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Development of the composition and technology of a soap with sapropel

Hygienic treatment of hands is an effective means of reducing the spread of transient microflora and is considered as one of the most important procedures for preventing the infection transmission by the contact-household way. Hygienic treatment of hands is necessary in public catering establishments, treatment and prevention institutions, for immunity compromised patients, in the period of seasonal diseases, etc. Most antibacterial soaps are based on synthetic surfactants using such synthetic antibacterial additives as triclosan, triclocarbanum, farnesol, benzalkonium chloride, pyroctonolamine. Therefore, development of soaps containing natural substances in their composition is relevant.

Aim. To develop a soap with sapropel, which would have the antibacterial effect and satisfactory sensory properties.

Materials and methods. To make the soap the liquid corn and castor oils, solid palm and coconut oils, as well as argan oil were selected as a superfatting agent. Oil saponification was carried out with sodium hydroxide solution. The quality of the samples obtained was assessed by the organoleptic and physicochemical parameters (the qualitative number (the mass of fatty acids calculated with reference to the nominal weight of a soap bar of 100 g), the mass fraction of free caustic alkali, the mass fraction of sodium products calculated with reference to Na_2O, the temperature of fatty acid (titer) gelation, the mass fraction of sodium chloride).

Results and discussion. By the indicators of the saponification value of the selected components of the soap fatty base containing 43.8 % of palm oil and 25 % of coconut oil, 6.2 % of corn oil and 25 % of castor oil, and with the necessary consistency properties, soap ductility, high solubility and foaming in cold water the amount of alkali needed for making soap has been calculated. According to the results of determination of the soap consumer properties the concentration of argan oil has been chosen. As a result of studying the organoleptic and physicochemical parameters of the soap with 5 and 10 % of sapropel it has been found that the soap obtained by the cold method meets the standards for soap of the brand “Special” with disinfectants or therapeutic additives.

Conclusions. The soap composition containing 5 and 10 % of sapropel has been proposed. In the laboratory conditions the cold and hot methods for obtaining the soap with sapropel have been tested. It has been found that the samples obtained by the cold method meet the requirements of the normative documentation in contrast to the soap with the unsatisfactory organoleptic parameters obtained by the hot method.

Key words: *sapropel; cold method obtaining soap; antibacterial soap*

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Розробка складу і технології мила з сапропелем

Гігієнічна обробка рук, що є ефективним засобом зниження поширення транзиторної мікрофлори, розглядається в якості однієї з найважливіших процедур для запобігання передачі інфекцій контактно-побутовим шляхом. Гігієнічна обробка рук є необхідною у закладах громадського харчування, лікувально-профілактичних закладах, для осіб зі зниженим імунітетом у період сезонних захворювань. Більшість антибактеріальних мил виготовлена на основі синтетичних поверхнево-активних речовин з використанням синтетичних антибактеріальних добавок: триклозану, триклокарбану, фарнезолу, бензалконію хлориду, піроктоноламіну. Тому актуальним є розробка мил, які у своєму складі містять речовини природного походження.

Мета роботи – створення мила з сапропелем, яке б володіло антибактеріальним ефектом та задовільними сенсорними властивостями.

Матеріали та методи. Для виготовлення мила обрано кукурудзяну, рицинову олії та пальмове і кокосове масла та арганову олію. Омилення олій проводили розчином натрію гідроксиду. Якість отриманих зразків оцінювали за органолептичними та фізико-хімічними показниками (якісне число (маса жирних кислот у перерахунку на номінальну масу куска 100 г), масова частка вільного їдкого лугу, масова частка содопродуктів у перерахунку на Na_2O, температура застигання жирних кислот (титр), масова частка хлориду натрію).

Результати та їх обговорення. За показниками числа омилення обраних компонентів жирової основи мила, яке містить 43,8 % пальмового та 25 % кокосове масло, 6,2 %, кукурудзяної та 25 % рицинової олії і забезпечує необхідні консистентні властивості, пластичність мила, високу розчинність і піноутворення в холодній воді, розраховували кількість лугу, необхідну для одержання мила. За результатами визначення споживчих властивостей мила обрано концентрацію ароганової олії. В результаті дослідження органолептичних і фізико-хімічних показників мила з 5 та 10 % сапропелю встановлено, що мило, отримане холодним методом, відповідає нормам для мила марки «Спеціальне» з дезінфікуючими або лікувальними-профілактичними добавками.

Висновки. Запропоновано склад мила, що містить 5 та 10 % сапропелю. В лабораторних умовах апробовано холодний та гарячий методи одержання мила з сапропелем. Встановлено, що зразки, отримані холодним методом, відповідають вимогам нормативної документації на відміну від мила, отриманого гарячим методом, яке має незадовільні органолептичні показники.

