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Development of a Moisturizing Cream based on Prickly Pear Seed Oil

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Abstract

In this work, we developed a moisturizer based on prickly pear seed oil, highly valuable oil for its anti-aging benefits on the skin.

To achieve this, we conducted several research studies and analyses. First, we studied the raw materials: prickly pear seed oil, Shea butter, and surfactants, in order to create a stable oil-in-water emulsion. In the second part, we performed several tests and analyses: a centrifuge test, which allowed us to choose the right surfactants for a better emulsion; a pH test, which assesses the effectiveness of the cream produced. This is often considered a significant parameter in order to ensure a cream's pH is close to that of human skin; viscosity measurement determines whether it is viscous enough to be "sticky" or easy to spread; and finally, we performed five antibacterial tests: enumeration and detection of mesophilic aerobic bacteria, enumeration of yeasts and molds, Staphylococcus aureus, detection of Pseudomonas aeruginosa, and detection of Escherichia coli. From this, we obtained our glossy, white, highly viscous moisturizer with a pleasant odor that poses no harmful effects on human skin.

Keywords: *Prickly Pear Seed Oil, Moisturizer, Skin, Shea Butter, Emulsion.*

I. Introduction

The skin is defined as the outer covering of the mammalian body [1]. In humans, it occupies approximately 1.8 m² of surface area and represents 16% of the total body weight [2, 3]. It has three superimposed tissues in its structure: the epidermis, the dermis and the hypodermis. The dermis is the site of insertion of the skin appendages, represented by the appendages (hair and nails), the sebaceous glands and the sweat glands [4].

The skin has many functions mainly involved in maintaining the body's homeostasis, and in particular in thermoregulation and defense against external aggressions [5, 6]. It also plays a role in sensory and metabolic functions such as the synthesis of vitamin D [7].

For a long time, natural cosmetics remained unattractive, but today, against all expectations, they are experiencing a real boom among consumers. This means that the beauty industry is undergoing a complete revival, with the rise of natural products [8]. Therefore, we thought of formulating emulsions based on a natural product (prickly pear oil), Rich in vitamin E, omega-6 and sterols makes this precious oil an exceptional ingredient for fighting the signs of skin aging. It works wonders for maintaining the suppleness and tone of the skin [9]. Emulsions are thermodynamically unstable formulations. Knowledge of emulsion stabilization mechanisms and the development of new formulations are therefore of great importance; for this purpose, all tests were characterized microscopically, physico-chemically and rheologically. The formulation of these emulsions is based on the addition of the following excipients: water (aqueous phase), prickly pear seed oil (oily phase).

II. Material and methods

Prickly pear seed oil (PPSO) has been purchased from a Vegetable Oils Extraction, Micro-Enterprise, Algeria.

Shea butter was purchased from a store under the Commercial name "BEURRE ROYAL" in Bejaia, Algeria. This version of Shea Butter is a raw, unrefined, and undeodorized quality.

Vaseline oil was purchased from a store under the Commercial name "ELEIS" in Bejaia, Algeria.

Xanthan Gum in fine powder form, Loss on drying (%): 15. PH (1% solution): 6.0-8.0.

Glycerol (MW=92.09) was used to ensure optimal stability and reliability of the cream.

Polysorbitale 80 and Sorbitan monoaleate:

- Tween 80: is a non-ionic surfactant solution used as a supplement in various culture media in a laboratory setting. The name "Polysorbate 80" is a synonym for Tween 80, which has an HLB of 15.
- Span 80: Named polysorbate 80, it is a nonionic surfactant and emulsifier often used in foods and cosmetics. This synthetic compound is a viscous yellow liquid that is soluble in water.

Phenoxyethanol (MW=138.16), it is a synthetic preservative (prevents the development of microorganisms).

II.1. Preparation of the emulsion

We chose to formulate aqueous emulsions of the oil-in-water (O/W) type for their good tolerance, their strong penetrating power (unlike W/O emulsions which are weak), thanks to the auxiliary substances (wetting surfactants and emulsifiers) and since they are washable with water, which is not the case for W/O emulsions [10,11].

O/W emulsions undergo more transformations from the vehicle after application:

Friction causes the aqueous phase to evaporate, resulting in a cooling effect. Because these emulsions do not leave an oily film on the skin's surface, they can release lipophilic materials into the skin as well as water-soluble molecules from the continuous phase.

