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Original Article

Pharmacotechnical development and evaluation of the physicochemical stability of a cosmetic gel from *Aloe vera* mucilage

Kellvin Costa Maciel, José Tarso Gabriel de Oliveira e Sousa*, Stéphanie Camilla Vasconcelos Tavares, Bianca Lorena Bernardo Silva, Bárbara Myllena Alves Silva, Ellison Neves de Lima, Carlos Eduardo Miranda de Sousa

Caruaru, Pernambuco, Brazil

***Correspondence to**
José Tarso Sousa, Email: josetgabriel3@gmail.com

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Abstract

Background: *Aloe vera* is a medicinal plant of the family *Xanthorrhoeaceae* found in tropical regions, better known as slug. It has medicinal and cosmetic properties. The present work aimed to develop a gel based on *Aloe vera* with cosmetic action in capillary application.

Materials and Methods: A qualitative and quantitative analysis of the following components was used for the development: Carbomer, propylene glycol and methylparaben in order to identify the best formulation. The samples were made in triplicate and stored in three different conditions: hothouse, refrigerator and room temperature, where they were submitted to tests. The data obtained were used to evaluate the organoleptic and physicochemical characteristics.

Results: The results obtained from the organoleptic characteristics presented variations and instability in their color, odor and appearance. The formulations presented different results even the samples being exposed to the same conditions. Only one formulation underwent changes considered significant having the need for stabilization of its physicochemical constituents. And the others presented satisfactory results to our research.

Conclusions: When evaluating the physico-chemical characteristics, we analyzed the pH, density and spreadability of each sample and no formulation presented significant changes where they remained within the range of values established by the quality control guide for cosmetic products of the Agencia Nacional de Vigilância Sanitária (ANVISA).

Keywords: Formulation, *Aloe vera*, Xanthorrhoeaceae

Background

From the Xanthorrhoeaceae family, *Aloe vera* meaning 'true bitter' and brilliant substance, popularly known as *Aloe vera* found in tropical regions. Due to the presence of vitamins and nutrients presents properties for cosmetic and medicinal purposes. It is an ancient plant whose name derived from Greek ('aleo'), Hebrew (halal) and Arabic (alloeh). In ancient Egypt it was known as the "plant of immortality", used by Cleopatra in hair and skin care.[1]

Inside the leaves of Babosa has stored a gelatinous pulp, known as gel, and it is this part and substance of the plant that is used in folk medicine. Mainly made up of water and polysaccharides, plus 70 other components such as vitamin A B, C and E, calcium, potassium, magnesium and zinc, various amino acids, enzymes and carbohydrates.[2] The processing of these leaves should be done soon after harvest, because the gel quickly oxidizes when it comes in contact with air.[3]

Gel is a semi-solid pharmaceutical form of one or more active ingredients that contains a gelling agent to provide firmness to a colloidal solution or dispersion (a system in which colloidally sized particles are evenly distributed throughout the liquid), where such a gel may contain suspended particles.[4] Hydrophilic gels have been widely used in cosmetic products and as a dermatological base because they are easy to spread, non-greasy and may carry water-soluble, fat-soluble active ingredients (in association with solubilizing agents) and liposomes.[5]

For gel formation some accelerated stability tests are employed after product finalization, such as pH verification, storage at different temperatures and analysis of organoleptic characteristics (color, odor and appearance). Performing stability studies serves as a predictive tool for possible deviations in the efficacy and safety defined for the product during its development.[6] Carbomer as a polymer acts as a suspension that slows down sedimentation and agglomeration of particles by acting as an energy barrier that minimizes attraction between and aggregation of particles, thereby increasing viscosity and improving suspension stability.[7]

Despite the vast number of articles that correlate *Aloe vera*'s medicinal properties as well as their

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applications, the amount of writings contained in the literature on pharmacotechnical development as well as physicochemical stability testing are excipients. Thus their work aimed to develop a cosmetic gel based *Aloe vera* with cosmetic action in the hair application, describing the results of the organoleptic properties presented by the product and its physicochemical properties for use of the product.

Materials and Methods

The experiment consisted of an experimental elaboration developed in the Laboratory of Pharmaceutical Technology, Biosciences and Health (LaFarBios). The plant was obtained from a domestic plantation, cultivated and collected by the researchers themselves. Obtaining base substances such as Carbomer was handled by Pharmaspecial of Japanese origin. Propylene glycol handled by the Korean company ENFAL and ىٔ ethylparaben handled by the Japanese company ENFAL. In the present study it was observed the interference of certain ingredients on the stability of the cosmetic gel, where it was observed alteration in the durability of the product due or not of the presence of some ingredients contained in the formula.

