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Formulation and Development of Thymol Loaded Gum Acacia and Carbopol Crosslinked Hydrogel Wound Dressings

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Abstract: ***Thymol, an antibacterial agent, was entrapped in acacia−carbopol (TAC) hydrogel films for rapid wound healing. Hydrogel was prepared by cross linking acacia and carbopol with N, N - methylenebis - (acrylamide). This hydrogel was further formulated into film (TAC) using solvent casting method and triethyl citrate as a plasticizer. Hydrogel and TAC films were characterized by NMR and FTIR. Both, the hydrogel and the films were evaluated for diffusion study of thymol which showed slow release of drug for wound healing. Antimicrobial activity of thymol against Pseudomonas aeruginosa was found to be retained in TCA film. Tensile strength and mucoadhesion of film performed using texture analyzer, showed elasticity and adhesiveness needed to retain on the wound area. High folding endurance confirmed flexibility of film. Films were also evaluated for degradation study, microbial penetration andrate of water vapor transmission. In vivo study of TCA film was performed using rats excision wound model which showed rapid wound healing and closure activity within day 10. Histology study revealed inflammatory cell infiltrations and neovascularization in granulation tissues, ultimately healing the wound. The mucoahesiveness of carbopol along with the antibacterial nature of thymol and astringent effect of acacia make the TCA film as a potential candidate for rapid wound healing.***

Keywords: thymol, wound healing, hydrogel dressings

1. Introduction

Skin is the largest organ of the body which performs many crucial roles for instance as a barrier against exogenous substances including pathogens and mechanical stresses [1]. Skin is always in direct contact with the external environment which make them highly susceptible to damage and/or injury [3]. Thus, fast repair of the skin after an injury is necessary. Now – a days, polymeric wound dressings were developed to act as analog of the skin by performing many of the functions of natural skin like exudate management capacity, preventing microbial invasion and thermal protection [1, 2]. Hydrogels can manage the excessive exudate produced in the wound site and can act as a thermal barrier [4]. However, additional strategies should be adopted to prevent the bacteria linvasion and colonization in the wound. Incorporation of antimicrobial agents in the wound dressing is a robust approach to overcome wound infections [5]. Antibiotics have been tried as antibacterial agents in polymeric wound dressings to avoid bacterial colonizationin the wound [6]. Due to the bacterial drug resistance and less chemical stability of the antibiotics, relatively stable novel materials should be exploited as antibacterial agents in wound dressings.

Hydrogels are swellable hydrophilic materials. They are made from synthetic polymers such as polymethacrylate or polyvinylpyrrolidine. Hydrogels can be produced in two shapes, amorphous or solid sheet/films [4, 6]. If hydrogels are applied to the wound as gels, they need a second cover such as gauze. On the other hand if they are applied as films to the wound, they can be used both as a primary and secondary dressing. Hydrogels fit most criteria for a suitable wound dressing as they:

- Help to the rehydration of dead tissues and increase the healing of debridement.
- Are suitable for cleansing of dry, sloughy or necrotic wounds.
- Do not react with biological reacts.
- Are permeable to metabolites.
- Are nonirritant.
- Promote moist healing.
- Are non - adherent.
- Cool the surface of the wound [7, 8].

Hydrogels should be used for dry or low level of exudate wounds. The excess moisture can lead to maceration of skin. Hydrogels can be applied and removed with minimal trauma and pain from wound bed. Because of the cooling effect that hydrogels have on wound bed, they can give a relief feeling to patients [9]. However, hydrogels have some disadvantages also. Due to the higher amount of water (70 - 90%) hydrogels do not have the ability of absorption of exudates.

Accumulation of fluid in hydrogels provides a suitable environment for bacterial growth and can produce infected smell afterward [10]. Therefore, hydrogels should be changed quite often. Hydrogels have low mechanical strength.

The aim of study is to get the crosslinked hydrogel and the anti - microbial activity of the Gum - Acacia. The use of thymol is to get the improved the anti - microbial activity of the hydrogel dressing [11]. The use of the hydrogel dressing shows the property of the hydration and helps in the process of the gases exchange from wound to atmosphere. The use

of hydrogel dressing shows the improved self adhesive nature and also avoid the side effects of the dressings over hydrogel dressing [12, 13].

2. Method and Material

Materials

Thymol (99%), Gum acacia (extra pure), Carbopol 934 (extra pure), N, N - Methylene Bisacrylamide (99%), Ammonium Persulphate (98%) and Tri - ethyl citrate (extra pure) were got by the gift samples by the LOBA CHEMIE, TARAPUR M. I. D. C, BOISAR, MH.