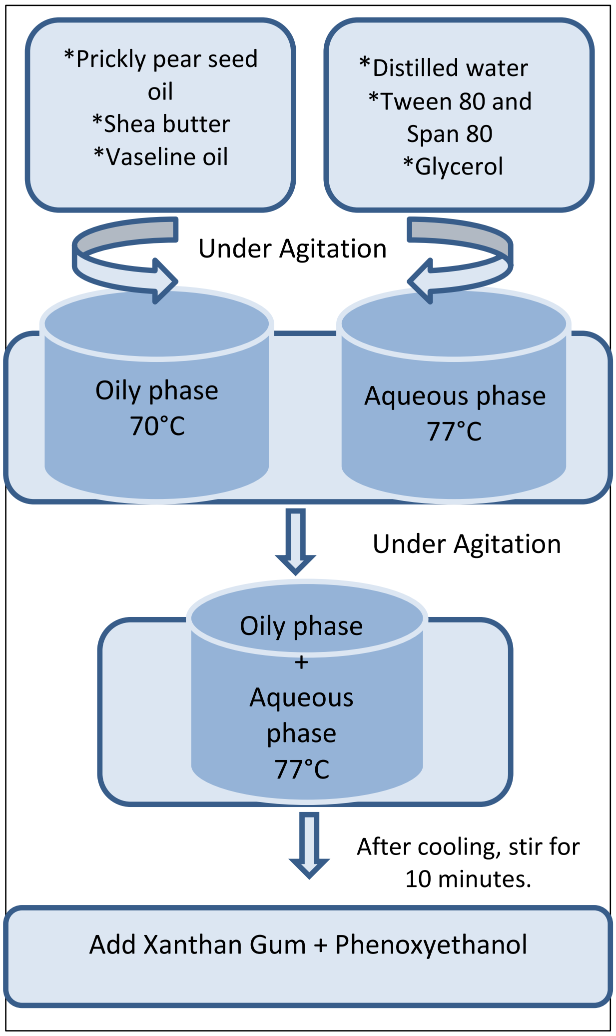

Figure1: Experimental protocol

II.1.1. Amount of Span 80 and Tween 80

The required amount of surfactants (Tween 80 and Span 80) in the formulation of each emulsion test was imposed by respecting the equation, giving the HLB of the mixture of two surfactants of different HLB [12].

$$HLB_{mixture} = [HLB_A * X_A + HLB_B (100-X_A)] / 100.$$

II.2. Formulation test

The aim of this section is to optimize the various proportions of compounds used in the formulation. To achieve this, we use the design of experiments method, which allows us to plan formulation tests, streamline the number of trials, and ensure the quality of the results.

We worked on six formulations (F1-F6).

II.3. Characterization of emulsions

II.3.1. Centrifuge Test

The stability of our formulation over time and under rigorous physical conditions was determined using a centrifuge (NEUATION iFuge C4000) set at 4000 rpm for 20 min.

II.3.2. Potentiometric measurement (pH measurement)

Once the device is calibrated, first wash the electrodes with distilled water. Homogenize the sample, add a sufficient volume to the measuring container, and immerse the electrodes. Check that the pH meter reading remains stable after one minute. Then record the pH. The pH meter used in this section is from AZ Instruments.

II.3.3. Viscometric analysis

The active part of the viscometer (VISCO ^{TM}) is a vibrating rod driven by a constant electrical supply. The amplitude of the vibration varies according to the viscosity of the fluid in which the rod is immersed. Its digital display allows a direct reading of the viscosity.

II.3.4. Bacteriological analysis

In our work, carried out five tests anti-bacterial enumeration and detection of aerobic mesophilic bacteria, enumeration of yeasts and molds, Staphylococcus aureus, detection of Pseudomonas aeruginosa, detection of Escherichia coli [13].

a. Preparation of culture media

Liquefy the Muller Hinton culture media for bacteria in a 95°C water bath and keep supercooled in a 45°C incubator.

- Under a laminar flow hood, aseptically pour the culture media into Petri dishes at a rate of 15 ml per dish.
- Allow to cool and solidify at room temperature, and store under conditions that prevent any alteration of their composition.

b. Seeding

- Aseptically soak a swab with the microbial suspension.
- Wring the swab by firmly pressing and twisting the inner wall of the tube to remove excess suspension.
- Aseptically inoculate a Petri dish by gently rubbing the swab across the surface of the Muller Hinton in tight lines.

c. Disk deposit

- Aseptically remove a sterile 6 mm diameter disc using sterile forceps.
- Place the tip of the disc in contact with the cream solution of known concentration, which will be absorbed by capillary action.
- Place the disc, thus soaked in cream solution, on the surface of the Muller Hinton, in the center of the Petri dish.
- Incubate the dishes at 37°C for 24 hours for bacteria.

- The medium is then inoculated with a determined level of microorganisms and, after incubation, the presence or absence of culture is noted; reading can be visual or spectrophotometric, as the degree of inhibition is related to the turbidity of the medium.

III. Results and discussion

III.1. pH measurement result

The results obtained show that the pH values of the different formulations are relatively variable, ranging between (5.58 ≤ pH ≤ 6.17) and are grouped in the following table:

Table 1: Results of pH measurement.

Formulation	F1	F2	F3	F4	F5	F6	F7
pH	5, 58	5,52	5,00	5,59	6,55	5,70	6,17

The most important elements of chemical stability are performance in accelerated tests and pH kinetics. When it comes to cream efficacy, pH is often considered a significant parameter.
The pH of human skin normally ranges from 4.5 to 7, and 5.5 is considered an average pH of human skin.
According to the measurement, the pH of formula (F4) is 5.59, close to the pH of the skin.
We can therefore say that this formulation is compatible with our skin and presents no risk of irritation [13].

