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ORIGINAL ARTICLE

Artificial Intelligence Based Formulation and Evaluation of Anti Acne Polyherbal Face Serum

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ABSTRACT
A highly concentrated product based on water or oil is cosmetic serum. In addition to its non-greasy finish, intense formula with a very high concentration of active ingredients, and quick absorption, serum also has the capacity to penetrate into the skin's deeper layers. The objective of this study is to create an anti-acne serum with a variety of physicochemical and biological extracts and assess the results. The equity Serum's extremely unique combination of potent natural ingredients penetrates the skin's epidermis to provide anti-acne benefits. It leaves skin feeling fair, smooth, and soft thanks to its skin-smoothing ingredients. It contains extracts from potato peels, avocado peels, fenugreek shoot tips, chia seeds, olive oil, glycerine, lecithin, and rose water. Tests were conducted on the PH, viscosity, spreadability, and physical appearance of the facial serum. The anti-aging characteristic of the facial serum indicates that the herbal extracts' flavonoids, iso-flavonoids, riboflavin, anthocyanins, ascorbic acid (Vit C), and phenolic compounds are what give the product its anti-aging effect.
Keywords: *Face serum, Physico chemical evaluation, anti-bacterial evaluation, Active substances and Polyherbal.*

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INTRODUCTION

There have been reports of using medicinal plants and phytochemicals to treat skin conditions, including acne vulgaris, over the past few decades [1]. When hair follicles beneath the skin get clogged, acne, a common skin condition in young people, results. Pus-filled, occasionally painful bumps on your skin are called pimples. Acne vulgaris is the medical term for acne. Oil, bacteria, dead skin cells, and debris clog your pores, causing yeast to accumulate in your hair follicles. Excessive production of sebum, the oil that prevents skin from drying out, also contributes to the development of acne.

Among the risk factors for acne are age and hormonal fluctuations, like those that occur during pregnancy or puberty. ancestry by family, oily or gritty materials, applied pressure or friction to your skin. The four primary factors that contribute to the pathogenesis of acne are treated with an emphasis on increased sebum production, hyper keratinization, Propionibacterium acnes overgrowth—the most important bacteria responsible for acne—and inflammation. Propionibacterium acnes, a gram-positive commensal that is present on human skin, is known to favour anaerobic growth conditions and is involved in the genesis of acne. [2].

Side effects accompany steroidal effects in all synthetic methods. Due to its easy availability, better bioavailability, and lower side effect profile, poly herbal serum formulation may be a better option to address these shortcomings of the current therapies [3]. Herbal formulations for treating acne can be assessed based on both antimicrobial activity and physical-chemical characteristics. Synthetic topical medications are found to be irritating and have a history of poor tolerability and decreased patient adherence, even though they are effective in treating mild to moderate acne vulgaris [4].

Therefore, the most effective method for treating these acne pores is herbal topical therapy, which also has the ability to mitigate the negative effects of synthetic medication. Some herbs, like *Trigonella foenum*

graecum L, *Solanum tuberosum*, and *Salvia hispanica*, are said to have anti-acne properties according to current research. L,

***Solanum tuberosum*,** or potato, is a naturally occurring source of hyaluronic acid, which is a great way to hydrate and replenish moisture in your skin. Rich in phenolic compounds, riboflavin, flavonoids, anthocyanins, folic acid, and b-vitamins, potato peels support the general health of our skin, eyes, and nervous system. Its anti-inflammatory, anti-oxidant, and anti-septic qualities are just a few of its numerous medicinal qualities [5].

Also referred to as fenugreek or menthi, *Trigonella foenum graecum L.* have a variety of therapeutic uses, including treating burning sensations. They also have anti-fungal, anti-bacterial, and anti-inflammatory qualities. A wide range of phytoconstituents are thought to be responsible for fenugreek's pharmacological effects. The presence of steroids, alkaloids, saponins, flavonoids, polyphenols, lipids, carbohydrates, amino acids, and hydrocarbons was identified by the phytochemical analysis [6].

Also referred to as chia seeds, *Salvia hispanica L.* These tiny, black seeds are produced from the chia seed plant, an annual herbaceous plant. Chia seeds contain the following phytochemicals: proteins, free amino acids, carbohydrates, alkaloids, flavonoids, polyunsaturated fatty acids, steroids, and vitamin C [7]. Omega-3 fatty acids, which are abundant in chia seeds and have anti-aging, antioxidant, and anti-inflammatory properties, can help reduce signs of ageing.

The tree *Persea Americana* belongs to the Lauraceae family, and its fruit is edible. Avocado fruits have green or yellowish flesh that has a buttery texture. The raw avocado peel has a higher flavonoid content than the peels of other tropical fruits, such as bananas, melon, passion fruit, papaya, pineapple, and watermelon. Avocado peels are rich in phenols, tannins, saponins, and alkaloids, and they also have anti-inflammatory, anti-microbial, antioxidant, and anti-aging properties [8].

