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RESEARCH ON THE DEVELOPMENT OF SOLID SOAP COMPOSITION FOR THE PREVENTION AND TREATMENT OF PSORIASIS RELAPSE

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The aim of the research *is to develop the composition of solid soaps for the treatment and prevention of exacerbation of psoriasis using a classic recipe based on vegetable oils.*

Materials and methods. *The studied samples of solid soaps were made based on vegetable oils of domestic and foreign production using an aqueous solution of sodium hydroxide for their saponification. Citric acid (China, p. K707784), salicylic acid (China, p. Y1504007) and lactobionic acid (Poland, p. 20161118) were used as active pharmaceutical ingredients. Organoleptic (appearance, shape, color, smell) and physico-chemical (mass fraction of fatty acids, initial volume of foam, mass fraction of soda products) studies were carried out following DSTU 4537:2006 Solid toilet soap. General technical conditions. Indicators were chosen as standards for soap of the special - therapeutic brand.*

Results. *Samples containing a combination of coconut, avocado, castor, jojoba and palm oils, as well as a combination of castor, jojoba, macadamia, mango and avocado oils were found to have insufficient foaming capacity. Most samples are not firm enough, especially those containing rosehip oil. The composition of solid soap based on palm kernel oil, coconut oil, avocado oil, castor oil, almond oil, and olive oil, among others, showed the best organoleptic properties. All the studied samples were within the normal range according to the parameters of the mass fraction of soda products and the mass fraction of fatty acids. At the same time, introducing active substances into the composition did not lead to a deterioration of the developed solid soap's normative or controlled organoleptic and physicochemical properties.*

Conclusions. *The research conducted made it possible to obtain the optimal composition of solid soap, which can be used to prevent psoriasis exacerbation due to the introduction of pomegranate seed oil. Based on this, solid soaps were created for the treatment of psoriasis in the period of exacerbation, one of which includes lactobionic acid and the other – a combination of citric and salicylic acids*

Keywords: *solid soap, vegetable oils, saponification number, iodine number, psoriasis*

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1. Introduction

Psoriasis is a systemic chronic immune-mediated disease mainly affecting skin and joints. According to the International Federation of Psoriasis Associations, its prevalence in the world is from 1.2 % to 5 %, the average rate is about 3 %. In Western European countries, the incidence of psoriasis is more than 2 %; in other European countries, it does not exceed 6 %; in the USA – 2.2 %; in Canada – 4.7 %. The most common form of the disease is simple or plaque psoriasis, which is registered in 80–90 % of patients. In Ukraine, the prevalence of the disease has increased significantly in recent years. As of 2020, 1.5 million people in Ukraine suffered from psoriasis [1].

The disease can begin at any age, but according to statistics, the onset of the disease most often occurs between the ages of 20 and 40. The clinical picture is characterized by roughened erythematous areas covered with silver scales and, first of all, excessive skin dryness [2]. The use of modern methods and approaches to treating psoriasis makes it possible to significantly reduce the manifestations of psoriasis and achieve long-term remission. In order to ensure a positive therapeutic effect, a complex approach is used, which involves the use of special hygiene products for care treatment and prevention together with specific systemic and local medicinal preparations. The main tasks of hygiene products, besides cleaning, are moisturizing, softening and nourishing the skin. Their regular use makes it possible to reduce the peeling of the skin and prevent the appearance of cracks. It is also an important factor for accelerating the transition from relapse to remission and, subsequently, prolonging the remission phase [3].

Hygiene products for use in psoriasis, available on the pharmaceutical market of Ukraine, are presented in the form of shampoo, liquid soap, gel or cream-gel for showering. Means in the form of solid soaps for use in psoriasis are few, so patients who prefer this form are forced to use solid soaps for atopic skin [4]. This is because psoriasis and atopic dermatitis are somewhat similar symptomatically. However, a number of differences cannot be neglected when choosing medical or hygienic means. This is the allergic etiology of atopic dermatitis and the presence of skin itching, which are not characteristic of psoriasis [5].

