Study of Physical, Chemical and Consumer Properties for Development of Dental Gel Basis Aimed to Cure of Parodont Diseases

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Abstract

The modern range of products for cure of parodont diseases is mostly represented by liquid medical forms (solutions, tinctures, liquid spirit extracts) and by ointments and gels. The largest number of advantages belongs to medical forms such as hydrophilic gels due to their ability to reduce the puffiness, to be well-distributed on the mucous membrane creating the local therapeutic concentrations, and their use is convenient. Nowadays the market of Russian Federation is represented by gels, which basis are the rare-stitched acrylic polymers, ethers of cellulose and soluble recipients. Among them no natural bases were identified and in particular, the pectin. In pharmaceutical technology, apple pectin is the most commonly used natural thickener. The apple pectin is a complex ether of methanol and pectic acid. Many important properties belong to apple pectin which can be explained by presence of the free carboxyl and hydrocarboxyl groups from galacturonic acid. This article provides the results of the technology development of gel based on apple pectin. Physical, chemical and consumers properties of the gel were also studied in the framework of this article.

Introduction

These days the rate of parodont diseases has strongly increased, so this situation obtained the status of social and general medical problem, which takes place to be among 98% of adult population [1].

All the elements of parodont might trend to inflammatory processes. Such statuses are commonly named the parodont diseases. The direct reason for chronical inflammatory processes of parodont is the microbial plaque. Based on the scientific popular research, the following microbial species are identified in the mouth:

- *Porphyromonas gingivalis, Bacteroidies forsihus, Treponema denticola.*
- *Streptococcus sanguinis, Streptococcus mitis, Streptococcus oralis u ðp.*
- *Actinomyces odontolyticus, Actinomyces naeslundii, Veillonella parvulla.*
- *Prevotella intermedia, Fusobacterium nucleatum, Campilobacter rectus.*

That strongly explains why the modern medicines for cure of parodont diseases should contain the components that perform the antimicrobial effect [2,3].

Various groups of medicines are used in modern medicine to cure the dental diseases, but the fundamental medical group is consisted of antibacterial medical drugs. For parodont cure the preference is given to the medicines that both are effective and don't perform the severe side effects. Such medicines can be classified as the medicines obtained from products of natural origin [4].

Currently the pharmaceutical market does not have a sufficient number of dosage forms based on medicinal plant materials. In the dental gels registered in the pharmaceutical market of the Russian Federation (Dentinox, Kamistad, Pansoral, Parodium), the composition is represented by extracts of chamomile flowers, Althea grass, and Rheum. However, among the medicinal plant materials, *Juniperus communis L* is the most important and promising for dental practice [5,6,7]. The presence of terpene compounds in the composition of the etheric oils that make it possible to use them as effective antimicrobial agents. The antimicrobial action of etheric oils is based on the fact that some of their components affect the integrity of the cell membrane, which increases its permeability (especially cyclic terpene compounds). As a result, the cellular structure is destroyed, the function of the bacterial enzyme system is disturbed, and oxygen penetration and synthesis of structural components of the cell worsens. Microbial cell dies. To date, no dental products containing extracts from juniper cones have been registered on the pharmaceutical market of the Russian Federation.

The most suitable for the preparation of dental gels are hydrophilic gelling agents. These bases have a high mucoad-geesivity, that is, the ability to stay on the mucous membrane, the method of localizing the action of the active components of the drug, on the one hand, and

prolongation of their pharmacological effect - on the other. Hydrophilic gel forcing agents quite easily incorporate many medicinal substances and promote their good release. In addition, the use of hydrophilic bases allows regulating the biopharmaceutical and structural-mechanical properties of dental gels in the required range. [8,9,10]

Objects and Methods of Research

The materials used in experimental research are shown in table 1.

Table 1. Characteristics of pharmaceutical substances

N	Substance name	Brand, normative document
1	Apple pectine	ТУ 9197-011-83387545-13
2	Juniperus etheric oil*	LLC «Aspera PK», «Rainbow Aromas », «Mirolla Nature», «SINAM», TP/TC (Technical Regulation Customs Union) 009/2011, TU (Technical Conditions) 9151-001-48538080-2005

* Due to the high content of characteristic components in the essential oil of juniper manufacturer "Rainbow Aromas", as compared with the tested samples, the further oil will use the essential oil of the manufacturer "Rainbow Aromas" [11].

Methods of the research: physical and chemical, technological, consumer properties study.

Results and Discussion

The technological development of the gel is shown in table 2.

At the beginning of the experiment, three samples of pectin with masses of 1.0; 3.0; 5.0 g (samples 1-3) were weighed. Each sample was dissolved in 50 ml of purified water in various temperature ranges: 20 ° C (room temperature), 50 ° C (warm), 80 ° C (hot). Pectin was input into a heat-resistant chemical glass installed on a heating pad of a heated magnetic stirrer and the heating function was turned on. When the required temperature was reached, a portion of the substance was gradually added in the glass, and turned on the mixing. Homogeneous consistency was achieved by dissolving pectin in water with a temperature of 80 ° C. Subsequently, the remaining 50 ml of purified water were added to the glass with the dissolved pectin at room temperature. Stirring was performed for next 30 minutes. It was determined that samples 1-3 are pectin solutions of liquid consistency.