Ключові слова**:** *сапропель; холодний метод отримання мила; антибактеріальне мило*

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Разработка состава и технологии мыла с сапропелем

Гигиеническая обработка рук является эффективным средством снижения распространения транзиторной микрофлоры и рассматривается в качестве одной из важнейших процедур для предотвращения передачи инфекций контактно-бытовым путем. Гигиеническая обработка рук является необходимой в заведениях общественного питания, лечебно-профилактических учреждениях, для лиц с пониженным иммунитетом в период сезонных заболеваний. Большинство антибактериальных мыл изготовлено на основе синтетических поверхностно-активных веществ с использованием синтетических антибактериальных добавок: триклозана, триклокарбана, фарнезола, бензалкония хлорида, пироктоноламина. Поэтому актуальным является разработка мыл, которые в своем составе содержат вещества природного происхождения.

Цель работы – создание мыла с сапропелем, которое бы обладало антибактериальным эффектом и удовлетворительными сенсорными свойствами.

Материалы и методы. Для изготовления мыла выбрано кукурузное, касторовое жидкие масла, пальмовое и кокосовое твердые масла и аргановое масло в качестве пережиривающей добавки. Омыления масел проводили раствором натрия гидроксида. Качество полученных образцов оценивали по органолептическим и физико-химическим показателям (качественное число (масса жирных кислот в пересчете на номинальную массу куска 100 г), массовая доля свободной едкой щелочи, массовая доля содопродуктов в пересчете на Na_2O, температура застывания жирных кислот (титр), массовая доля хлорида натрия).

Результаты и их обсуждение. По показателям числа омыления выбраных компонентов жировой основы мыла, которое содержит 43,8 % пальмового и 25 % кокосового масла, 6,2 % кукурузного, 25 % касторового масла и обеспечивает необходимые консистентные свойства, пластичность мыла, высокую растворимость и пенообразование в холодной воде, рассчитывали количество щелочи, необходимой для получения мыла. По результатам определения потребительских свойств мыла выбрана концентрация арганового масла. В результате исследования органолептических и физико-химических показателей мыла с 5 и 10 % сапропеля установлено, что мыло, полученное холодным методом, соответствует нормам для мыла марки «Специальное» с дезинфицирующими или лечебно-профилактическими добавками.

Выводы. Предложен состав мыла, содержащий 5 и 10 % сапропеля. В лабораторных условиях апробирован холодный и горячий метод получения мыла с сапропелем. Установлено, что образцы, полученные холодным методом варки мыла, соответствуют требованиям нормативной документации в отличие от мыла, полученного горячим методом, которое имеет неудовлетворительные органолептические свойства.

Ключевые слова*: *сапропель; холодный метод получения мыла; антибактериальное мыло

Hygienic treatment of hands is an effective means of reducing the spread of transient microflora and is considered as one of the most important procedures for preventing the infection transmission by the contact-household way. However, its effectiveness depends not only on the diligence and regularity of this procedure, but also on the quality of the cleaning agents used.

The problem of reducing the level of the transient microflora on hands is the subject of many studies. In recent decades, antibacterial soaps have become very popular. The use of antibacterial soaps for daily hygiene is debatable since the safety of antibacterial components is usually lower than the expected benefit of their use [1, 2, 3].

According to recent reports of the Food and Drug Administration (FDA) in the United States, triclosan and triclocarban and other antiseptic components (in total 19 items) must be removed from the composition of foamy agents intended for mass consumers with the purpose of daily care [3].

Among the forbidden substances particular attention should be given to triclosan, which is contained in more than 90 % of antibacterial and antimicrobial foamy agents, including the composition of soap, toothpaste, dishwashing detergents, cosmetics, kitchen utensils, toys, mattress covers, etc. In addition, it has been proven that triclosan shows its antibacterial effects only after a much longer exposure than a few seconds that most people spend on washing their hands [1, 4].

However, hygienic treatment of hands with an antibacterial soap is necessary in many cases: in public catering establishments prior the work with products, treatment and prevention institutions, during the work of nurses in schools and kindergartens, for immunity compromised patients, in the period of seasonal diseases, etc. [5].

Therefore, development of organic soaps containing natural substances in their composition is relevant. The main advantage of natural substances is their complex and soft action on the human skin, the absence of manifestations of side effects (allergies, peeling, etc.) and contraindications. These natural substances include sapropel, which is an organic raw material and has a marked antibacterial and antimicrobial effect [6, 7].