Most hygiene products that can be used for psoriasis have one common drawback – the presence of substances in the composition that negatively affect the condition of the skin. Usually, this is a foaming base containing anionic surfactants aggressive towards the skin, and capable of cumulation. While the skin needs to be moisturized and softened, ethanol, parabens, petroleum products, and surface-active substances that are part of modern hygiene products, on the contrary, can cause dryness, irritation and allergic reactions [6]. Therefore, the development of the composition of solid soap based on natural components for the treatment and prevention of exacerbation of psoriasis is relevant. It is the use of such soap in complex therapy that can improve the condition of the skin.

Considering one of the pathogenetic features of psoriasis, the increased proliferation of epidermal cells, it can be concluded that a positive therapeutic effect can also be achieved by adding exfoliating substances to the composition of soap. Studies were conducted on the moisturizing and exfoliating activity of citric and salicylic acids as part of combined preparations for various skin pathologies. Their effectiveness has been proven when used for 6–8 weeks [7, 8].

Citric acid - α-hydroxy acid and salicylic acid – β-hydroxy acid have excellent exfoliating properties and are widely used in medical and cosmetic products (chemical peels, anti-aging products, etc.). Polyhydroxy acids, such as lactobionic acid, have a softer exfoliating ability. Such acids are used in products for sensitive, irritated skin [9, 10].

The aim of the research. The development of the composition of solid soaps for treating and preventing exacerbation of psoriasis using a classic recipe based on vegetable oils.

2. Research planning (methodology)

The study consisted of two stages:

Theoretical – search for information, study, analysis and generalization of obtained data from publications and patents of both domestic and foreign scientists on a given topic. This stage also included the selection of vegetable oils for the production of solid soaps based on the study of the properties that certain oils impart to the finished soap. Castor and almond oils are added to form a thick, high foam; coconut, shea, palm, and cocoa butter are used to ensure firmness, and castor, avocado, jojoba, and olive oils are added to the soap to soften and moisturize it (Fig. 1).

2. Experimental – conducting the study to determine the organoleptic and physicochemical properties of solid soaps using the methods described below, as well as the introduction of active substances into the composition of the soap and the study of their influence on the organoleptic and physicochemical properties.

The experimental stage is also divided into two parts:

– development of the composition of solid soap for the prevention of psoriasis, where pomegranate seed oil was chosen as a superfat, which contains about 60 % garnetic (punicic) acid, which has a moisturizing and softening effect [11–13];

– development of test samples of solid soaps for the treatment of psoriasis during exacerbations, which, in addition to pomegranate seed oil, will provide symptomatic treatment, will include traditional exfoliants citric and salicylic acid and more modern lactobionic acid, which will provide pathogenetic treatment.

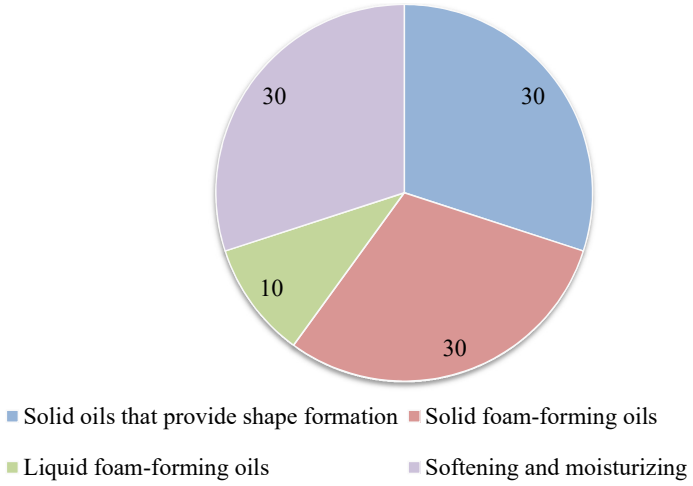

Fig. 1. Universal ratio of oils included in the composition of solid soap, %

3. Materials and methods

The samples under study were made using domestic and foreign vegetable oils (Table 1), sodium hydroxide, and purified water [14–18].

