https://doi.org/10.48047/AFJBS.6.9.2024.5315-5328

African Journal of Biological Sciences

Journal homepage: http://www.afjbs.com

Research Paper Open Access

"DEVELOPMENT AND CHARACTERIZATION OF *CINNAMON* AND *HONEY* LOADED OINTMENT FOR ACNE"

Pratibha Sharma*, Mukesh Kumar, Km. Bhumika

Department of Pharmaceutics, IIMT College of Medical Sciences, IIMT University, Ganga Nagar Meerut Uttar Pradesh -250001.

Volume 6, Issue 9, May 2024

Received: 12 March 2024

Accepted: 02 April 2024

Published: 28 April 2024

doi: 10.48047/AFJBS.6.9.2024.5315-5328

ABSTRACT

Introduction: One of the most common skin issues people faces is acne, which is often caused by a bacterial infection. Usually, acne develops when skin particles or dead skin cells obstruct hair follicles, leading to inflammation caused by the bacteria living deep inside the cells and secreting enzymes that damage the cells. This condition, known as acne vulgaris. **Objective:** This study aimed to develop and assess the effectiveness and safety of an ointment using of cinnamon oil and honey in patients with facial acne. **Materials and Methods:** The purpose of this study was to cure acne using a mixture of honey and cinnamon oil. The physicochemical characteristics of the formulations, such as color, consistency, odor, and viscosity, as well as stability tests and pH observations, were then assessed. **Results:** The effectiveness of the process for producing ointments is indicated by the physical assessment findings of the ointment made with honey and cinnamon oil. All three formulations are stable for Three weeks even after storing at 5^0 C, 15^0 C, and 30^0 C. F3 provided good texture, coverage, and spreadability and stable under determined storage conditions. Different concentration of Cinnamon and Honey was ensured in ointment and labelled them as F-1, F-2, and F-3. F-1 contained 0.05 %w/w, F-2 contained 0.1 %w/w and F-3 was composed of 1.5%w/w. the batch with the optimal quantity of medication permeated F-3 was determined to be 83.33± 4.38%, respectively the pH of all the formulations is within the usual range of 6.5 ± 0.3 for human skin. **Conclusion:** According to our findings, using topical cinnamon ointment to mild-to-moderate face acne is both effective and safe

Keywords: Ointment, Acne, bacterial infection, Cinnamon and Honey

INTRODUCTION

It is considerable that in our body Skin is the largest organ and it is made up of fats, protein and minerals 25% fat, mineral 3% and 70% water the area covered by human skin in our body is about 1.5-2m^2.Primary function of skin is to maintain a fence between the external Environment and body. This fence protects the skin from UV radiations, chemicals, allergens and microorganism it also protects the skin from moisture loss. There are so many medicaments available in the market that shows their therapeutic actions by absorb though skin.so skin is an ideal site for administration of drug.[1,2] Acne vulgaris is one of the most prevalent skin conditions. it causes at adulthood age (70-80%). The simplest name of Acne vulgaris is acne. Acne vulgaris shows effect on skin: Scaly red skin also known as Seborrhoea, Comedones (blackheads and white heads) ,Nodules (large papules), Pinheads (papules) It is not a life-threatening disease but it affects people day to day life and social activities Acne is a complicated skin condition that affects the hair follicles and oil glands.[3] Acne, a condition with a multiplex pathophysiology, Acne may be caused by sebaceous hyperplasia, immunological process, microorganism hypercolonization, inflammatory processes and follicular hyperkeratinization[4 ,5]

In pathogenesis there is a very important role of sebaceous gland that has been recognized from a long time. The pilosebaceous unit is also known as seat of acne. this acne is cell lined follicle with vellus hairs and wide sebaceous gland. The sebum production is increased on those area where acne occurs. The most common areas of acne are nose, cheeks, chest, back and forehead.[6]In Acne pathogenesis the possible role of sebum is Comedogenesis. Sebum helps in growth of Acne its act like substrate for its growth. The fatty acid, diglyceride and Monoglyceride is formed when triglyceride act upon Pilosebaceous acne lipase.[7,8] These Mono and Di glyceride forms glycerol that help in Pilosebaceous acne production. Acne forms when a blockage occurs in the hair follicle. This blockage is caused by a buildup of dead skin cells, which prevents sebum (oil) from exiting the follicle.[9] The exact cause of this blockage is not known, but it is thought to be related to hormones (androgens) and changes in the skin's oil production, leading to an increased production of skin cells. Comedones can form in the pilosebaceous duct when there is not enough linoleic acid. Linoleic acid is absorbed into the sebaceous gland cells through the bloodstream, where it mixes with a large amount of sebum. However, the ductal corneocytes (cells in the duct) have low levels of linoleic acid.[10] Due to abnormally shedding follicular cells, follicular lumen becomes blocks. The sebum get Hyperkeratinized plugs block the follicle, causing it to expand in size That's why development of black heads white heads comedone. The P. acnes (anaerobic bacteria) increase rapidly in the ideal environment. It decreased oxygen tension with clogged lumen that is lipid rich.[11] This over production of P. acnes hydrolyses sebum triglycerides, that produce free fatty acids which may lead to Acne. Inflammation is also caused by P.acne by activation of various chemotactic factors. P.acne is ingested by neutrophil by engulfing P.acne it regularly release of hydrolytic enzymes that effect the follicar wall rupture and dysfunction. This damage helps the intrafollicular contents to release in dermis and cause inflammation. P.acne release proinflammatory mediators due to combination of sebum, keratin and microorganism T-helper lymphocyte, giant foreign body and neutrophil accumulated. This cause the formation of lesions,Inflamatory papules [12,13]