Currently, the Ukrainian market is presented by a sufficiently wide range of antibacterial soaps of domestic and foreign manufacture in various forms of production: solid, liquid and cream-soaps. However, as shown by the analysis of the antibacterial soap composition at the Ukrainian market, most of them is based on synthetic surfactants and has the following antibacterial components: triclosan, triclocarbanum, farnesol, benzalkonium chloride, pyroctonolamine, ionized and colloidal silver, medicinal plant extracts (cedar, cetera, celandine, lovers, sage, marigold, wood) and essential oils (eucalyptus, tea tree, citrus) [8].

It should be noted that synthetic surfactants can cause toxic effects in humans, they are often allergens. In addition, they interact with the cell cytoplasmic membrane, de-

polarize it, and it leads to the change in permeability of the membrane for certain substances and its destruction. Practically all surfactants used in the cleanser compositions are usually able to remove all fatty foods from the body surface, in particular a thin protective film that is formed by greasy and sweat glands of hair and skin. Surfactants affect the structural and functional state of the blood (hemoglobin, erythrocyte content, leukocytes, changes in the leukocyte formula), and in animals, as shown by the study, they affect the metabolic processes and the activity of a number of enzymes [9].

The aim of the work was to develop a domestic detergent with sapropel, which would have the antibacterial effect, a soft action on the skin and minimal side effects.

Materials and methods

The following plant oils were chosen for soap preparation: corn, ricin, as well as palm and coconut oils. Argan oil was used as a superfatting agent. Sodium hydroxide solution was used to saponify oils.

Coconut and palm oils are solid plant oils, which are classical components of the solid soap base providing the necessary consistency properties, soap ductility during treatment, high solubility and foam formation in cold water.

Corn and castor oils are used as a component of the soap fatty base to optimize the fatty acid content of the soap. Due to the plant oil introduction the soap base is more plastic, does not dry and crack in the process of storage and dry the skin coverings to a lesser extent. However, despite the presence of plant oils in the soap base it is expedient to use emollients that moisturize the skin, promote restoration of the skin lipid mantle. As an emollient, argan oil was used. It is rich in natural antioxidants such as polyphenols (56 mg / kg) and tocopherols, omega-6 polyunsaturated fatty acids, and sterols.

Polyphenols have the anti-inflammatory effect, and tocopherols protect the skin from the negative effects of free radicals. Due to the content of sterols that are not found in any other oil, it has the sedative and anti-inflammatory properties. It is effectively used in a number of dermatological diseases such as acne, psoriasis, eczema and mycosis, burns, scarring, etc.

As a natural antibacterial component of the soap sapropel was used, it was introduced to the soap composition in the amount of 5 and 10 %.

The quality of the soap samples obtained was assessed by the organoleptic and physicochemical parameters, according to SSTU 4537: 2006 by the methods of SSTU 790-89 [10, 11]. The qualitative number (the mass of fatty acids calculated with reference to the nominal weight of a soap bar of 100 g), the mass fraction of free caustic alkali, the mass fraction of sodium products calculated with reference to Na_2O, the temperature of fatty acid (titer) gelation, the mass fraction of sodium chloride) was assessed [10].

Results and discussion

Consumer properties (washing ability, foaming, skin softening, conditioning effect) and qualitative characteristics (fatty acid content, soap titer, expiration date, etc.) of the soap on a fatty base (solid or liquid) are laid at the stage of development of their composition. Consideration of the fatty acid composition of plant oils, observance of certain ratios between the components allows us to obtain products with the given properties. The soap quality also depends on the quality of the raw material from which it is made and observance of the technological process requirements.

When selecting components for making a solid soap on a fatty base the following requirements should be met: the soap should have a good cleansing ability, be nonirritant and should not dry hands, have satisfactory indexes of the foaming ability, and a long expiration date. Such properties are provided by a certain ratio of oils with the different fatty acid composition. To neutralize fatty acids and fat saponification, alkalis are used, preferably sodium hydroxide solution.

For making the soap the raw material, which meets the requirements of the current normative documentation, is used. Critical quality indicators for oils used in the soap preparation are the iodine number and the saponification number. The latter characterizes the content of groups that are able to react with alkali in fats and oils. The composition of the soap fatty base proposed contains palm (43.8 %) and coconut oil (25 %), corn (6.2 %), and castor oil (25 %). It is this ratio that provides the necessary consistency properties, soap ductility, high solubility and foaming in cold water. By the indicators of the saponification number the amount of alkali needed for soap was calculated.