Table 1

Characteristics of vegetable oils that were used for the production of the studied samples

Oil	Iodine number, mgKOH/g	Saponification number, mgKOH/g	Unsaponifiable substances, %
Liquid			
Pomegranate seeds	185	–	–
Olives	81	188	0.64
Castor oil	86	181	0.44
Jojoba	85	94	50
Avocado	85	190	0.07
Rosehips	180	169	2.5
Almond	97.9	190	0.5
Macadamia	76	193	0.5
Solid			
Shea	68	171	15
Coconut	9.5	190	0.2
Palm kernel	19	245	≈ 0
Babassu	18	251	0.8
Mango	45	190	2
Avocado	60	190	26
Palm	51	194	0.99
Cocoa oil	35	194	0.7

Based on the data given in Table 1, 10 research samples were formed (Table 2). At the same time, the total iodine amount of the future soap was considered, which was calculated according to formula (1). According to literature sources, the total iodine number of soap

should not be higher than 60 for optimal shelf life and resistance to rancidity [19]:

$$IN_{s.} = \frac{\sum(IN_{o.} \times A_{o.})_n}{100}, \quad (1)$$

where *INo.* – iodine number of the oil;

$A_{o.}$ – amount of oil, %;

n – 1–6.

To calculate the amount of sodium hydroxide (X, g) required for the saponification of higher carboxylic acids of oils, formula (2) was used. The number of unsaponifiable substances and the coefficient of conversion to sodium hydroxide, which is equal to 0.72, were considered, since the tabular value of the number of saponification is indicated for potassium hydroxide, which is used to make liquid soaps [20]. At the same time, these indicators for pomegranate seed oil were not taken into account, since in the studied samples of solid soaps, pomegranate seed oil is superfat – an oil that does not saponify and is responsible for the expected softening and moisturizing properties of soap [21]:

$$X, \text{g} = \frac{\sum\left(SN_{o.} \times A_{o.}\right)_n}{100 * 100}, \quad (2)$$

where $SN_{o.}$ – oil saponification number;

$A_{o.}$ – amount of the oil, %.

n – 1–5.

Table 2

The composition of the studied samples

Component \ Sample	1	2	3	4	5	6	7	8	9	10
Pomegranate seed oil	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Olive oil	1.0	1.0	1.0	1.0	1.0	–	1.0	–	1.0	–
Castor oil	1.0	–	1.0	1.0	–	1.0	–	1.0	1.0	1.0
Jojoba oil	1.0	1.0	–	1.0	1.0	1.0	–	–	–	–
Avocado oil	–	–	1.0	–	–	1.0	–	–	–	1.0
Rosehip oil	–	1.0	–	–	–	–	1.0	–	–	–
Almond oil	–	–	–	–	–	–	–	1.0	1.0	1.0
Macadamia oil	–	–	–	–	1.0	–	1.0	1.0	–	–
Shea oil	–	3.0	–	–	–	–	–	–	3.0	–
Coconut oil	–	3.0	–	–	–	3.0	3.0	–	–	3.0
Palm kernel oil	3.0	–	–	–	–	–	3.0	3.0	–	–
Babassu oil	–	–	3.0	–	–	–	–	–	3.0	–
Mango oil	–	–	3.0	–	3.0	–	–	–	–	–
Avocado oil	3.0	–	–	3.0	3.0	–	–	–	–	–
Palm oil	–	–	–	–	–	3.0	–	–	–	–
Cocoa oil	–	–	–	3.0	–	–	–	3.0	–	3.0
Aqueous solution of sodium hydroxide	≈3–4 ml									

Samples were made by the cold method: sodium hydroxide is dissolved in cold water purified using an ice bath. An alloy of vegetable oils is made in a steam bath. When the alloy and solution reach the same temperature, they are combined. With the help of a homogenizer, at the lowest revolutions, with 10-second breaks, gently stir until a white color appears, which indicates the successful course of the main hydrolysis and saponification of higher carboxylic acids, which are part of the oils. Add superfat and, where necessary, active substances. Then gently stir until thickened. Placed in a mold, left to stabilize for 7 weeks.

Control of the saponification process was carried out by taking microphotographs at various stages of soap formation. Photomicrographs were obtained using a Granum R40 microscope and a ToupCam FMA050 camera with a magnification of ×10.