Benefits of face serum

- Soothes irritated skin
- Absorbs quickly into the skin
- Improves the appearance of fine lines and wrinkles
- Protects the skin from free radicals and future damage
- Has the potential to provide more visible results
- Feels light on the skin

Formulation (Design Expert Software) based on Artificial Intelligence (Quality by Design) takes into account factors that indicate the impact on the formulation, such as the amount of glycerine and lecithin in the formulation and the corresponding responses, such as pH and viscosity. The final amounts of lecithin and glycerine in the formulation will be determined based on those values [9].

MATERIAL AND METHODS

The local market provided the following ingredients: fenugreek shoot tips, chia seeds, avocado and potato peels, almond oil, glycerin, vitamin E, and lecithin. Analytical grade ingredients were used in addition to methanol and ethanol that were purchased from Millipore Chemicals in Bangalore. The Propionibacterium acnes standard bacterial culture, which was utilised for this study, was obtained from the Microbial Type Culture Collection and Gene Bank (MTCC), CSIR-Institute of Microbial Technology, Chandigarh. It is kept in anaerobic conditions at 37 °C.

PREPARATION OF THE EXTRACTS

The following herbal extracts are used in the formulation of polyherbal face serum.

Fenugreek Extract

Following the completion of the extraction process, the cooled liquid was concentrated by evaporating its liquid contents in a rotary evaporator to remove the solvents, and residue of extract was obtained [10]. The percentage yield of the fenugreek extract is determined by

Yield (%) =Weight of Fenugreek Extract /Weight of seeds×100

Chia seed Extract

One hundred grammes of whole seed samples were put into containers with purified water. A temperature controller was utilised to maintain a temperature of 80 ± 1.5 °C and to adjust and maintain the pH at 8 [11]. For two hours, the mixture was magnetically agitated and hydrated. Subsequently, the water suspension was transferred onto a drying tray and subjected to 50 °C for a duration of 48 hours. After the seed mucilage was separated, the pulp's weight was determined by sieving it through a 40-mesh screen. The Chia Seed Extract Yield is calculated as a percentage.

Avocado peel Extract

Using the Soxhlet extraction method, the extract from avocado peel was made. The dried avocado peel was first ground into a fine powder and then sieved through a mesh no. 80 sieve. 3 g of powdered

avocado peel and 150 ml of hexane were combined to perform Soxhlet extraction [12]. The cooled liquid will be concentrated after the extraction process is finished by removing the solvents by evaporating its liquid contents in a rotary evaporator, leaving behind residue. It is decided how much avocado peel extract will yield.

Potato peel Extract:

A mesh no. 80 sieve was used to finely powder the dried potato peel before sieving it. A mixture of approximately 10 g of potato peel powder and 100 ml of ethanol was left overnight before being filtered [13]. The filtrate was first stored at -200C and then evaporated under a rotary evaporator at 400C. It is determined how much potato peel extract is produced during the maceration processes.

PROCEDURE INVOLVED IN FORMULATION OF SERUM

After combining all of the chosen herbal extracts, a polyherbal anti-acne face serum is created. Quality by Design principles are then used to further optimise the product.

Table 1: Ingredients of Serum Formulation

Ingredients	**Quantities**
Potato peel extract	1.5gm
Avocado peel extract	2 gm
Fenugreek	1.5gm
Chia seed	4gm
Almond oil	3ml
Glycerine	3.5ml
Vit. E	1 drop
Lecithin	2.5 gm
Water	Quantity sufficient

Glycerine and lecithin content, as well as corresponding responses like pH and viscosity, are examples of factors that demonstrate the effect on the formulation and are taken into consideration with the help of Artificial Intelligence (Quality by Design) based formulation (design expert software). Using the software-generated amounts of glycerine and lecithin in the formulation, the final optimised formulation is created based on those. In the 50 ml beaker, the oil phase which contains ingredients like avocado peel extract, vitamin E, and almond oil is continuously mixed. The final herbal extract mixture potato peel, fenugreek, and chia seed extracts was combined with lecithin and glycerine in the aqueous phase. To obtain the final serum formulation, the oil in water mixture is added drop by drop uniformly using a mechanical stirrer set at 2500 rpm.

Fig. 1. Poly Herbal Face Serum

(i) Selection of Critical factors and Responses for further Optimization of Formulation

Critical factors and responses that have a significant impact on Formulation development have been determined. The amount of Lecithin and the content of Glycerin are used to determine the levels for Experimental design (DoE) to optimise the formulation process, taking into account the pH and viscosity of the final formulation.