Sample processing (Aloe vera)

Aloe vera leaves were harvested, washed with running water, dried with filter paper, peeled (separating the mucilage contained within the plant from its bark). The shell was discarded and the mucilage ground in a blender for 5 minutes and finally in a container waited for the liquid to settle.

Sample Preparation

After handling, the formulations were placed in their proper packaging, all identified and later exposed in the pre-established conditions (Table 1). To carry out the tests with the formulations it was necessary to produce 150 g of each one of them.

Physicochemical characterization and evaluation of organoleptic characteristics of formulations

Stability study

The samples were subjected to accelerated stability studies according to the procedures described in the Cosmetic Products Stability Guide of the National Health Surveillance Agency (ANVISA), being stored at ambient temperature (20-25°C); refrigerator (3-8°C) and hothouse (40°C) to evaluate appearance, color, odor, pH and spreadability within 24 hours, 10, 20, 30, 50, 70, 90 days after formulation production, following reference to the sample initially evaluated.

Table 1. Ingredients Used in the Formulations

	Constituents
Formulation 1	*Aloe* (*Aloe vera*) leaf extract (50 g), Carbomer (0.5g), propylene Glycol (3.2 g), methylparaben (0.075 g) and aminomethyl propanol (q.s.).
Formulation 2	*Aloe* (*Aloe vera*) leaf extract (50 g), Carbomer (0.5 g), methylparaben (0.075 g) and aminomethyl propanol (q.s.).
Formulation 3	*Aloe* (*Aloe vera*) leaf extract (50 g), Carbomer (0.5 g) and aminomethyl propanol (q.s.).

Organoleptic aspects

These are procedures performed to evaluate the formulation characteristics detected by the sense organs such as appearance, color and odor. The appearance is visually detected by checking for any changes in formulation such as precipitation, turbidity, phase separation. The odor is verified by the sense organ and the color analysis is verified by visual or instrumental mode.

pH study

For pH verification, the pHmeter was used, with a previously calibrated apparatus with standardized solutions with pH = 7 and pH = 4, the data were subjected to analysis of variance.

Spreadability study

Determination of spreadability was performed according to methodology as described in the literature by Knorst.[8] The equipment used to determine the spreadability consists of a circular glass mold plate with a central hole of 1.2 cm in diameter where it was placed on a glass support plate positioned on graph paper. The sample was introduced into the hole of the mold plate and leveled with the aid of a spatula. On the sample was placed a glass plate of known weight. After one minute the diameters covered by the sample were read in opposite positions, using the graph paper and then the average diameter was calculated. This procedure was repeated by adding the predetermined weighted glass plates at one minute intervals from one plate to another. The spreadability is obtained from the calculation below:

$$Ei = d^2 . \pi / 4$$

where: Ei = sample spreadability for a given weight *i* (mm^2) and d = mean diameter (mm).

Density study

For the determination of the density was used syringe and analytical balance, determining the apparent density of the formulated products. The density calculation is made by dividing the object's mass by its volume.

$$Density = mass/volume$$

Results and Discussion

Organoleptic aspects

The development of sustainable and economically viable products is increasing. Aloe sterol intake induced a significant increase in skin hydration and stimulates

hyaluronic acid production and hyaluronic acid synthesis in human dermal fibroblastos.[9] Therefore the gels were formulated aiming at obtaining a low cost product, easy handling, with characteristics of good stability and capillary hydration.

In the stability evaluation of the formulations, preliminary stability tests were initially performed. These tests aimed to provide an idea of the quality of the product relative to its formulation, indicating the need or not to improve pre-formulations. As the preformulations studied were approved at this stage, they were considered adequate.

The products were submitted to physicochemical tests and analysis of organoleptic characteristics, where the bases used (F1, F2, F3) remained stable presenting normal and Accelerated stability, corresponding to 90 days with samples subjected to stay at standard temperatures over a certain period of time according to the ANVISA. The organoleptic characteristics of the formulations showed changes observed in the final product evaluation, which may compromise the product. Physicochemical aspects within the analysis times (time zero and 24 hours).