Organoleptic (appearance, shape, colour, smell) and physicochemical tests were carried out following DSTU 4537:2006 Solid toilet soap. General technical conditions are currently being modernized in accordance with the requirements of the Regulation of Ukraine on Cosmetic Products. Indicators for soap of the special-therapeutic brand were chosen as standards [22].

Determination of the qualitative number or mass of fatty acids in terms of the nominal mass of soap 100 g (norm – not less than 74) is carried out using acid-base titration. An ethanolic solution of fatty acids is previously obtained using a three-stage ethyl ether extraction. For titration, a 0.5 M solution of sodium hydroxide is used as a titrated solution; the indicator is phenolphthalein, and the endpoint of the titration is the appearance of a pink colour that does not disappear upon stirring. After the titration, ethanol is distilled off in a water bath; the residue is dried in an oven at 120±3 °C for 2 hours and cooled. The dry residue is weighed every hour until a stable result is obtained. The weight is considered constant if the difference between weighings does not exceed 0.002 g.

The mass fraction of fatty acids (X) in percent is calculated according to formula (3).

$$X = \frac{\left(m_1 - V \cdot K \cdot 0.011\right)}{m} \cdot 100, \quad (3)$$

where m_1 – the weight of the residue after drying, g;

V – volume of alcoholic sodium hydroxide solution used for titration, cm^3;

K – correction that considers the ratio of the actual concentration of sodium hydroxide to the nominal (0.5 mol/dm^3);

m – mass of the weight, g;

0.011 – the difference between the atomic mass of sodium and hydrogen, equivalent to 1 cm^3 of an alcoholic solution of sodium hydroxide with a concentration of 0.5 mol/dm^3.

The measurement result is the average arithmetic value of the results of two parallel measurements. Differences between parallel measurements should not exceed 0.5 % at a confidence level of 0.95.

Formula (4) determines the mass fraction of fatty acids in terms of the nominal weight of the soap (X_0) in percent.

$$X_0 = \frac{m_1 \cdot X}{m_2}, \quad (4)$$

where m_1 – actual mass of soap, g;

X – mass fraction of fatty acids, %;

m_2 – nominal mass of soap.

Mass share of sodium products in terms of Na_2O (norm – not less than 0.15 %). When calculating this indicator, the values of the mass fraction of caustic alkali and the mass fraction of free sodium carbonate are used.

Determination of the mass fraction of caustic alkali is carried out using acid-base titration. Preliminarily, 100 ml of an alcoholic solution of the sample under study (5 g of the weight is added to ethanol neutralized by phenolphthalein) is heated in a water bath, 25 barium chloride is added, titrated without cooling and without removing the formed precipitate. The titrated solution is a 0.1 M solution of hydrochloric acid, the indicator is phenolphthalein, the end point of the titration is the discoloration of the solution, which does not disappear upon stirring. Calculations are carried out according to formula (5).

$$X_1 = \frac{V \cdot K \cdot 0.004 \cdot 100}{m}, \quad (5)$$

where X_1 – mass fraction of free caustic alkali, %;

V – volume of hydrochloric acid solution with a concentration of 0.1 mol/dm^3 used for titration, cm^3;

K – correction that considers the ratio of the actual concentration of the hydrochloric acid solution to the nominal one (0.1 mol/dm^3);

m – mass of the sample, g;

0.004 – the mass of caustic alkali, equivalent to 1 cm^3 of hydrochloric acid solution with a concentration of 0.1 mol/dm^3.

The measurement result is the average arithmetic value of the results of two parallel measurements. At a confidence level of 0.95, differences between parallel measurements should not exceed 0.01.

Determination of the mass fraction of free sodium carbonate is also carried out using acid-base titration. Pre-dissolve 5 g of the test sample in 75 ml of ethanol neutralized with phenolphthalein by heating in a water bath. The resulting solution is cooled and titrated. The titrated solution is a 0.1 M solution of hydrochloric acid, the indicator is phenolphthalein, the end point of the titration is the discoloration of the solution, which does not disappear upon stirring. Calculations are carried out according to formula (6).

$$X_2 = \left(\frac{V \cdot K \cdot 0.4}{m} - X_1 \right) \cdot 2.65, \quad (6)$$

where X_2 – mass fraction of free sodium carbonate, %;

V – volume of hydrochloric acid solution with a concentration of 0.1 mol/dm^3 used for titration, cm^3;

K – correction that considers the ratio of the actual concentration of the hydrochloric acid solution to the nominal one (0.1 mol/dm^3);

m – weight of the sample, g;

X_1 – mass fraction of free caustic alkali, %;

0.4 – the mass of caustic alkali, equivalent to 1 cm^3 of hydrochloric acid solution with a concentration of 0.1 mol/dm^3/g, multiplied by 100;

2.65 – conversion factor of caustic alkali to sodium carbonate.