Table 2 Final Selected Factors & Responses

Factor 1 (F1)	Amount of Lecithin
Factor 2 (F2)	Amount of Glycerin
Response 1 (R1)	PH
Response 2 (R2)	Viscosity

ii. Experimental design

CENTRAL COMPOSITE DESIGN (CCD)

Drug delivery systems were systematically optimised through the use of experimental design techniques like central-composite design. BBD is the approach that is most widely used for formulation optimisation to create robust formulations. Compared to other designs, it requires fewer experimental runs due to its simplicity in interpretation and execution. Response surface analyses were conducted to ascertain the influence of different independent variables on the observed responses [14]. A two-factor, two-level Central Composite Design was used to study the quadratic response surfaces. Second-order polynomial models were generated using Design Expert Software and fitted into a multiple linear regression model.

The quadratic nonlinear polynomial model is defined as follows:

$Y=\beta0+\beta1A+\beta2B+\beta12AB+ \beta11A2+\beta22B2+$……..

where A and B are the coded levels [low (−) and high (+)] of independent variables, β0 is the constant, β1, β2 are linear coefficients, β12 are interaction coefficients between the two factors, and β11, β22 are quadratic coefficients computed from the observed experimental values of Y from experimental runs. Y is the measured response connected to every combination of factor levels. AB and A2 (i = 1 or 2) are the terms for the interaction and quadratic terms, respectively. The quantity of glycerin (B) and lecithin (A) was selected as the independent variable, and PH and viscosity were the dependent variables. The responses were statistically evaluated using the ANOVA procedure. Furthermore, the optimal formulation was selected through a numerical optimisation process based on a desirability function.

Table 3 Independent variables (factor) and responses investigated in CCD design

Translation of coded value in Actual units				
Independent variable(factor)	**Level of variable**		**Dependent variable**	**Target**
	Low	High		
Amount of Lecithin(gm)	1.79	3.21	PH	Optimised formulation with less viscosity and suitable PH
Amount of Glycerine(ml)	3.79	5.21	Viscosity	

Table 4 Total formulations with actual values for two variables and two factors

		Factor 1	**Factor 2**	**Response 1**	**Response 2**
Std	**Run**	**A: Amount of Lecithin**	**B: Amount of Glycerin**	**pH**	**Viscosity**
		gms	**ml**	**Num**	**Num**
4	1	3	5	4.2	4.8
5	2	1.79289	4.5	4.5	5.1
1	3	2	4	4	4.5
6	4	3.20711	4.5	4.7	4.7
11	5	2.5	4.5	5.6	4.3
8	6	2.5	5.20711	5	4.6
2	7	3	4	4.1	4.9
3	8	2	5	4.3	5
13	9	2.5	4.5	6	4.6
10	10	2.5	4.5	5.4	4.1
7	11	2.5	3.79289	4.9	4.2
12	12	2.5	4.5	5.8	4.2

9	13	2.5	4.5	5.2	5.5

F1-Amount of Lecithin(gm)
F2-Amount of Glycerin (ml)

(ii) Statistical analysis

Not only were responses predicted, but statistical analysis was also used to generate second-order quadratic equations that best fit the experimental data. Each response variable had a polynomial model made up of linear, interaction, and quadratic terms using the design expert 12.0 software. Several statistical parameters were compared by the Design Expert 12.0 programme, and the model with the best fit was selected. The major contribution of significant factors to the model's prediction was also ascertained using ANOVA. The F test and p values were also ascertained with the aid of the Design Expert 12.0 programme. P-values less than 0.05 were found to be statistically significant [15].

***(iv)* Perturbation, 2D-Contour and 3D-Response surface plots**

The relationship between the independent and dependent variables was further elucidated through the utilisation of contour plots and response surface plots. These charts can be used to analyse the effects of different factors on the responses at a given time as well as to forecast dependent variable responses at intermediate concentrations of different factors. Using graphical interpretation in the form of response graphs (three-dimensional, two-dimensional, and perturbation), the main effects and interaction effects of the independent factors were determined. A perturbation plot's steepest slope, or curvature, denotes sensitivity to a specific factor and illustrates how the response changes from its nominal value at a reference point when all other factors are held constant.

A visual representation of the response values is provided by the three-dimensional response surface plots and two-dimensional contour graphs.

***(v)* Validation of the experimental design**

A checkpoint analysis was carried out to evaluate the reliability of the developed mathematical model and to validate the function of the contour plots and the derived polynomial equation in predicting the responses. The adequacy of the model was assessed by looking at residual plots and linear correlation plots between the actual and predicted response variables. These methods, known as check-point methods, corresponded to random compositions and converted the whole range of the experimental domain.