The results obtained from the organoleptic characteristics showed variations and instability in their color, odor and appearance at the end of the analysis, but the results were satisfactory for the research. As shown in Table 2 for formulations F1, F2 and F3, different results exist even when samples are exposed to the same conditions. The alterations of formulations F1 and F2 were not significant, however, the formulation based on F3 underwent changes that are considered significant, showing mold under all exposed conditions. Nevertheless, shampoos and hair conditioners are non-sterile topical cosmetics, which admit a limited number of viable non-pathogenic microorganisms.[10]

Changes in formulation F3 began within 24 hours with minor changes in color and odor. In this case, the changes may have as a source of contamination the operators handling the raw materials, the raw material itself, the equipment processing the raw materials, the environment or a combination of these factors.[11] These changes were intensified throughout the study, which led to the exclusion of the formulation in 90 days due to instability, which suggests the need for physical-chemical stabilization of its natural constituents. destruction caused by oxidation, oxidizing substances are employed.[12,13]

Table 2. Organoleptic Characteristics of Samples Submitted to 40ºC in Hothouse, Refrigerator (3-8ºC) and Ambient Temperature (20-25ºC)

	Color			Odor			Aspect		
	F1	F2	F3	F1	F2	F3	F1	F2	F3
Zero time	S	S	S	S	S	S	S	S	S
Rom temperature	S	S	S	S	C	S	S	S	S
Refrigerator	S	S	S	S	S	C	S	S	S
Hothouse	S	S	S	S	C	S	S	S	S

S= Standard, C= Changed.

Physical and chemical characteristics

Determination of density

Figure 1 below presents the formulations under analysis exposed to various conditions, according to the Cosmetic Stability Guide (ANVISA). The results of the stored samples show increase and decrease with few changes in the analysis time intervals. Thus, there are no significant changes in determining the density of formulations where the other values are within the standards described by the ANVISA. Thus, the formulations are considered fit to continue the study.

Determination of pH

Table 3 contains the pH result of formulations F1, F2 and F3 at different exposed temperatures. The pH results are between 4.5 and 6.0, not presenting significant alterations, where they remained within the pH range of the values established by the Cosmetic Products Quality Control Guide of the ANVISA. For the purpose of capillary application.

Determination of spreadability

The spreadability assessment is used to evaluate possible changes in formulation characteristics under different storage conditions during the study. Spreadability is one of the essential characteristics of pharmaceutical forms intended for semi-solid topical formulations, quantification of this parameter is important for accompanying changes in the formulation's ability to spread in a given area as it is closely related to the application of these formulations in action site that may facilitate or hinder its application, distribution and/or absorption through the skin.[14]

The spreadability values obtained for the formulations (F1, F2 and F3) after 90 days under ambient temperature

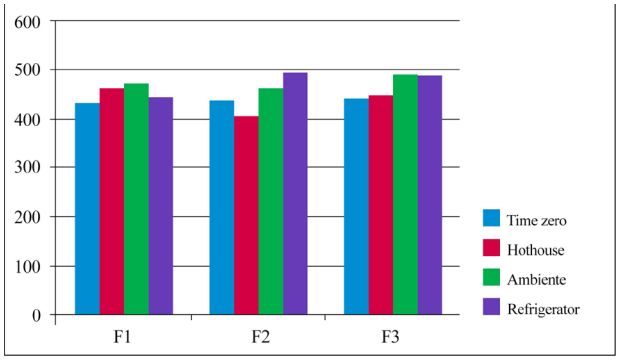

Figure 1. Initial and Final Base Spreadability as a Function of Added Weight. T0 = Time 0 /T90 = Time 90 /F1= Aloe (Aloe vera) leaf extract, Carbomer (0.5g), propylene glycol, methylparaben, aminomethyl propanol. F 2 = Aloe (Aloe vera) leaf extract, Carbomer, methylparaben, aminomethyl propanol. F 3 = Aloe (Aloe vera) leaf extract, Carbomer, aminomethyl propanol.

Table 3. pH of the Formulations (F1, F2, F3)

	Hothouse			Refrigerator			Ambiente		
	F1	F2	F3	F1	F2	F3	F1	F2	F3
Team zero	5,4	6,0	5,3	4,9	5,0	5,1	5,3	4,8	5,3
24 hours	5,3	5,5	5,1	5,0	4,7	4,7	5,2	4,7	5,0
10 days	5,3	5,4	5,1	4,9	4,9	4,7	4,9	4,8	4,4
20 days	5,3	5,4	5,5	4,9	4,6	4,8	4,9	4,8	5,5
30 days	5,3	5,4	5,5	4,9	4,6	4,8	4,9	4,8	5,5
50 days	5,3	5,4	5,8	5,0	4,8	5,1	4,9	4,8	5,6
70 days	5,4	5,3	5,6	4,9	4,5	5,0	5,0	5,6	5,4
90 days	5,2	5,3	6,5	4,7	4,5	4,9	4,9	4,8	5,4

F1 = Aloe (Aloe vera) leaf extract, Carbomer, propylene glycol, methylparaben, aminomethyl propanol. F 2 = Aloe (Aloe vera) leaf extract, Carbomer, methylparaben, aminomethyl propanol. F 3 = Aloe (Aloe vera) leaf extract, Carbomer, aminomethyl propanol.

conditions (20-25ºC); refrigerator (3-8ºC) and hothouse (40ºC) represented in Figure 2 revealed similar behaviors in the different conditions to which they were submitted, where the results do not present significant alterations, thus not impairing the quality of the formulations.