METHODS:

Preparation and physicochemical evaluation of cinnamon and honey formulation

Honey was acquired from the Etah marketplace, while cinnamon oil was sourced from S.R. Scientific House in Rambhag, Agra. We purchased white soft paraffin and hard paraffin from SD Fine Chem Limited.

Preparation of ointment:

In a china dish placed over a water bath set to 70 degrees Celsius, combine hard paraffin and cetostearyl alcohol. Once melted, add wool fat and white soft paraffin. Stir continuously until all ingredients are fully integrated. If necessary, filter or strain the mixture. Allow it to cool while stirring occasionally. Once cooled, transfer the preparation into an appropriate container for storage. To make an herbal ointment, carefully weigh and mix cinnamon oil and honey with an ointment base. Grind them together until a smooth paste forms, using 2-3 times the base's weight. Gradually add more base to create a uniform ointment. Finally, transfer it to an appropriate storage container.[14]

Table 1: Formulation of ointment base

S. No.	Name of Ingredient	Quantity to be taken
1.	Wool fat	0.5gm
2.	Cetostearyl alcohol	0.5gm
3.	Hard paraffin	0.5gm
4.	Yellow soft paraffin	8.5gm

Table 2: Formulation of Herbal ointment

S. No.	Name of Ingredient	Quantity to be taken		
		F1	F2	F3
1.	Cinnamon oil	0.05gm	1gm	1.5gm
2.	Honey	0.05gm	1gm	1.5gm
3.	Ointment base	10gm	10gm	10gm

CHARACTERIZATION OF *CINNAMON* OIL AND *HONEY* LOADED OINTMENT:

a) **Physical appearance** The finished ointment preparations were visually examined to assess their:

Colour, Odour, Consistency

b) Measurement of PH

A 100 ml beaker was filled with 2.5 g of ointment and 50 ml of water. The mixture was heated to between 60 and 70 degrees Celsius for 10 minutes, then cooled to room temperature and centrifuged for 10 minutes at 3000 rpm. A digital pH meter was used to determine the pH of the ointment. pH is crucial in topical application because an acidic or alkaline pH can irritate the skin. The goal was to maintain the formulation's pH close to neutral to avoid irritation.[15,16]

c) Viscosity

We used a Brookfield viscometer to measure the thickness of the formula. We followed the standard operating procedure for the viscometer to determine its viscosity.[17] We used spindles numbered 1 through 4. We found the viscosity of the test sample using spindles 1, 2, 3, and 4.

Each spindle was attached and spun at speeds of 0.3, 0.6, 1.5, 3, 6, 12, 30, and 60 revolutions per minute (rpm). We only noted readings when the dial reading exceeded 10. These readings were utilized to calculate viscosity.[18]

d) Spreadability

Spreadability is measured by the time it takes for two glass slides coated with ointment to separate under a specific load. The shorter the time required for separation, the easier the ointment spreads. Therefore, a shorter separation time indicates better spreadability.[19]

The following formula was used to calculate the spreadability.

$$S = M.L/T$$

e) Washability

The skin was treated with the ointment and then washed with water. Then, it was seen how simple it was to remove the ointment after washing..[20,21]

f) Extrudability

The ointment was stored in a tube for easy application. The ease of squeezing the ointment out of the tube was determined by measuring the weight of ointment needed to extrude a 0.5cm strip of ointment in 10 seconds. The ointment was extruded smoothly without difficulty, indicating that the formulated ointment was of acceptable quality.[22]

g) Drug content

The ointment was dissolved in 10 milligrams of distilled water. The absorbance of the solution was then determined at a wavelength of 220 nanometers using a UV-Visible spectrophotometer.[23]

h) *In-Vitro* DIFFUSION STUDIES

An in-vitro diffusion research on the ointment was carried out using a Franz diffusion cell. Prior to the experiment, a dialysis membrane with a 0.1g sample was placed in the donor compartment. The membrane was then submerged in phosphate buffer (PB) with a pH of 6.8 in the receptor compartment for a whole day.25, 24,A constant 37 ± 0.5°C was maintained. Diffusion times for the ointment were not constant. Using PB pH 6.8, 1 ml samples were obtained at regular intervals, diluted to 5 ml, and then replaced with an equivalent volume of new dissolving fluid at the same temperature. Also, a standard solution was made.[26]

i) Stability study

The herb ointment was exposed to three distinct temperature ranges—2°C, 15°C, and 30°C—for a period of four weeks in order to evaluate its physical stability. During the testing period, the ointment maintained its physical stability at all of these temperatures.[27,28,29,30]