Using the developed mathematical model and experimental techniques, the responses were estimated for each method. Using Microsoft Excel 2016, the linear correlation plots between the observed and predicted values of the responses were created. The experimental values of the responses were quantitatively compared with predicted values to validate the selected experimental design. The percentage predicted error was then computed using the equation below.

$$\%\ PredictedError = Predictedvalue - ObservedvaluePredictedvalue \times 100$$

In order to validate the produced equations and delineate the RSM model's applicability domain, the percentage prediction error was established. To be within acceptable bounds, the percentage prediction value must be less than ± 15%. [16]

***(vi)* Optimization of the multiple responses- Numerical optimization and Graphical optimization**

The optimal experimental parameters were found through the combination of numerical and graphical optimisation techniques, following the establishment and analysis of suitable models for individual responses. Design-Expert 12.0 software was utilised to optimise multiple responses simultaneously. Through this process, design elements are found where the system is most likely to respond in a way that is desired. The optimised method with the desired responses was developed by applying the desirability approach in numerical optimisation. A desired goal (maximum, minimum, target, or within range value) was selected for each independent variable and response variable in order to calculate the desirability function.

After the objectives were integrated into a single simultaneous objective function called desirability, a desirability plot with optimal conditions was produced. "D" is the geometric mean of all the transformed responses as predicted by DoE. Ramp solutions were then produced in order to display the combined individual graphs for simpler understanding. A new optimised method with the desired responses was obtained using the desirability plot and ramp solutions, and an analytical method was carried out under new optimised conditions [17].

PHYSICO-CHEMICAL EVALUATION TESTS FOR POLYHERBAL FACE SERUM

Colour and Appearance: The formulation's colour and appearance (Poly herbal face serum) were visually assessed [18].

Homogenity: The extracts produced have an even distribution throughout the prepared formulation. The homogeneity of the preparation was verified both tactilely by feeling the product and visually by looking for any particles [19].

pH of the serum: The serum's pH was determined by accurately measuring and dissolving nearly 1 millilitre in 50 millilitres of distilled water [20].

Distribution of globule sizes: The prepared serum is properly examined under a microscope to determine and validate the globule size. One drop of the serum, diluted with water, should be applied to a glass slide and covered with a coverslip. [21]

Washability: A small amount of formulation was applied to the hand and then washed with tap water to test the formulation's washability; the formulation should be readily washable [22]. Viscosity: Because emulsions are not Newtonian systems, the formulation's viscosity was measured using a multipoint viscometer (Brookfield Viscometer) set to 100 rpm. A small amount of the serum was placed in a beaker, and the spindle was dipped in it for approximately five minutes before the readings were recorded [23].

Phase separation: The prepared formulation was stored clear of light in a closed container at room temperature between 25 and 100 degrees Celsius. Following a 24-hour period, the phase separation was examined to see if there had been any changes [24].

Irritancy:

The serum was applied to the affected area, and after a duration of up to 24 hours, the area was observed and checked for erythema, Edema , and irritation [25].

MICROBIOLOGICAL EVALUATION OF POLYHERBAL SERUM

Microbial Assay Procedure:

Disk Diffusion Method

Nutrient agar media was used for the disc diffusion method. This medium is ideal for routine susceptibility testing due to its high reproducibility and ability to support the growth of the majority of bacterial pathogens. Utilising nutrient agar media, the inoculum for the disc diffusion method is made [26].

Preparation of nutrient agar medium

Nutrient agar medium was prepared using following ingredients

Ingredients	Quantity
Peptone	5g
Beef extract	3g
Agar Agar	15 g
Glucose	2.5g
Distilled water	Up to 1 litre

After nutrient agar was suspended in distilled water and frequently stirred, the medium was fully dissolved by boiling it, and it was then autoclaved for 15 minutes at 121°C to sterilise it. The pH of every preparation was measured following sterilisation, and at room temperature, it should be between 7.2 and 7.4.

Sterile disc preparation

Pouring the cooled agar medium to a consistent depth of 4 mm into a sterile glass or plastic petri dish on a level surface allowed it to solidify. Plates were dried in an incubator at a temperature between 30 and 37°C for a maximum of 30 minutes, or until excess moisture on the surface was removed. The media needs to be damp but not have any water droplets on the surface.

Plating inoculation

By streaking with the swab containing the inoculum, agar was inoculated. After turning the plate sixty degrees, rub it two more times. By doing this, the inoculum will be distributed evenly.

Developing

1. Either at the ideal growth temperature or inverted, the plates were incubated at 30°C. 2. After 16 to 18 hours, a zone of inhibition was noted. It might take longer to incubate organisms that grow slowly.