It was defined that in further studies it's rational to dissolve pectin in 50 ml of purified water at the temperature of 80 °C and fill it to 100 ml after dissolving pectin with purified water in the conditions of room temperature.

To obtain a jelly-like consistency, pectin in a mass of 7.0 was dissolved in water; 10.0; 15.0 (samples 4-6).

As can be seen from table 2, pectin with a concentration of 10% has a jelly-like consistency.

Table 2 . Technology development of manufacturing of gel

N sample	Pectin mass, g	Water volume, ml: V sum = V wat at T (20℃, 50℃, 80℃) +V water at room T (15-25℃)	Water temperature, °C	Results
1	1.0	100=50+50	20/50/80	Liquid consistency
2	3.0	100=50+50	20/50/80	Liquid consistency
3	5.0	100=50+50	20/50/80	Liquid consistency
4	7.0	100=50+50	80	Liquid consistency
5	10.0	100=50+50	80	Gelatinous consistency
6	15.0	100=50+50	80	Pectin was not dissolved at all

As can be seen from table 2, gelatinous consistency is obtained by sample 5 – 10% pectin solution.

The manufacturing technology for the gel is based on the following method: on electronic scales with an accuracy of up to 0.001 g, an exact mass of apple pectin 10.0 g was weighed in accordance with the required concentration of the gel. 50 ml of purified water was measured into a heat-resistant chemical glass and placed on a heating pad with a magnetic stirrer with heater unit. The heating function was turned on. After the water temperature reached 80-90 °C, the heating unit was turned off, but the stirrer was turned on. The required mass of pectin

(10.0 g) was gradually input into a glass by small portions. Stirring was performed for 30 minutes, after which the solution of apple pectin was adjusted to 100 ml with purified water, mixed thoroughly and left at room temperature until it's completely cooled. The gel base was considered to be properly prepared if particles of insoluble substance were visually absent in transmitted light.

The table 3 represents the organoleptic properties of the sample 5 (10% pectin solution).

The organoleptic properties of 10% pectin gel

Gel content	Description
Apple pectin 10.0 g Purified water ad 100 ml	Viscous, plastic, resilient, with good spreading, homogeneous gel, with a low degree of transparency, odorless and tasteless

At the next step of the study, the kinematic viscosity of the pectin gel of 10% (9.04 cSt) was studied and it was determined that apple pectin meets the requirements in the rheological optimum and has the specified structural and mechanical properties. Testing of pH of the water extract (5.8) allowed to establish, that 10% gel based on apple pectin is in the optimal range (5.5–7.5) for dental gels.

Further, the consumer properties (covering ability and spreadability) of gel with apple pectin were studied, the methods of determination of which are not standard and prescribed for dental gels, but are applicable to soft dosage forms that have a direct connection with the developed gel, shows a directly proportional dependence of smearing on the oral mucosa on the consistency. The higher the percentage of application of the sample to the substrate, the softer the smear.

The covering ability was determined by a relative index with the help of a modified technique, where smears of a dental gel were applied onto a previously weighed substrate (a piece of filter paper 2 cm^2 in area) three times in the same place. The coating (applied layer) was examined for uniformity, absence of irregularities, weighed on an analytical balance, erasure was imitated by laying filter paper on the substrate and rolling a weight of 500 g over it.

The percentage of application (resistance) was calculated by the formula 1.

$$X = \frac{m-m2}{m-m1} \times 100\ \% \qquad (1)$$

where m – the initial mass of the substrate with the applied layer

m_1, m_2 – respectively, the mass of the substrate without coating and coated after erasing.

The result of the study was 21.4%. This result indicates that when applying the dental gel, a soft smear will be applied and the gel will be evenly distributed on the oral mucosa.

The spreadability index was determined by two methods, presented in table 4.

Table 4. Evaluation of spreadability for 10% pectin gel

N	Method descriprion	Results
1	The initial diameter of the test sample is measured (weighing 1.0 g), which is placed between two glass plates measuring 10*10 cm. A load (1000 g) is placed on top for 10 minutes, after which the resulting spot diameter of the crushed sample is measured.	The sample has a soft consistency and easy ability to spread, because the size of the spot after the load doubled (the diameter of the initial 20 mm, after exposure to the load 38 mm
2	Determine the smear on the surface of the body.	Sample has a good spreadability

Conclusion

10% pectin gel represents viscous, plastic, resilient, with good spreading, homogeneous gel, with a low degree of transpar-ency, odorless and tasteless. The sample has a soft consistency and easy ability to spread. Sample has a good spreadability and will be evenly distributed on the oral mucosa.

Apple pectin can be used in the production of stomatologic gels because it forms a homogeneous gel system with a pH (5.8) and kinematic viscosity (9.04 cSt), is easily spread and equally distributed on the oral mucosa.

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