RESULT AND DISCUSSION:

Pre-formulation Studies:

- **PHYTOCHEMICAL SCREENING OF CINNAMON OIL:**

The oil was studied for its phytochemical analysis by qualitative chemical test. The major phytoconstituents were presented in Table:3

S. No	Phytochemical Test	Cinnamon oil

1	Alkaloid	+
2	Glycoside	+
3	Saponin	-
4	Phenol	+
5	Coumarins	+
6	Flavanoid	+
7	Terpenoid	+
8	Anthrocyamin	-
9	Tannin	+

+Indicates Present, - Indicates Absence

- **PHYTOCHEMICAL SCREENING OF HONEY:**

The honey was studied for its phytochemical analysis by qualitative chemical test. The major phytoconstituents were presented in Table 4.

S.No	**Phytochemical Test**	**Honey**
1	Alkaloid	+
2	Glycoside	+
3	Saponin	-
4	Phenol	+
5	Coumarins	+
6	Flavanoid	+
7	Terpenoid	+
8	Anthrocyamin	-
9	Tannin	-

+ Indicates Present, -Indicates Absence

- **PHYSICAL PROPERTIES OF CINNAMON OILAND HONEY:**

Physical Properties like physical state, colour, odour of cinnamon oil was obtained by visual examination in Table 5:

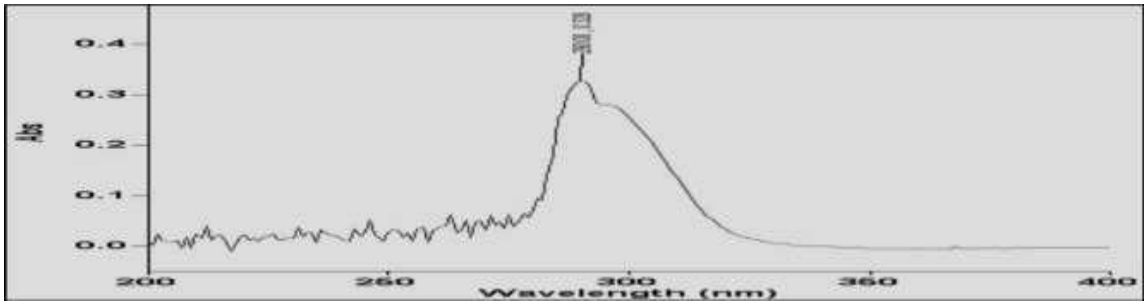
S. No	**Properties**	**Experimental observation**
1.	Physical state	Liquid (oil)
2.	Colour	Yellow/amber/dark brown/clear
3.	Odour	Distinct cinnamon spice aroma
4.	Boiling point	247°C (Cinnamaldehyde)
S. No	**Properties**	**Experimental observation**
1.	Physical state	Viscous liquid
2.	Colour	Amber or gold

3.	Odour	Pleasant
4.	Boiling point	85°C

***UV-VIS SPECTRUM* CINNAMALDEHYDE:**

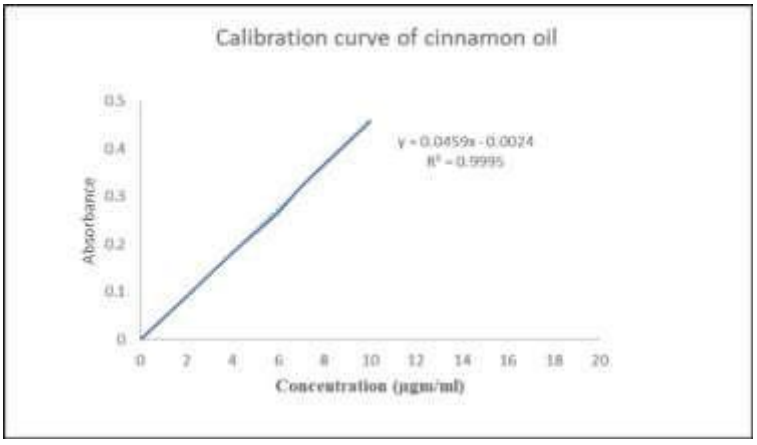
The use of a UV-Vis Spectrophotometer for cinnamon analysis. Around 290.00 nm, there was a noticeable absorption. Cinnamaldehyde's maximum wavelength is corresponding with this wavelength.

Chemical constituents	**λ_{max}**
Cinnamaldehyde	**290nm**



- **CALIBRATION CURVE OF CINNAMON OIL:**

It shows the strong linear relationship between the concentration and absorbance.