Assay of antimicrobial activity using Disc diffusion method

As illustrated in Fig. 2, optimised formulation was created using 10% DMSO at concentrations of 0, 1, 2, 4, 8, and 16 mg.ml-1. Using Propionibacterium acnes as the bacterial strain, an antimicrobial assay was conducted using a modified disc diffusion method. Agar plates were seeded with 0.1 mL of the overnight bacterial suspension after it had been adjusted to a concentration of 107 CFU.mL-1. Serum (5 µL) is applied to each treatment on an agar plate. This assay uses a negative control (no extract) and a positive

control (chloramphenicol). For a full day, agar plates were incubated at 37°C. By calculating the zone of inhibition, antimicrobial activity was assessed.

Fig 2. Dilutions of optimized formulation by 10% DMSO

RESULTS

The formulation of the Polyherbal Face Serum was optimised using the Central Composite Design, and 2D contour and 3D response surface plots were used to interpret the effects of the factors (amount of lecithin (X1) and glycerine (X2)) on the responses (PH (Y1) and Viscosity (Y2)) are investigated.

Experiments and statistical analysis for optimization of the formulation:

Thirteen formulation conditions were used in a full factorial design. For every one of these circumstances, a formula was created. There were differences in the serum's PH (Y1) and viscosity (Y2), ranging from 4 to 5. In order to create the ideal circumstances for achieving the goals of the current study, these data can be used and analysed. The significance of the 2FI experimental models was examined using ANOVA. Based on Fisher's ratio (F-value), each model's significance was assessed. P-values less than 0.05 were discovered for all three models, indicating their significance. Every other term was also significant, based on the corresponding F- and p-values for each term. The predicted determination coefficient (pred. R2), adjusted determination coefficient (adj. R2), and determination coefficient (R2) were used to assess the quality of the obtained polynomial regressions. The R2 values were found to be very close to 1 in each case, indicating a higher than 99% accuracy in the regression curve's fit to the data. There was a good level of agreement (difference less than 0.2) between the adjusted R2 values and the predicted R2 values. In the current study, high precision values were found, suggesting a sufficient signal. The following polynomial equations (Eqs. (1)–(2)) were found for each model in coded form:

pH of Serum = +5.60+ 0.0354× A + 0.0677 × B -0.0500 × AB-0.6562× A^2 - 0.4812× B^2 (1)

Viscosity of Serum = 4.635+ 0.0263× A + 0.0867 × B -0.0323 × AB-0.8560× A^2 - 0.8912× B^2(2)

where A denotes the lecithin content and B the glycerin content. The terms A and B represent the main effect, and the terms AB, A2, and B2 represent the interaction effect. The model's suitability was assessed visually by examining the residual vs. predicted plot and the normal probability plot. There was minimal scatter and a normal distribution of the residuals along the straight line, suggesting a good fit to the data. Using the equation expressed in terms of coded factors, the response for particular levels of each factor can be predicted. Relative to the trend, the residual plots showed a random distribution of residuals between +4 and 4, indicating the lack of systematic bias or outliers.

Desirability function of Derringer. Using the Derringer desirability function, the specification for optimising each and every response is shown in Fig. 1. The basis of this methodology is the desirability value for every response. The desirability function is a scale that goes from zero to one, where zero is considered to be the most undesirable response. A value near one is needed for a fully desired response. Value was used to select the most desirable trials. In order to optimise the method, the first trial with desirability one (i = 1) was selected. The results are shown in Table 6.

Design area and ideal conditions for separation. Figs. 3–4 show the standardised effects of independent factors on the responses and their interactions with each other through the use of two-dimensional (2D) overlay contour plots and three-dimensional (3D) response surface graphs. An overlay contour plot was constructed using the data for the experimental conditions and corresponding responses in order to determine the design space and the optimal lecithin and glycerine composition. More precisely, 4 ≥ pH of serum ≤ 6 and 4.1 ≥ Viscosity of serum ≤ 5.5 were the minimum and maximum responses that were to be attained. The most advantageous specifications were chosen after a desirability analysis of all the specifications within the design space. Additionally, as illustrated in Fig. 5, the graphical optimisation

defined the ideal formulation conditions and the method operable design region (MODR). The final pH of the serum obtained was 5.283, and its viscosity was 4.6538, as shown in Fig. 6. The entire target was achieved with a desirability value of 1.00 using amounts of lecithin 2.4347g and glycerine 4.935mL.