As a superfatting agent in soaps the plant oils are used in the concentration of 4-10 %. Argan oil was selected, its content varied within the indicated limits and determined its effect on the soap consumer properties. The consumer properties were assessed by subjective indicators (the washing ability (1), foam formation (2), the skin condition: dryness (3) and skin sensation (4), softening effect (5) and skin moisturizing (6). These indicators were determined according the five-point scale: 1 – absent, 2 – expressed, 3 – clearly expressed, 4 – strong, 5 – very strong (Fig.).

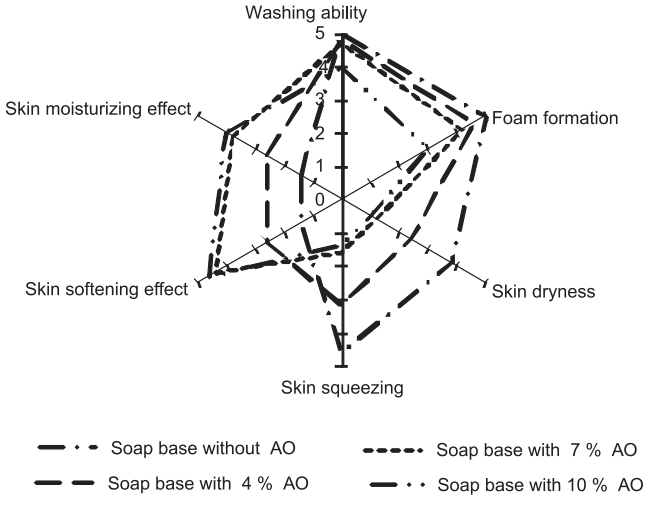

Fig. The soap sensory profile depending on the concentration of argan oil

The basis of making the soap is the saponification reaction that occurs when mixing the molten oil mixture and aqueous alkaline solution.

In the laboratory conditions the technology of obtaining the soap with sapropel was developed by the hot and cold methods.

When obtaining the soap by the classic hot method on a water bath solids were melted, liquid oils were added, heated to the temperature of about 60-70 °C. To the oil mixture the alkaline solution was gradually added while stirring, and then allowed to stand for 10 min. Further in several stages with intervals of 10 min a creamy consistency without stratification for 10 min was reached using a high speed mixer. The mass obtained was placed on a boiling water bath, covered with a lid and heated for 1.5-2 h while stirring every 30 min. The heating was carried out until the pH value of the sample was 7-8. The mass was taken from the bath, cooled to the temperature of 50 °C. Then argan oil and sapropel were added. The resulting mass were poured into forms and allowed to stand for a day.

Toilet soap prepararion by the cold method has several advantages, which consist in the fact that excipients, and in our case the antibacterial component, and the superfatting agent were added simultaneously. When performing this version of the technology the weighed coconut and palm oil were melted on a water bath, liquid oils were added, and heated to the temperature of about 60-70 °C. To the oil mixture the alkaline solution was gradually added while stirring. The temperatures of the components should be maximally the same – approximately 60-70 °C. The mixture was allowed to stand for 10 min, after that in several stages with intervals of 10 min a creamy consistency without stratification for 10 min was reached using a high speed mixer. After that, argan oil and sapropel were added, poured into forms, and left for a day. A day later, they were taken out of the form and left to "ripen" for 4-6 weeks to complete the saponification reaction.

In the samples obtained the organoleptic and physicochemical parameters were determined (the mass fraction of fatty acids, the mass fraction of free caustic alkali, the temperature of fatty acid gelation extracted from the soap (titer) and the mass fraction of sodium chloride).

The soap samples with the sapropel content of 5 and 10% obtained by two different technologies and the reference sample were examined for the organoleptic and physicochemical characteristics.

The results of the studies are presented in Tab. 1 and 2.

According to the results of the organoleptic parameter determination (Tab. 1) all samples of the solid toilet soap obtained by the hot method do not meet the requirements of SSTU 4537 : 2006 since there are cracks, stripes, effervescences and spots on the soap surface, the soap studied is heterogeneous in the section. When using the cold method for obtaining the soap by the organoleptic parameters the samples meet the requirements of the normative documentation.

The results of studying the physicochemical parameters of the soap experimental samples according to the requirements of SSTU 4537: 2006 are given in Tab. 2.

According to the test results the mass fraction of fatty acids in the soap sample 1 and 4 is 79-80 % (78.8 and 80.1 g of fatty acids per 100 g of the soap, respectively). When dissolving the soap samples in hot water there were spots of the fatty herbal raw material formed on the surface. It may indicate that saponification of the fatty raw material was not completed.