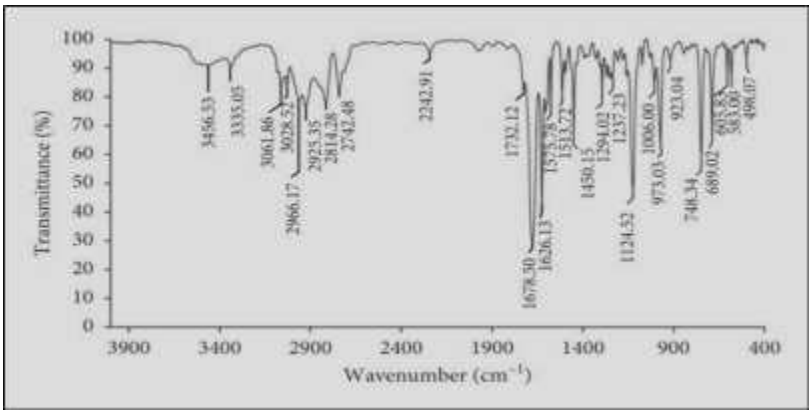
- **IR SPECTRAL ANALYSIS OF CINNAMON OIL:**

Essential oils were thought to be complicated mixing systems. Its functional group was determined via FTIR spectroscopy. The cinnamon oil's high points were displayed in a table 6. Figure 2 displays the honey's FTIR spectrum in the 3400–400cm−1 spectral range.

Wavelength (cm^{-1})	**Functional groups**
$3026cm^{-1}$	C-H bond (stretch)
$2925cm^{-1}$	=C-H bond
$1678cm^{-1}$ - $1626cm^{-1}$	Cinnamaldehyde (C=O)
$1450–1626cm^{-1}$	C=C bond (stretching)

1237cm^{-1}	C-OH
1124cm^{-1}	C-O and C-OH bonds
973cm^{-1}	C-H bond
748cm^{-1}	(benzene rings=CH)

FTIR OF CINNAMON:

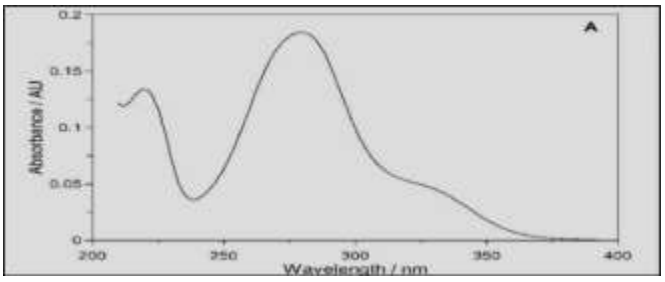


Fourier transform infrared spectrum for cinnamon in the 400-3900cm^{-1}spectral Region.

- ***UV-VIS SPECTRUM* HONEY:**

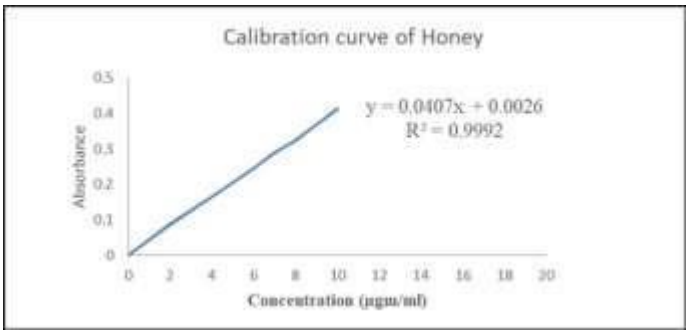
The UV-Vis Spectrophotometer's study of honey in the 200–400 nm range. It demonstrated a significant absorption at 280 nm in wavelength. This wavelength is the same as the maximum wavelength of benzoic,
aryl-aliphatic, salicylic, and flavonoid acids found in honey**.**

Chemical constituents	**λ_{max}**
Honey	**280nm**



- **CALIBRATION CURVE OF HONEY:**

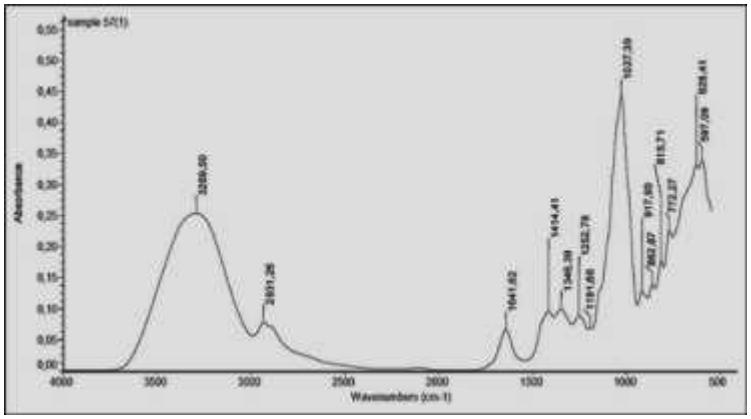
The R^2 value indicates that the calibration curve was a good fit for the data, with 99.92% of the variation in the data being explained by the equation.