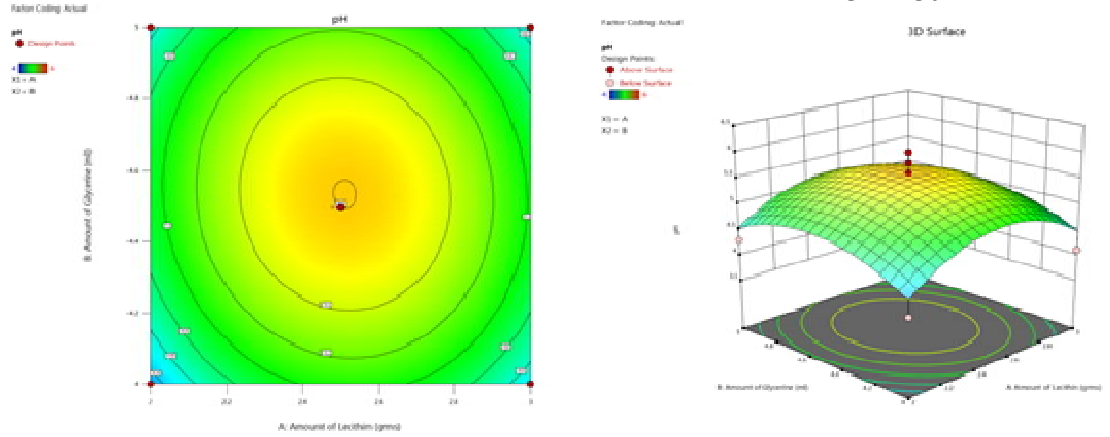


Fig 3: 2D contour and 3D response surface plots showing the influence of amount of lecithin and glycerin on PH

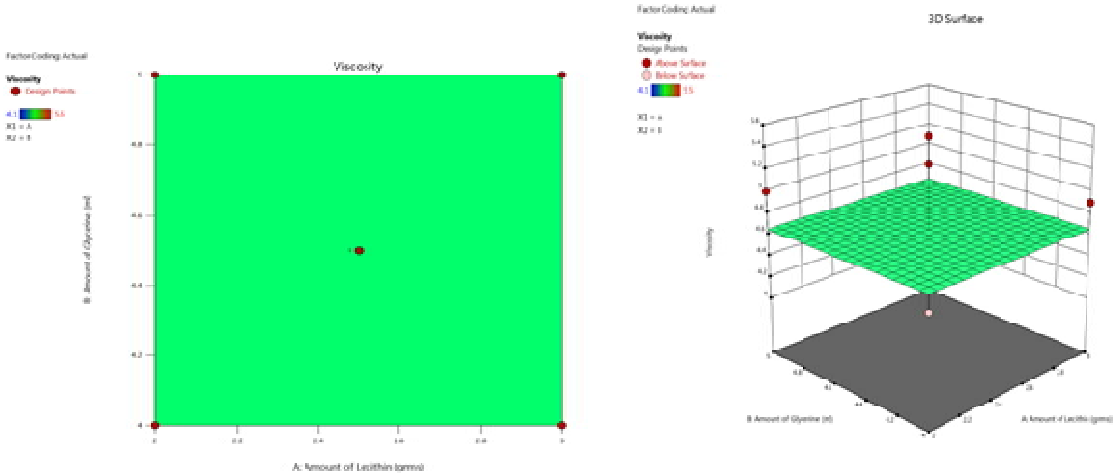


Fig 4: 2D contour and 3D response surface plots showing the influence of amount of lecithin and glycerin on Viscosity

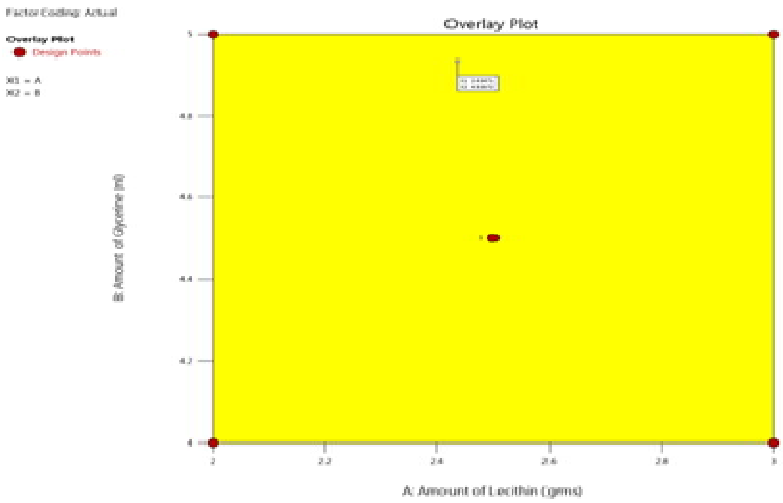


Fig 5: Overlay plot in graphical form displaying the ideal design space or technique operational design region