The measurement result is the average arithmetic value of the results of two parallel measurements. At a confidence level of 0.95, differences between parallel measurements should not exceed 0.05 %.

Calculation of the mass fraction of soda products in terms of Na_2O (X', %) is carried out according to formula (7).

$$X' = 0.775X_1 + 0.590X_2, \quad (7)$$

where 0.775 – conversion factor of sodium hydroxide to Na_2O;

X_1 – mass fraction of free caustic alkali, %;

0.590 – conversion factor of sodium carbonate to Na_2O;

X_2 – mass fraction of free sodium carbonate, %.

Measurement of the initial volume of the foam (norm - not less than 380 cm^3). Hard water is used as a solvent, 300 ml of an aqueous solution of the test sample is prepared at a temperature of 20 °C, while the content of fatty acids in the solution should be 0.5 %. Place 100 ml of the resulting solution in a transparent, colourless glass container (in our case, a cylindrical container with a diameter of 10 cm and a height of 30 cm), cover it with a lid and shake for 1 minute (about 180 times). Measure the height of the formed foam and calculate the initial foam volume (V, cm^3) according to formula (8).

$$V = \pi r^2 h, \quad (8)$$

where π – 3,14;

r – radius of the container, cm;

h – the height of the formed foam, cm.

The result of the measurement is the arithmetic mean of three measurements, which are carried out each time with new portions of solutions.

Microbiological purity tests of the developed samples, as well as tests for individual types of microorganisms, were carried out in accordance with the methods given in SPhU [23]. When testing microbiological purity, the method of surface seeding in Petri dishes with soybean-casein for viable aerobic microorganisms (TAMS) and Sabouraud-dextrose agar for yeast and mould fungi (TYMC) agar was used. For each nutrient medium, the average arithmetic value of the number of colonies was calculated, and the number of colony-forming units (CFU) in 1 ml of the sample was determined. During long-term storage, control tests were performed every 3 months during the first year of storage and every six months during the second year of storage (0, 3, 6, 9, 12, 18, 24, 27 months).

The safety indicators of solid soaps were determined in vivo according to the hygienic requirements of the State Sanitary Rules and Regulations 2.2.9.027 [24]. Acute toxicity and skin irritant effects were studied on sexually mature rats of both sexes, aged 3–4 months, with a body mass of 255±5 g at the start of the experiment. The animals were observed for 14 days after applying the test samples. The general physiological state of the animals, as well as the condition of the fur and mucous membranes, were assessed daily. The behavior of

the animals, food, and water consumption were monitored. Animal survival was recorded. Body mass dynamics were studied on the experiment's 3rd, 7th, and 14th days. At the same time, the condition of the skin in the area where the test samples were applied was monitored to study the skin irritant effect. The study was conducted following Directive 2010/63/EU of the European Parliament and of the Council of the EU of September 22, 2010, "On the protection of animals used for scientific purposes" (Protocol No. 10 dated October 3, 2023).

Statistical analysis of the study results was performed using Excel 2010 and XLSTAT 2021 software.

4. Research results

Studying the process of soap formation with the help of microphotographs made it possible to reveal changes in the shape and size of particles and the uniformity of their distribution in dynamics. In general, three main stages of soap formation can be distinguished for all samples: – the first – from 1 to 3 minutes after combining the alloys of oils and an aqueous solution of sodium hydroxide, the beginning of saponification, which is characterized by an uneven distribution of particles of different shapes and sizes (Fig. 2);

– the second – from 3 to 8 minutes, the transition to the active phase of saponification and the addition of superfat and active substances (where necessary), characterized by a decrease in the size of particles, an improvement in their distribution and the absence of changes in their shape (Fig. 3);

– the third – from 8 to 12 minutes, the completion of the active process of saponification and the transition to a long stabilization period, characterized by a uniform distribution, a smaller, compared to the previous stages, particle size, a significant predominance of rounded particles (Fig. 4).