- **FTIR FOR HONEY:**

An actual honey FTIR spectrum is displayed in Figure 2 and is segmented into five distinct areas. In Table 1, the band allocations and associated modes of vibration were displayed. Figure 3 displays the actual honey's FTIR spectrum in the 550–4000 cm−1 spectral range.

Wavelength	**Assignment**
700-940 cm^{-1}	C-H bending
940-1175 cm^{-1}	C-O and C-C stretching (carbohydrates)
1175-1540 cm^{-1}	O-H stretching/bending C-O stretching (carbohydrates) C-H stretching
1600-1700 cm^{-1}	O-H stretching/bending (water) C=O stretching (mainly from carbohydrates) N-H bending of amide I (mainly proteins)
2800-3000 cm^{-1}	C-H stretching (carbohydrates) O-H stretching (carboxylic acids) NH3 stretching (free amino acids)



Fourier transform infrared spectrum for honey in the 550-4000 cm−1 spectral Region.

CHARACTERIZATION OF *CINNAMON* OIL AND *HONEY* LOADED OINTMENT:

The physicochemical characterization of ointments F1, F2, and F3, as mentioned in the provided context, includes evaluating various properties such as spreadability, consistency, viscosity, and pH. Additionally, Extrudibility, Homogeneity, Viscosity, Washability was also part of the study. These tests were commonly performed according to the Indian Pharmacopoeia (IP) standards to ensure the quality and safety of the ointments.

➢ PHYSICAL EVALUATION PARAMETERS OF THE FORMULATIONS

The formulated ointment was checked visually for color, appearance and consistency and the results were listed in Table No.10

Formulation	Appearance	Odour	Consistency	color
F1	Semisolid	Characteristic	Gummy	Pale yellow
F2	Semisolid	Characteristic	Gummy	Pale yellow
F3	Semisolid	Characteristic	Gummy	Pale yellow

➢ DRUG CONTENT, PH, SPREADABILITY OF FORMULATION:

Based on the results, the drug content, pH, and spreadability of different formulation batches were evaluated. The optimized F1, F2 and F3 batch had a drug content of 94.44%, 96.23%,97.89%, pH 6.30, 6.70, 6.90 and spreadability of 21.66, 6.90, 30.13 were found respectively. The results indicate that the F3 batch had a drug content of 97.89%, pH of 6.90, and spreadability of 30.13, making it the best-performing batch among the three. These findings suggest that the F3 batch may be the most suitable formulation for further development or use.

S.No	Formulation	Drug Content	PH	Spreadabilty (g.cm/S)
1.	F1	94.44%	6.30	21.66
2.	F2	96.23%	6.70	6.90
3.	**F3**	**97.89%**	**6.90**	**30.13**

➢ EXTRUDIBILITY, HOMOGENEITY, VISCOSITY OF FORMULATION:

Formulations F1, F2, F3 are viscous, as we can see. The viscosity was highest in formulations F1 and lowest in formulation F3. F1, F2, and F3 formulations have extrudability values of 0.5 gm and 0.4 gm, respectively. All three batches are found to have high homogeneity and washability.

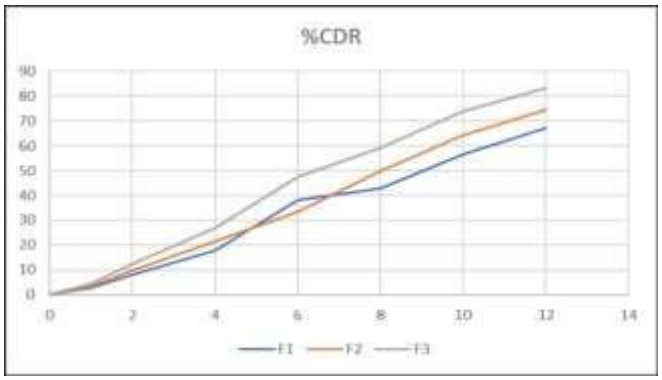
Formulation	Extrudibility	Homogeneity	Viscosity	Washability
F1	0.5 gm	Good	1258cps	Good
F2	0.5 gm	Good	1125cps	Good
F3	0.4 gm	Good	970cps	Good

➢ *IN VITRO* DRUG RELEASE OF FORMULATIONS:

In vitro drug release testing is an essential assessment in the development of new drugs and quality assurance. It measures the release of the active pharmaceutical ingredient (API) from the drug product matrix in a regulated laboratory setting. The F3 batch exhibits the greatest results, and the study was completed in one to six hours.