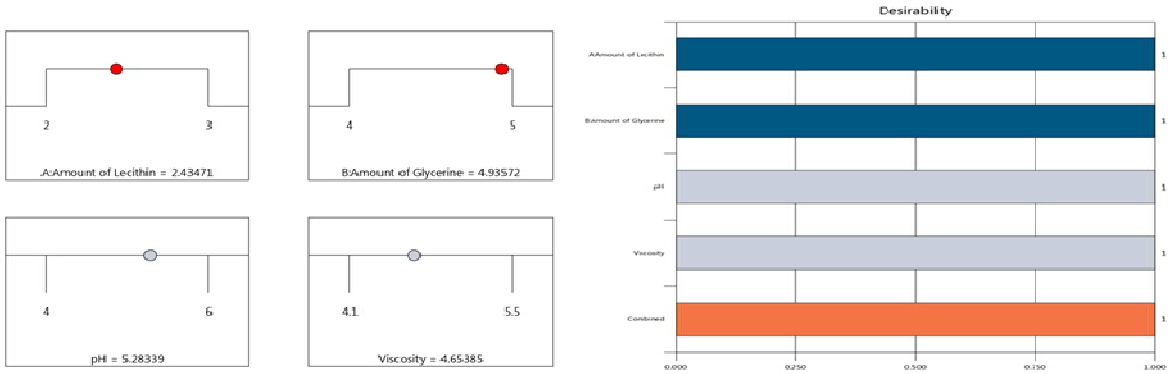


Fig 6: Ramps (a) and bar graph (b) of Derringer's desirability function representing the optimized experimental conditions, the individual and combined desirability values.

RESULTS OF PHYSICO-CHEMICAL EVALUATION STUDIES

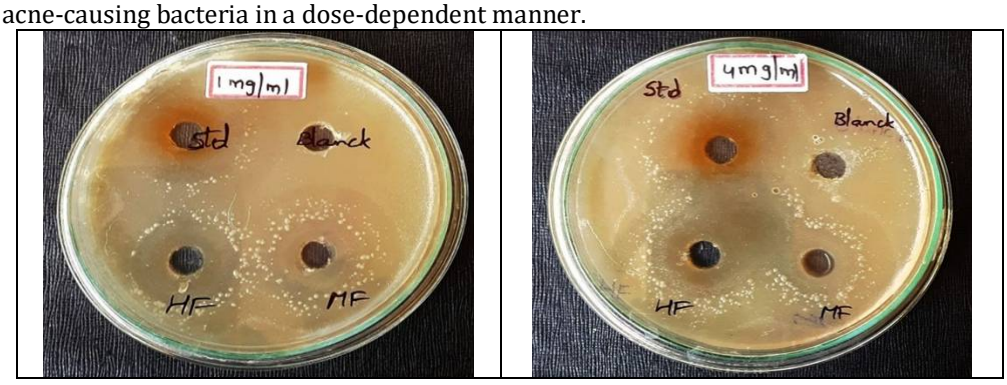
The following are the parameters checked for the physico chemical studies and the results are given below in the table 6.

Table 6: Physico-Chemical evaluation studies

Parameters	In-House formulation	Marketed Formulation
Colour	Olive green	Transparent
Appearance	Glossy	Glossy
Odour	Pleasant	Pleasant
Spreadability	Good Spreadability	Good Spreadability
PH	5.6 ± 0.369	5.15 ± 0.487
Viscosity(Cps)	1,520 ± 0.547	3,200 ± 0.375
Homogenesity	Passed	Passed
Irritancy	No	No
Washability	Good	Good
After feel	Good	Good
Globule size distribution	Uniform size	Uniform size

ANTI-MICROBIAL ASSAY

Based on the zone of inhibition, the growth of Propionibacterium acnes was observed on the agar medium slope, as depicted in Figure 7. The in-house and commercial serum concentrations at 1, 2, 4, 8, and 16 mg/ml are used to measure the zone of inhibition. The results of this measurement are shown in Table 7 below. With an increase in serum concentration levels, the zone of inhibition also increased, peaking at 16 mg/ml of facial serum concentration. Next, the face serum's efficacy was compared to that of regular chloramphenicol. The results of the study showed that the herbal face serum was effective at fighting acne-causing bacteria in a dose-dependent manner.