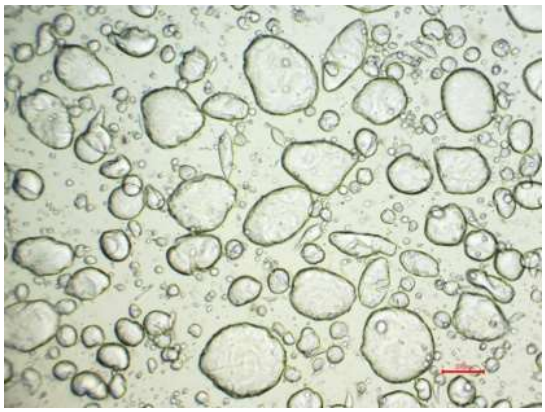

Fig. 2. Photomicrograph of the first stage of soap formation

The results of organoleptic tests showed that all samples have a smooth surface, are homogeneous in section, are uniform in colour, and have a light characteristic smell. However, the consistency is significantly different (Table 3).

Studies of physical and chemical properties showed that the foaming ability of some samples is unsatisfactory, while the rest of the indicators are within the normal range (Table 3).

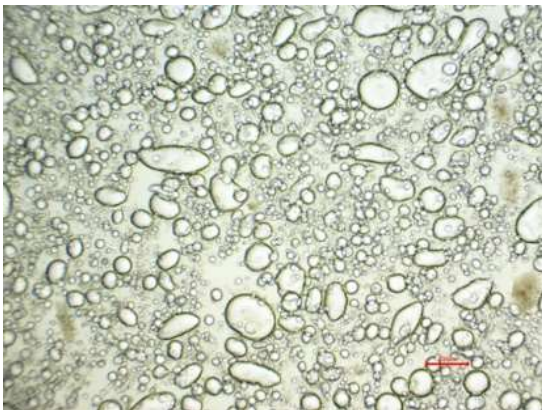

Fig. 3. Photomicrograph of the second stage of soap formation

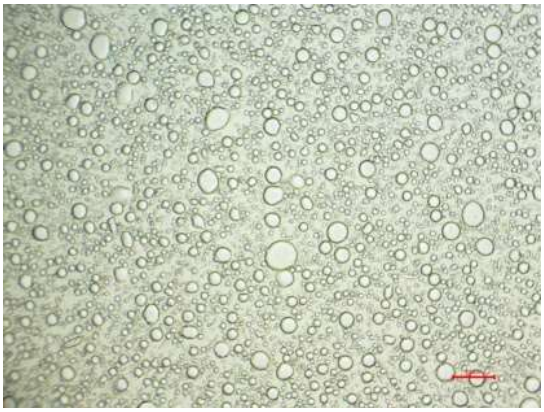

Fig. 4. Photomicrograph of the third stage of soap formation

Table 3

Results of organoleptic and physicochemical studies of solid soaps

Sample	Consistency	Mass fraction of fatty acids, %	Mass share of soda products, %	Initial foam volume, cm^3
1	Medium softness	81	0.16	473.6±1.08
2	The softest of all samples	89	0.15	382±0.46
3	Soft	80	0.3	447.5±1.91
4	Hard enough, but fragile	77	0.2	421.3±0.89
5	Hard enough	74	0.29	193.6±0.63
6	Hard enough, but has a greasy film on the surface	79	0.16	225.1±1.56
7	Soft	82	0.19	426.5±0.87
8	Soft, has a greasy film on the surface	84	0.15	389.9±0.91
9	Medium softness, has a greasy film on the surface	84	0.17	379.4±1.21
10	Medium softness, has a greasy film on the surface	85	0.16	387.3±1.18

So according to the results of previous studies, none of the 10 presented samples is successful. Despite the homogeneity and smoothness of the surface of the

soaps, a greasy film formed on the surface of samples No. 6, No. 8–10. Only samples No. 4–6 had a satisfactory consistency. At the same time, samples No. 5, No. 6 and No. 9 did not meet the requirements for foaming ability.