Time (hrs)	Release of ointment

	F1	**F2**	**F3**
0	0	0	0
1	2.75	3.38	4.38
2	8.02	9.79	12.57
3	17.73	21.38	26.91
4	38	33.56	47.54
5	42.73	49.7	59.17
6	56.66	64.32	73.91
7	67.2	74.7	83.33



- **IN VITRO RELEASE KINETICS OF BY ZERO ORDER, FIRST ORDER, HIGUCHI:**

The Higuchi model pattern for the kinetics of drug release, zero order, first order, was applied to the data. The regression equation of the optimized formulation F3 was determined using the Higuchi model 0.997, first order equation 0.034, and zero order equation 0.935, in that order. It is evident from these results that Higuchi kinetics provided the optimum expression for the formulation. The Higuchi release pattern was being followed.

FORMULATION	**ZERO ORDER**	**FIRST ORDER**	**HIGUCHI**
	R^2	**R^2**	**R^2**
F3	0.935	0.034	0.997

- **STABILITY DATA OF FORMULATION AT DIFFERENT TEMPERATURE:**

Three weeks of testing the herbal ointment's physical stability at several temperatures—2°C, 15°C, and 30°C—were conducted. After three weeks, it was discovered that the herbal ointment was physically stable at a variety of temperatures, including 2°C, 15°C, and 30°C.

S.No	**Stability condition (temp)**	**5^0 C**		
		pH	**Centrifugation**	**Drug Content**
	Formulations	F3	F3	F3
1.	Week 1	6.84	No	93.78%

2.	Week 2	6.2	No	95.23%
3.	Week 3	6.23	No	94.76%

S.No	**Stability condition (temp)**	**15^0 C**		
		pH	**Centrifugation**	**Drug Content**
	Formulations	F3	F3	F3
1	Week 1	6.1	No	94.52%
2	Week 2	6.91	No	96.23%
3	Week 3	6.2	No	94.72%

S.No	**Stability condition (temp)**	**30^0 C**		
		pH	**Centrifugation**	**Drug Content**
	Formulations	F3	F3	F3
1	Week 1	6.23	No	95.83%
2	Week 2	6.34	No	93.65%
3	Week 3	6.37	No	94.76%

CONCLUSION

The presented research work focuses on developing an herbal anti acne ointment using Cinnamomum zeylanicum (cinnamon) and honey. This combination is novel in that it combines the known antibacterial and anti- inflammatory properties of both cinnamon and honey. While there may be existing topical herbal formulations containing cinnamon for treating acne, this specific research aims to introduce the synergistic effects of combining cinnamon and honey into new formulations. The in vitro diffusion studies mentioned in the context suggest that these newly developed formulations will undergo testing to evaluate their performance in terms of drug release or penetration through artificial membranes simulating skin barriers. These tests help determine how well the active ingredients can reach the target site within the body when applied topically. In summary, the research proposes to create unique anti acne ointments by utilizing the combined benefits of cinnamon and honey, which have demonstrated antimicrobial and anti-inflammatory properties. In vitro diffusion studies will assess the effectiveness of these formulations.

AUTHOR'S CONTRIBUTION:

Pratibha Sharma - Data Collection & Writing the manuscript; Mukesh Kumar & Bhumika - Supervision.

CONSENT FOR PUBLICATION:

All authors agreed on the publication.

FUNDING:

None

CONFLICT OF INTEREST:

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

ACKNOWLEDGEMENT:

Pratibha Sharma thanks to the management, IIMT College Of Medical Science Meerut, India, for providing necessary facilities to accomplish the paper.

We are extremely thankful Associate. Professor Mukesh Kumar, Faculty of IIMT College Medical Sciences, Department of Pharmaceutics, IIMT University of Meerut, Asst. Professor, Bhumika Faculty of Pharmacy, Department of Pharmaceutics IIMT University of Meerut, for their input and support throughout the work.

REFERENCE:

