopharmaceutical studies on chosen MP base samples: a, b – samples of bases no. 3 and 4 at the beginning of the experiment; c, d – samples of bases nNo. 3 and 4 after 24 hours of incubation in a thermostat. **Source:** Own elaboration.

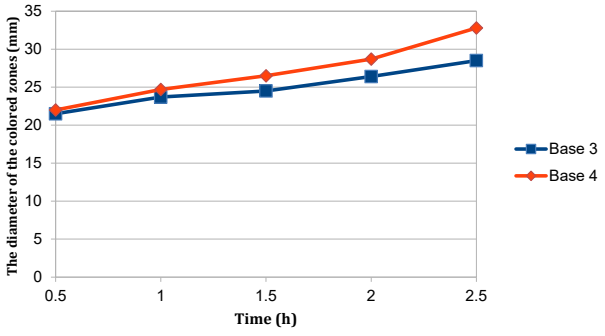



**Fig. 2.** Graph of the dependence of the colored zone diameter on the experiment time. **Source:** Own elaboration.

Thus, the sample of the MP base no. 4, which included almond oil, cetyl alcohol, soy wax, and cocoa butter, had a rational combination of ingredients, since the components provided proper organoleptic properties, melting point, the best spreading and sticking ability, and effectively released salicylic acid.

## DISCUSSION

Modern approaches to topical treatment of viral warts mainly rely on liquid, semisolid, and transdermal dosage forms. However, each system has pharmaceutico-technological limitations that reduce therapeutic efficacy. Liquid dosage forms are characterized by the risk of uncontrolled spreading of the active substance beyond the target lesion, which may lead to damage to healthy tissues and reduced dosing accuracy. Semisolid dosage forms, including ointments and gels, although providing better skin contact, do not ensure precise localization of the active substance and may demonstrate dose variability depending on the method of application [7, 9, 10, 15].

Transdermal patch systems improve exposure control to some extent; however, their use is limited by difficulties adapting to small or irregularly distributed lesions, which are typical of warts. In addition, metered solid dosage forms for the local treatment of this pathology are not widely implemented on the pharmaceutical market [11]. The present study demonstrated that the physicochemical and biopharmaceutical performance of wax-lipid bases for MPs strongly depend on the qualitative and quantitative composition of structuring agents, particularly the ratio of vegetable waxes and solid lipids. The results confirm that formulation design plays a decisive role in achieving an optimal balance between hardness, spreadability, adhesion, and drug-release behaviour.

According to pharmaceutical technology literature, wax-lipid systems are widely recognized as matrix-forming carriers that allow modulation of mechanical strength and melting characteristics through variation in wax type and lipid composition. Consistent with these findings, formulations containing soy wax combined with cocoa butter (sample no. 4) showed a more favourable melting range (38.0 ± 0.6°C) than systems enriched with sunflower wax, which showed significantly higher melting points (up to 69.5 ± 0.8°C). This confirms previously reported findings that saturated waxes increase structural rigidity, while mixed lipid systems improve thermoplastic behaviour and skin compatibility.

The spreadability and adhesion evaluation further highlighted the importance of balanced lipid-wax interactions. Samples with moderate wax content and plasticizing lipid components demonstrated improved spreading diameter and higher adhesion mass, indicating better application performance. These findings are consistent with earlier reports on topical solid dosage forms, where increased plasticity correlates with improved drug distribution over the skin surface and enhanced patient acceptability.

Biopharmaceutical studies confirmed that base composition significantly influences the release kinetics of the active pharmaceutical ingredient (API). Sample no. 4 showed more efficient diffusion of salicylic acid than the other formulations, which may be attributed to its optimal microstructure and lower melting temperature, facilitating faster matrix softening at skin temperature. Similar effects have been described in studies on lipid-based topical delivery systems, where softer matrices enhance drug mobility and diffusion rates.

Importantly, the obtained results are in line with current trends in dermatological pharmaceutics, which emphasize the transition from conventional semi-solid formulations toward solid, metered, and patient-friendly delivery systems such as sticks and pencils. However, as highlighted in the literature, the number of commercially available MPs remains limited, and most existing products lack systematic optimization of base composition, which further underscores the scientific relevance of the present work.

Overall, comparing experimental formulations with literature data confirms that the developed wax–lipid system, particularly sample no. 4, provides a rational compromise between mechanical stability and efficient drug release. This positions it as a promising platform for further development of an MP for localized treatment of viral warts.Incorporating active pharmaceutical ingredients, such as salicylic acid, lactic acid, or resorcinol, at relatively high concentrations may significantly affect the physicochemical properties of the final dosage form, particularly the hardness, melting temperature, plasticity, and stability of the wax-lipid matrix. Therefore, optimization of the base formulation alone cannot automatically ensure the preservation of optimal properties after the introduction of APIs.

At the same time, in the present study, optimization of the base was considered as an initial stage in the development of a more complex multicomponent system. Such an approach is well established in pharmaceutical technology, as it allows the formation of a stable and reproducible base with controlled rheological and thermomechanical properties, the assessment of compatibility between the base and potential active substances, and the minimization of instability risks upon further incorporation of APIs.

Furthermore, the developed wax-lipid matrix is characterized by a certain degree of plasticity and the possibility of adjusting its physicochemical properties through variation in component ratios, which creates prerequisites for further adaptation of the formulation after the incorporation of active ingredients.

Thus, the obtained base formulation should be regarded as a platform system requiring further optimization after API incorporation, which represents the next stage of the study. It is planned to continue research on the influence of keratolytic APIs (salicylic acid, lactic acid, resorcinol, etc.) [6, 10] on the structure and physicochemical properties of the MP, and to develop a rational technology for manufacturing a finished medicine.

## CONCLUSIONS

1. Comparative analysis of the experimental samples demonstrated that the composition of structuring agents significantly influences the performance characteristics of the wax-lipid base, particularly consistency, application properties, and API release.
2. Based on the obtained results, formulation no. 4 (almond oil – 50.0 g, cetyl alcohol – 5.0 g, soybean wax – 30.0 g, cocoa butter – 15.0 g) was selected as the optimal composition, providing the most balanced combination of mechanical properties and efficient API release for localized application.

## CONFLICTS OF INTEREST

Authors declare no conflict of interest.


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## AUTHORS' CONTRIBUTIONS

M.F.: conceptualization, methodology, investigation, data curation, writing – original draft; O.T.: methodology, validation, formal analysis, investigation, writing – review & editing; A.S.: resources, visualization, supervision, writing – review & editing; I.B.: conceptualization, supervision, project administration, funding acquisition, writing – review & editing.

All authors have read and approved the final version of the manuscript and agree to be accountable for all aspects of the work.

## ETHICS STATEMENT

Not applicable.

## USE OF AI TOOLS

Authors declare that no artificial intelligence tools were used in the preparation, writing, analysis, or illustration of this manuscript.

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