The results of determination showed the absence of free caustic alkali in the soap samples, but this did not guarantee that the alkaline saponification of the fatty herbal raw material was completed. Despite the fact that

Table 1

The results of studying the organoleptic parameters of the soap samples

The sample studied	Organoleptic parameters of the samples studied
The normative indicator	In the section it is homogeneous. The surface of the soap bar is with a pattern or without it. Cracks, stripes, effervescence, spots are not allowed on the soap surface. The stamp must be clear. The shape of a soap bar is according to the technical description for the soap with a specific name. The color is according to the technical description for the soap with a specific name. The odor is according to the technical description for the soap with a specific name
Cold method of soap obtaining	
Solid toilet soap without sapropel	In the section it is homogeneous. The surface of the soap bar is with a pattern. Cracks, stripes, effervescence, spots are absent on the soap surface. The stamp is absent (a laboratory sample)
Solid toilet soap with 5 % of sapropel	In the section it is homogeneous. The surface of the soap bar is. Cracks, stripes, effervescence, spots are absent on the soap surface. The stamp is absent. Odorless
Solid toilet soap with 10 % of sapropel	In the section it is homogeneous. The surface of the soap bar is without a pattern. Cracks, stripes, effervescence, spots are absent on the soap surface. The stamp is absent. Odorless
Hot method of soap obtaining	
Solid toilet soap without sapropel	In the section it is heterogeneous. The surface of the soap bar is without a pattern. There are cracks, stripes, effervescence, spots on the soap surface. The stamp is absent. Odorless
Solid toilet soap with 5 % of sapropel	In the section it is heterogeneous. The surface of the soap bar is without a pattern. There are cracks, stripes, effervescence, spots on the soap surface. The stamp is absent. Odorless
Solid toilet soap with 10 % of sapropel	In the section it is heterogeneous. The surface of the soap bar is without a pattern. There are cracks, stripes, effervescence, spots on the soap surface. The stamp is absent. Odorless

Table 2

The physicochemical indicators of soap with sapropel

The name of indicators	Standard indicator*	The test results		
		Sample 1 without sapropel	Sample 2 with 5 % of sapropel	Sample 3 with 10 % of sapropel
Hot method of soap obtaining				
The qualitative number (the mass of fatty acids calculated with reference to the nominal weight of a soap bar of 100 g), g, not less than	74	79	74	74
The mass fraction of free caustic alkali ,%	absent	absent	absent	absent
The mass fraction of sodium products calculated with reference to Na_2O, %, not more than	0.15	absent	0.02	0.01
The temperature of the fatty acid (titer) gelation, °C	35-41	37	39	39
The mass fraction of sodium chloride, %	0.4	absent	absent	absent
Cold method of soap obtaining				
The name of indicators	Standard indicator*	Sample 4 without sapropel	Sample 5 with 5 % of sapropel	Sample 6 with 10 % of sapropel
The qualitative number (the mass of fatty acids calculated with reference to the nominal weight of a soap bar of 100 g), g, not less than	74	80	74	74
The mass fraction of free caustic alkali ,%	absent	absent	absent	absent
The mass fraction of sodium products calculated with reference to Na_2O, %, not more than	0.15	0.05	0.02	0.01
The temperature of the fatty acid (titer) gelation,°C	35-41	37	39	40
The mass fraction of sodium chloride, %	0.4	absent	absent	absent

Note: * – The Standard parameter for "Special" (S) soap with disinfectant or therapeutic additives (T).

according to the parameters the soap obtained meets the quality indicators, it has unsatisfactory organoleptic properties, namely there are cracks, stripes, effervescence, spots on the soap surface.

As a result of the quality control and the study of the organoleptic and physicochemical parameters of the soap containing 5 and 10 % of sapropel such as the qualitative number (the mass of fatty acids calculated with reference to the nominal weight of a soap bar of 100 g), the mass fraction of free caustic alkali, the mass fraction of sodium products calculated with reference to Na_2O, and the mass fraction of sodium chloride (Tab. 2) it has been found that the solid toilet soap obtained by the cold method meets the standards for soap brands listed in SSTU4537: 2006 "Solid toilet soap. General technical conditions", namely "Special" (S) soap with disinfectant or therapeutic additives.

CONCLUSIONS

1. The composition of the soap base containing palm and coconut oils, corn and castor oils, argan oil as a superfatting agent and sapropel in the amounts of 5 and 10 % has been proposed.

2. In the laboratory conditions the cold and hot methods for obtaining the soap with sapropel have been tested.

3. The properties of the experimental soap samples have been studied. It has been found that the soap with 5 and 10 % of sapropel obtained by the cold method meets the requirements of SSTU4537: 2006 "Solid toilet soap. General technical conditions", but the soap obtained by the hot method has the unsatisfactory organoleptic parameters.

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