Samples No. 1 and No. 4 caught our attention, which differed by only one ingredient and required a slight correction of the consistency properties. Samples No. 11–13 were created on their basis (Table 4). At the same time, a slightly different approach to the formation of the oil composition was used, in addition to the iodine number, the fatty acid composition of each oil was taken into account and their ratio was changed.

Table 4

The composition and characteristics of additional studied samples

Sample	No. 11	No. 12	No. 13
Composition	Palm kernel oil 2.5; coconut oil 2.5; castor oil 1.5; jojoba oil 1.0; olive oil 1.5; pomegranate seed oil 1.0; aqueous solution of sodium hydroxide≈3–4 ml	Palm kernel oil 3.0; coconut oil 1.5; avocado oil 1.5; castor oil 1.0; jojoba oil 1.0; olive oil 1.5; pomegranate seed oil 1.0; aqueous solution of sodium hydroxide≈3–4 ml	Palm kernel oil 3.0; coconut oil 1.5; avocado oil tv. 1.5; almond oil 1.0; olive oil 1.0; castor oil 1.0; pomegranate seed oil 1.0; aqueous solution of sodium hydroxide≈3–4 ml
Organoleptic properties	The surface is smooth homogenous in section; the white color is uniform, it is still not hard enough	The surface is smooth homogeneous in section, the white colour is uniform, it is hard enough, but there is a problem of a greasy film on the surface	The surface is smooth homogenous in cross-section, the white color is uniform, it is quite hard
Mass fraction of fatty acids, %	75	79	78
Mass share of soda products, %	0.15	0.18	0.19
Initial foam volume, cm^3	421.3±0.44	408.2±1.52	423.9±0.75

The results of additional studies showed that sample No. 13 is the best among the proposed ones.

The next stage is the study of the influence of the introduction of active substances into the sample composition No. 13. Two samples were made with active substances: No. 14 – with citric and salicylic acids, No. 15 – with lactobionic acid.

Sample No. 14 has a smooth surface, is homogeneous in section, has a uniform colour and is sufficiently hard. The difference between the data obtained in the study of physical and chemical properties is not statistically significant (p=0.1994, p>0.05). The mass fraction of fatty acids is 77 %, the mass fraction of soda products is 0.18 %, and the initial foam volume is 397.7±2.27 cm^3.

Sample No. 15 has a smooth surface, is homogeneous in section, has a uniform colour and is sufficiently hard. At the same time, there were no statistically significant changes in the values of physical and chemical properties (p=0.9951, p>0.05). Mass fraction of fatty acids – 77.5 %, mass fraction of soda products – 0.19 %, initial foam volume – 421.3±0.43 cm^3.

The results of microbiological purity for all studied samples (No. 13–15) during 27 months of storage are shown in Table 5.

Table 5

Results of testing the gel sample for microbiological purity

Storage period	Total number, CFU / ml			
	TAMC	TYMC	*S. aureus*	*Ps. Aeruginosa*
After manufacturing	Less than 100	Less than 10	Absent	Absent
24 months storage	Less than 100	Less than 10	Absent	Absent
27 months storage	Less than 100	Less than 10	Absent	Absent

During the study of acute toxicity, no signs of intoxication were observed in the animals: the animals were tidy, active, had a normal appetite, reacted normally to sound and light stimuli, the processes of urination and defecation were normal, respiratory disorders and convulsions were not observed. Reflex excitability in animals was preserved. Deaths of animals were not observed during the entire period. Determining the body weight of experimental rats showed that the application of the studied samples did not affect the increase in body weight, which indicates the absence of toxic properties in the studied samples that could disrupt the general trophic processes of the animal body. In addition, no signs of skin irritation were found.

5. Discussion of research results

Despite the fact that the total iodine number of each of the samples was within the recommended limits, they differed greatly in consistency and foaming ability. In some cases, this can negatively affect the quality of the product being developed. For example, too soft a consistency makes soap inconvenient to use and store. It was also previously believed that the formation of low and thin foam can lead to the deterioration of cleaning properties. However, the cleaning properties are affected by the number of diphilic molecules formed due to the saponification of higher carboxylic acids of oils, and their sufficient amount, which ensures cleaning, does not always accompany the formation of a large amount of foam. For example, with the vast majority of myristic and lauric acids in the composition of oils, soap will have excellent cleansing properties with a small amount of foam.