1. Jakhetia, Vaibhavi, Rakesh K Patel, Pankaj Khatri, Neeraj Pahuja, Anupriya Pandey and Suresh Gyan. "CINNAMON: A PHARMACOLOGICAL REVIEW." (2010).
2. Wang, Jun; Su, Benzheng; Jiang, Haiqiang; Cui, Ning; Yu, Zongyuan; Yang, Yuhan; Sun, Yu (2020). Traditional uses, phytochemistry and pharmacological activities of the genus Cinnamomum (Lauraceae): A review. Fitoterapia, (), 104675–. doi: 10.1016/j.fitote.2020.104675
3. Bonlawar, J., Setia, A., Challa, R.R., Vallamkonda, B., Mehata, A.K., Vaishali, , Viswanadh, M.K., Muthu, M.S. (2024). Targeted Nanotheransotics: Integration of Preclinical MRI and CT in the Molecular Imaging and Therapy of Advanced Diseases. *Nanotheranostics*, 8(3), 401-426. https://doi.org/10.7150/ntno.95791.
4. Pasala, P. K., Rudrapal, M., Challa, R. R., Ahmad, S. F., Vallamkonda, B., & R., R. B. (2024). Anti-Parkinson potential of hesperetin nanoparticles: *in vivo* and *in silico* investigations. *Natural Product Research*, 1–10. https://doi.org/10.1080/14786419.2024.2344740
5. Suseela, M. N. L., Mehata, A. K., Vallamkonda, B., Gokul, P., Pradhan, A., Pandey, J., ... & Muthu, M. S. (2024). Comparative Evaluation of Liquid-Liquid Extraction and Nanosorbent Extraction for HPLC-PDA Analysis of Cabazitaxel from Rat Plasma. *Journal of Pharmaceutical and Biomedical Analysis*, 116149. https://doi.org/10.1016/j.jpba.2024.116149
6. Chakravarthy, P.S.A., Popli, P., Challa, R.R. *et al.* Bile salts: unlocking the potential as bio-surfactant for enhanced drug absorption. *J Nanopart Res* 26, 76 (2024). https://doi.org/10.1007/s11051-024-05985-6
7. Setia, A., Vallamkonda, B., Challa, R.R., Mehata, A.K., Badgujar, P., Muthu, M.S. (2024). Herbal Theranostics: Controlled, Targeted Delivery and Imaging of Herbal Molecules. *Nanotheranostics*, 8(3), 344-379. https://doi.org/10.7150/ntno.94987.
8. Dhamija P, Mehata AK, Tamang R, Bonlawar J, Vaishali, Malik AK, Setia A, Kumar S, Challa RR, Koch B, Muthu MS. Redox-Sensitive Poly(lactic-*co*-glycolic acid) Nanoparticles of Palbociclib: Development, Ultrasound/Photoacoustic Imaging, and Smart Breast Cancer Therapy. Mol Pharm. 2024 May 5. doi: 10.1021/acs.molpharmaceut.3c01086. Epub ahead of print. PMID: 38706253.
9. Eranti, Bhargav and Mohammed, Nawaz and Singh, Udit Narayan and Peraman, Ramalingam and Challa, Ranadheer Reddy and Vallamkonda, Bhaskar and Ahmad, Sheikh F. and DSNBK, Prasanth and Pasala, Praveen Kumar and Rudrapal, Mithun, A

Central Composite Design-Based Targeted Quercetin Nanoliposomal Formulation: Optimization and Cytotoxic Studies on MCF-7 Breast Cancer Cell Lines. Available at SSRN: https://ssrn.com/abstract=4840349 or http://dx.doi.org/10.2139/ssrn.4840349

10. Setia A, Challa RR, Vallamkonda B, Satti P, Mehata AK, Priya V, Kumar S, Muthu MS. Nanomedicine And Nanotheranostics: Special Focus on Imaging of Anticancer Drugs Induced Cardiac Toxicity. Nanotheranostics 2024; 8(4):473-496. doi:10.7150/ntno.96846. https://www.ntno.org/v08p0473.htm
11. Mandal S, Vishvakarma P. Nanoemulgel: A Smarter Topical Lipidic Emulsion-based Nanocarrier. Indian J of Pharmaceutical Education and Research. 2023;57(3s):s481-s498.
12. Mandal S, Jaiswal DV, Shiva K. A review on marketed Carica papaya leaf extract (CPLE) supplements for the treatment of dengue fever with thrombocytopenia and its drawback. International Journal of Pharmaceutical Research. 2020 Jul;12(3).
13. Bhandari S, Chauhan B, Gupta N, et al. Translational Implications of Neuronal Dopamine D3 Receptors for Preclinical Research and Cns Disorders. *African J Biol Sci (South Africa)*. 2024;6(8):128-140. doi:10.33472/AFJBS.6.8.2024.128-140
14. Tripathi A, Gupta N, Chauhan B, et al. Investigation of the structural and functional properties of starch-g-poly (acrylic acid) hydrogels reinforced with cellulose nanofibers for cu2+ ion adsorption. *African J Biol Sci (South Africa)*. 2024;6(8): 144-153, doi:10.33472/AFJBS.6.8.2024.141-153
15. Sharma R, Kar NR, Ahmad M, et al. Exploring the molecular dynamics of ethyl alcohol: Development of a comprehensive model for understanding its behavior in various environments. Community Pract. 2024;21(05):1812-1826. doi:10.5281/zenodo.11399708
16. Mandal S, Kar NR, Jain AV, Yadav P. Natural Products As Sources of Drug Discovery: Exploration, Optimisation, and Translation Into Clinical Practice. African J Biol Sci (South Africa). 2024;6(9):2486-2504. doi:10.33472/AFJBS.6.9.2024.2486-2504
17. Kumar S, Mandal S, Priya N, et al. Modeling the synthesis and kinetics of Ferrous Sulfate production: Towards Sustainable Manufacturing Processes. African J Biol Sci (South Africa). 2024;6(9):2444-2458. doi:10.33472/AFJBS.6.9.2024.
18. Revadigar RV, Keshamma E, Ahmad M, et al. Antioxidant Potential of Pyrazolines Synthesized Via Green Chemistry Methods. African J Biol Sci (South Africa). 2024;6(10):112-125. doi:10.33472/AFJBS.6.10.2024.112-125
19. Sahoo S, Gupta S, Chakraborty S, et al. Designing, Synthesizing, and Assessing the Biological Activity of Innovative Thiazolidinedione Derivatives With Dual Functionality. African J Biol Sci (South Africa). 2024;6(10):97-111. doi:10.33472/AFJBS.6.10.2024.97-111
20. Mandal S, Bhumika K, Kumar M, Hak J, Vishvakarma P, Sharma UK. A Novel Approach on Micro Sponges Drug Delivery System: Method of Preparations, Application, and its Future Prospective. Indian J of Pharmaceutical Education and Research. 2024;58(1):45-63.
21. Mishra, N., Alagusundaram, M., Sinha, A., Jain, A. V., Kenia, H., Mandal, S., & Sharma, M. (2024). Analytical Method, Development and Validation for Evaluating Repaglinide Efficacy in Type Ii Diabetes Mellitus Management: a Pharmaceutical