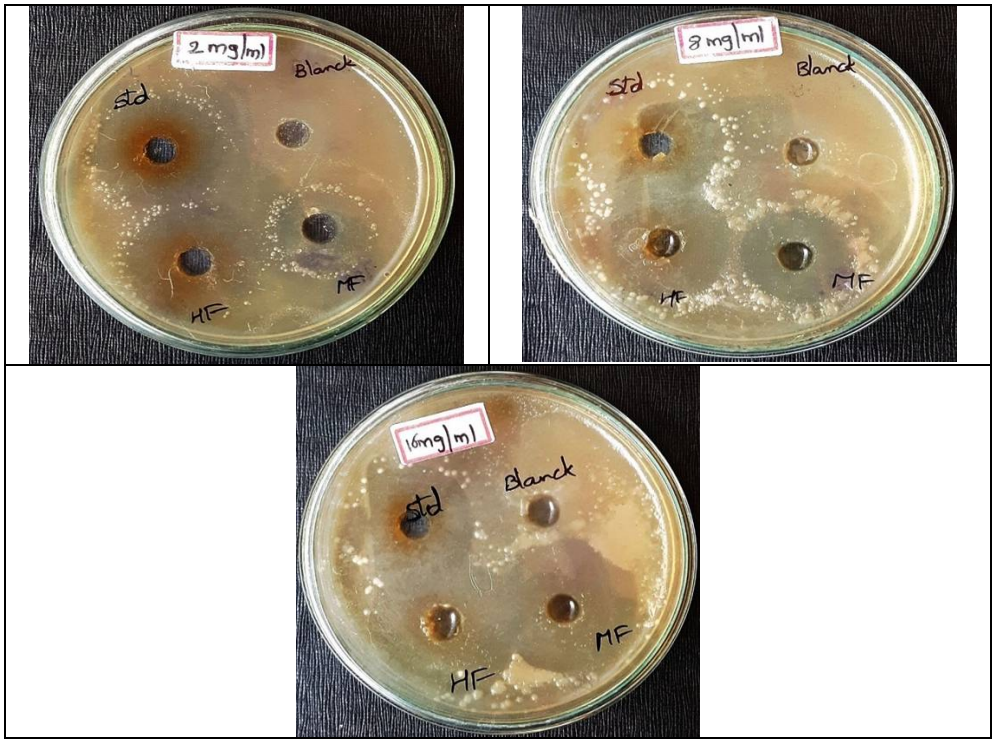


Fig. 7: Zone of Inhibitions for Marketed and In-House Formulation at various concentrations

Table 7: Results of Zone of Inhibition for Marketed and In-House Formulations

Concentration Level	Standard (Chloramphenicol)(mm)	Marketed Formulation(mm)	In-House Formulation(mm)
0 mg/ ml (Blank)	19.5± 0.467	9.6 ± 0.398	-
1 mg/ ml	19.73 ±0.469	1.16 ± 0.587	1.53±0.214
2 mg/ ml	19.4 ±0.781	3.04 ± 0.456	3.4 ± 0.375
4 mg/ ml	20.1 ± 0.218	6.96 ± 0.518	7.53 ± 0.481
8 mg/ ml	19.86 ± 0.365	12.16 ± 0.372	13.9 ± 0.208
16 mg/ ml	19.13 ± 0.384	24.13 ± 1.379	27.43 ± 0.291

DISCUSSION

Poly herbal Face serum was formulated using avocado peel extract, chia seed extract, potato peel Almond oil and fenugreek shoot tip extract should be extracted together with other excipients. By adjusting the lecithin and glycerin concentrations, the serum formulation was optimised through the use of design of experiments in Quality by design concepts for formulation design and development. Viscosity and pH can be adjusted by adjusting the glycerine and lecithin concentrations. The final, optimised formulation is obtained at 4.93 ml of glycerine concentration and 2.83 ml of lecithin concentration. The optimised formulation has a final pH of 5.2 and a final viscosity of 4.6 cps. Physical characteristics of the optimised formulation were assessed, including appearance, spreadability, pH, viscosity, homogeneity, and globule size. Upon completion of the aforementioned assessments, it can be inferred that the optimised formulation exhibits a pH that is optimal for skin contact and a lower viscosity. Fenugreek and avocado are loaded with vitamins and minerals that help prevent skin pigmentation, keep skin looking youthful, and have strong moisturising and anti-aging properties. Because of its antioxidant content, almond oil is useful in treating sunburn and UV-induced skin damage. Moreover, it delays and prevents premature ageing. It has fatty acids that help prevent dry skin, like omega 6 and omega 9. There was good spreadability found.

Based on the zone of inhibition and measurement of the anti-acne property, the growth of Propionibacterium acnes was observed on the agar medium slope. Because all of the chosen herbal ingredients have high concentrations of phenolics, flavonoids, and iso flavonoids—which are responsible for the anti-acne property—the zone of inhibition has increased as serum concentration levels have increased.

CONCLUSION

Synthetic drugs are losing ground to safe, all-natural remedies with fewer side effects when treating acne vulgaris. A unique herbal-based serum formulation has been created to treat acne, and the formulation's PH and viscosity are optimised by using quality by design principles. A better-performing formulation has been produced through the use of Design Expert software and the QbD method approach for formulation development. The physicochemical properties of the developed formulation, such as colour, appearance, odour, spreadability, PH, viscosity (Cps), homogeneity, and globule size distribution, have been assessed. The skin responds optimally to the optimised formulation's pH and reduced viscosity. By monitoring the zone of inhibition against Propionibacterium acnes, the optimised formulation's anti-acne properties are tested. When compared to marketed herbal serum formulation, the in-house formulation demonstrated superior anti-acne properties.

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