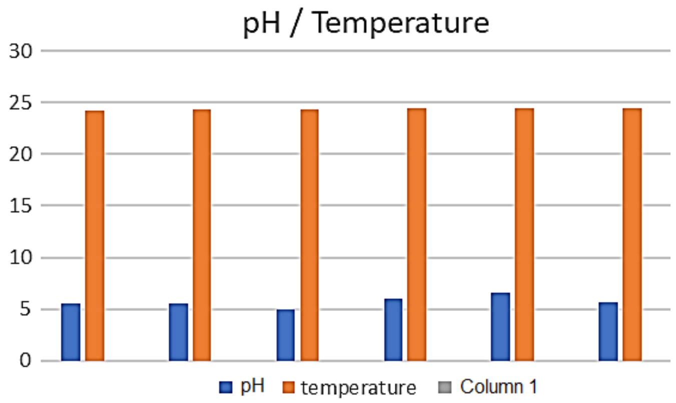

Figure 1: pH results a function of temperature.

III.2. Viscosity rate

Viscosity measurement allows us to know the flow properties of a formulation; the latter is sufficiently viscous, "sticky" or easy to spread [14]. The results of the measurement of the viscosity of the cream are shown in the following table:

Table 2: Viscosity rate measurement

Formulation	Viscosity (MPa.S)	Temperature (°C)
F 1	267	23,8
F 2	352	23,9
F 3	619	24,4
F 4	929	24,4

Viscosity differs for the four emulsion formulas prepared with the same HLB for use in cream form.
The results obtained show that the thicker the fluid, the higher the viscosity; however, the thinner the fluid, the lower the viscosity. In general, more viscous emulsions tend to have better stability over time. The results of our viscosity measurements show that the most viscous formulations generally correspond to those containing a high amount of xanthan gum, with varying percentages (15-40). Similar result reported in literature [15].
Because xanthan gum is a texturizing agent that allows the preparation to gel when cold, this indicates that it is a stabilizer and thickener, therefore increasing the viscosity of the emulsion [15].

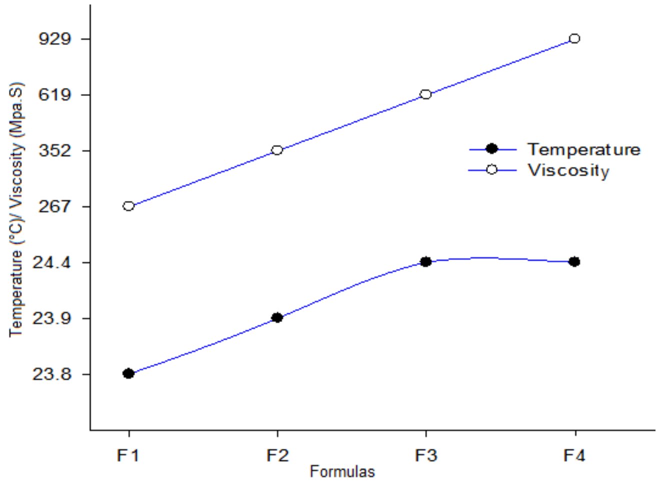

Figure 2: Evolution of the viscosity rate of different formulations

III.3. Centrifuge Test

The results revealed three distinct phases:
An organic phase in the supper part of the tube, and an aqueous phase in the lower part. These two phases are separated by a solid phase in the middle.
The results of the measurement of different stabilities of the cream are shown in the following table:

Table 3: Dilution results at different HLBs, (Phase separation (+); no phase separation (-))

Formulation	HLB	Dilution results
F1	8	-
F2	9	-
F3	10	-
F4	11	+
F5	12	+
F6	13	+
F7	14	-

- ✓ The chosen formula is the fourth formula

III.4. Antibacterial test

The antibacterial effect of the cream was tested by choosing five bacterial strains known for their resistance and the most used. After incubation at 32.5 °C ± 2.5 °C, for at least 24 hours (maximum 48 hours) absence of microbial growth. This means that our cream is of good microbiological quality.

IV. Conclusions

The objective of this work is to develop a moisturizer based on prickly pear seed oil, which is the active ingredient.
To achieve this goal and formulate a high-quality moisturizer, it is necessary to use virgin, cold-pressed oils.
We created an oil-in-water emulsion, respecting the standards for all the constituents of these two phases. This allowed us to obtain a moisturizer with a homogeneous, light texture, a

feeling of freshness and softness after use, with a sticky effect and good shine, and which spreads and penetrates the skin easily.

- According to the measurement, the pH of the developed cream is close to the pH of human skin.
- Viscosity measurement allows us to determine the flow properties of a formulation; it is sufficiently viscous, "sticky," or easy to spread.
- The developed cream poses no harmful effects or complications for the user.

The results of these analyses show that our cream is a light, moisturizing cream that spreads and penetrates the skin easily. It is very rich in antioxidants and vitamin E. The oils it contains are virgin and of high quality, and it meets all the criteria for commercialization.

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