Perspective. Community Practitioner, 21(2), 29–37. https://doi.org/10.5281/zenodo.10642768

22. Singh, M., Aparna, T. N., Vasanthi, S., Mandal, S., Nemade, L. S., Bali, S., & Kar, N. R. (2024). Enhancement and Evaluation of Soursop (Annona Muricata L.) Leaf Extract in Nanoemulgel: a Comprehensive Study Investigating Its Optimized Formulation and Anti-Acne Potential Against Propionibacterium Acnes, Staphylococcus Aureus, and Staphylococcus Epidermidis Bacteria. Community Practitioner, 21(1), 102–115. https://doi.org/10.5281/zenodo.10570746
23. Khalilullah, H., Balan, P., Jain, A. V., & Mandal, S. (n.d.). Eupatorium Rebaudianum Bertoni (Stevia): Investigating Its Anti-Inflammatory Potential Via Cyclooxygenase and Lipooxygenase Enzyme Inhibition - A Comprehensive Molecular Docking And ADMET. Community Practitioner, 21(03), 118–128. https://doi.org/10.5281/zenodo.10811642
24. Mandal, S. Vishvakarma, P. Pande M.S., Gentamicin Sulphate Based Ophthalmic Nanoemulgel: Formulation and Evaluation, Unravelling A Paradigm Shift in Novel Pharmaceutical Delivery Systems. Community Practitioner, 21(03), 173-211. https://doi.org/10.5281/zenodo.10811540
25. Mishra, N., Alagusundaram, M., Sinha, A., Jain, A. V., Kenia, H., Mandal, S., & Sharma, M. (2024). Analytical Method, Development and Validation for Evaluating Repaglinide Efficacy in Type Ii Diabetes Mellitus Management: A Pharmaceutical Perspective. Community Practitioner, 21(2), 29–37. https://doi.org/10.5281/zenodo.10642768
26. Singh, M., Aparna, T. N., Vasanthi, S., Mandal, S., Nemade, L. S., Bali, S., & Kar, N. R. (2024). Enhancement and Evaluation of Soursop (Annona Muricata L.) Leaf Extract in Nanoemulgel: a Comprehensive Study Investigating Its Optimized Formulation and Anti-Acne Potential Against Propionibacterium Acnes, Staphylococcus Aureus, and Staphylococcus Epidermidis Bacteria. Community Practitioner, 21(1), 102–115. https://doi.org/10.5281/zenodo.10570746
27. Gupta, N., Negi, P., Joshi, N., Gadipelli, P., Bhumika, K., Aijaz, M., Singhal, P. K., Shami, M., Gupta, A., & Mandal, S. (2024). Assessment of Immunomodulatory Activity in Swiss Albino Rats Utilizing a Poly-Herbal Formulation: A Comprehensive Study on Immunological Response Modulation. Community Practitioner, 21(3), 553–571. https://doi.org/10.5281/zenodo.10963801
28. Mandal S, Vishvakarma P, Bhumika K. Developments in Emerging Topical Drug Delivery Systems for Ocular Disorders. Curr Drug Res Rev. 2023 Dec 29. doi: 10.2174/0125899775266634231213044704. Epub ahead of print. PMID: 38158868.
29. Abdul Rasheed. A. R, K. Sowmiya, S. N., & Suraj Mandal, Surya Pratap Singh, Habibullah Khallullah, N. P. and D. K. E. (2024). In Silico Docking Analysis of Phytochemical Constituents from Traditional Medicinal Plants: Unveiling Potential Anxiolytic Activity Against Gaba, Community Practitioner, 21(04), 1322–1337. https://doi.org/10.5281/zenodo.11076471
30. Pal N, Mandal S, Shiva K, Kumar B. Pharmacognostical, Phytochemical and Pharmacological Evaluation of Mallotus philippensis. Journal of Drug Delivery and Therapeutics. 2022 Sep 20;12(5):175-81.