Therefore, when developing the composition of soaps, it is important to pay attention not only to the general characteristics of oils, which properties they give

to soaps, and the iodine number of samples, but also to study in detail the fatty acid composition of each oil to establish the optimal ratio of polyunsaturated and saturated fatty acids and to more accurately predict the properties of the future lovely However, when studying the publications of foreign scientists who were engaged in the creation of solid soaps or soaps in general, we noticed a trend – classic soap-making products are considered unpromising and, as a result, there is very rarely information about the relationship between the fatty acid composition of oils and the quality indicators of the finished soap [19–21].

In our case, the correction of the ratio of oils and the introduction of solid avocado oil in the production of sample No. 12 made it possible to increase the hardness of the soap, probably due to a shift in the balance towards lauric and stearic acids. Also, a sufficient amount of stearic acid affected the foaming, which remained at the same level. In addition, the replacement of jojoba oil, which contains about 80 % of gadoleic acid (it is in this composition, along with a large amount of oleic acid from other oils, that prevented the formation of a greasy film on the surface of the soap), with almond oil, made it possible to optimize the amount of emollient acids and improve the organoleptic properties of soap.

The research results obtained by us proved that after the introduction of active substances into the composition of soaps, they indicate that lactobionic acid does not in any way affect the organoleptic properties and physicochemical parameters of the studied sample. The introduction of a combination of citric and salicylic acids into the composition of the soap led to a slight decrease in the foaming capacity, which is not statistically significant, and the indicator of the initial foam volume is still within the normal range. Therefore, the combination of citric and salicylic acids also does not impair the properties of the finished product.

The study of the microbiological purity of the studied samples showed that the total number of aerobic microorganisms (TAMC) is no more than 100 CFU/g, the total number of yeast and mold fungi (TYMS) is no more than 10 CFU/g, microorganisms of the family *S. aureus* and *Ps. aeruginosa* in 1.0 g are absent, which meets the requirements of SPhU.

The obtained data from the study of acute toxicity when applied to the skin and skin-irritating effect indicate the safety of the developed samples of solid soap.

Practical significance. The conducted research will contribute to the revival and further development of the domestic scientific school of soap-making in Ukraine, as well as the introduction into the production of new products in the form of soap for therapeutic and preventive purposes.

Study limitations. Within this research stage, some aspects of the consumer properties of the studied samples remained unstudied. These are the cleansing properties and the effect on the skin when using soap (does or does not cause skin dryness).

Prospects for further research. The next stage of the research should be to identify and quantify the active substances that are released and interact with the skin when using soap.

6. Conclusions

Conducting research on the development of similar medicinal products is quite promising and relevant and will allow to expand the assortment of Ukrainian-made drugs based on natural raw materials.

Based on the results of the research, a composition of solid soap was developed for the prevention of exacerbation of psoriasis, which contains palm kernel oil – 30 %, coconut – 15 %, avocado oil – 15 %, castor oil – 10 %, almond oil – 10 %, olive oil – 15 % , pomegranate seed oil – 10 %, based on the oil content of the soap – 100 %.

On its basis, solid soaps were developed, which include citric acid in combination with salicylic acid and lactobionic acid for the symptomatic and pathogenetic therapy of psoriasis. It has been confirmed that the introduction of active substances into the composition of solid soaps does not negatively affect their organoleptic and physicochemical properties. The studied samples meet the SPhU requirements for microbiological purity and the requirements of the State Sanitary Rules and Regulations for the absence of skin irritation and acute toxicity when applied to the skin.

Conflict of interest

The authors declare that they have no conflict of interest in relation to this study, including financial, personal, authorship, or any other, that could affect the study and its results presented in this article.

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Data availability

The manuscript includes data as electronic supplementary material.

Use of artificial intelligence

The authors confirm that they did not use artificial intelligence technologies when creating the presented work.

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