Conclusions

It was found that the formulations (F1, F2 and F3) showed no signs of physicochemical changes at room temperature, hothouse and refrigerator. The alterations of formulations F1 and F2 were not significant in their organoleptic characteristics, however, the formulation F3 presented significant alterations in their organoleptic characteristics as presence of mold and color and odor changes in refrigerator temperature (3-8ºC), suggesting the need physicochemical stabilization of their natural constituents with the addition of antioxidants. However, further studies are still needed in future evaluations, in order to obtain more detailed information about the useful life of the product plus the cosmetic gel from the mucilage contained in the *Aloe*.

The results obtained in this work, under the conditions and parameters analyzed, it was possible to conclude that the precaution that should be observed in relation to the storage of it is kept at room temperature (20-25ºC), protected from light, heat and humidity.

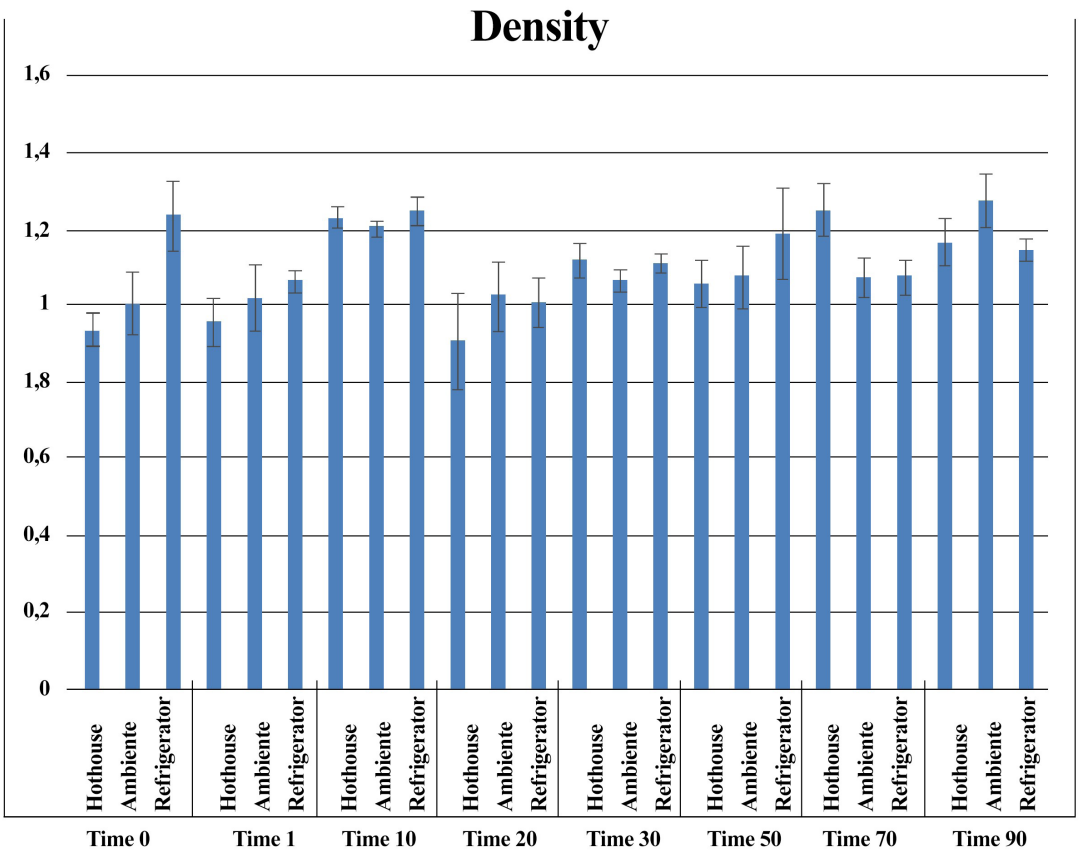

Figure 2. Density Variation of Samples Subjected to Accelerated Stability.

Formulations in which the organoleptic characteristics remained unchanged and no change in color, odor and texture of the preparations was found. Formulations that significantly increased the aqueous content of the capillary, thus fulfilling the function for which it was developed, and need to be further studied.

Competing Interests

None.

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