Method [1, 14]

Formulation of Gum - Acacia and Carbopol cross - linked hydrogel trial batches [1, 18]

Take the clean beaker with 250 ml volume and add the approximate 80 - 100 ml of water. In these add the approximate quantity of carbopol with proper stirring and then add Ammonium Persulphate (0.125 gm/100 ml) andN, N - Methylene Bisacrylamide (0.124 gm/100 ml) with proper stirring. Slowly add the sufficient amount of the Gum Acacia to the resultant solution and keep stirring for 24 hrs for the complete crosslinking of the Gum - acacia and Carbopol. The entire process of hydrogel was formed by the solution casting method. The resultant batches of hydrogel were prepared as shown in the table 1.

Table 1: Formulation batches of hydrogel

Batches	Gum-Acacia (w/v)	Carbopol (w/v)	N, N - Methylene Bisacrylamide	Ammonium persulphate
F1	1	4	0.124	0.125
F2	2	3	0.124	0.125
F3	2.5	2.5	0.124	0.125
F4	3	2	0.124	0.125
F5	4	1	0.124	0.125

Optimization of the batches [16]

Trial batches were optimized to get the final batch by checking the Texture Profile analysis of the formulated all the batches as shown in the table 3.

Incorporation of thymol in hydrogel [16]

The thymol is insoluble in the water so to incorporate the thymol in hydrogel some quantity of alcohol was added. The 2%w/v of thymol was dissolved in the alcohol and then added to hydrogel with constant stirring. The resultant hydrogel is containing the alcohol/water in which water is in higher concentration and alcohol in lower.

Formulation of Films

The formed hydrogels were poured in the clean petri plate and dried in the hot air oven at 55^0C for 24 Hrs. After complete drying slowly pull out the film from the plates.

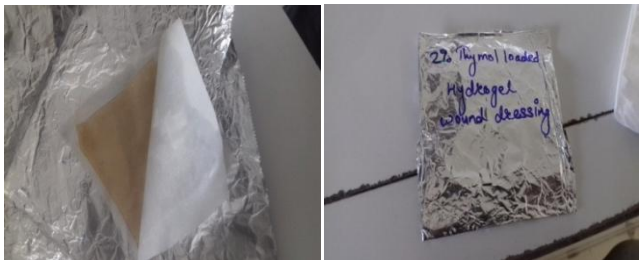


Figure 1: Formulated film in proper packaging

Evaluation of thymol loaded hydrogel dressings [1]

Physical evaluation

Formulations were evaluated for organoleptic characteristics, visual appearance, odour, color, texture, occlusiveness, washability and folding endurance of the film.

Crosslinking of Gum Acacia and Carbopol

Crosslinking of acacia and carbopol was checked by the taking NMR, SEM and FTIR graphs of the plain and hydrogel samples.

Measurement of pH

The pH of the formulated hydrogel and film was determined using digital pH meter (Systronics Instruments, India). The electrode was immersed in the gel and readings were recorded from pH meter.

Texture profile analysis of film [17]

Texture profile analysis (TPA) of gel was performed using a CT3 Texture Analyzer (Brookfield) in compression mode by using tensile strengt accessory (TA - BT - KIT). Optimized film formulation was filled into the female probe, taking care to avoid air pocket into the samples. A conical analytical male probe (35 mm diameter of 45°) was forced down into each sample at a defined rate (1 mm/s) and to a defined depth (10 mm). At least two replicate analysis of samples were performed. From the resulting force–time plots, the hardness (the force required to attain a given deformation), cohesiveness (the work required to deform the hydro gel in down movement of probe) and adhesiveness (the work necessary to overcome the attractive forces between the surface of the sample and the surface of the probe) were studied. Spreadability was calculated from the energy required to deform the sample or from the hardness of the sample.

Antimicrobial activity of hydrogel and Film

An antimicrobial activity of the hydrogel and hydrogel dressings were checked against *S. Aurious* and *P. Aurious*in aseptic condition by zone of inhibition.

Microbial penetration test [1]

In these test the formulated hydrogel film was tied on the mouth of the test tube containing nutrient broth in aseptic condition. Place the test tube aside for the 24 hrs. and observe the results by checking the growth by external view.

Drug content (hydrogel dressing) [18]

Hydrogel dressing (1.0g) of formulations was taken in 100 ml volumetric flask containing 20 ml of methanol and stirred for 30 min and allowed to stand for 24 h. The resultant

solution was filtered through membrane filter. The absorbance of the solution was measured spectrophotometrically at 272 nm using plain thymol as a reference.

Ex - Vivo diffusion Study of Final Optimized hydrogel film [18]

For this study previously sacrificed goat skin ether cellophenmembren was collected, membrane was washed with phosphate buffer solution and finally covered with aluminium foil and stored at 3 to5^0 cin a freezer for permeation study. Before permeation study, skin was taken outside and dipped into buffer solution for 24 hrs and 30 minutes before permeation study dip into 0.1 N NaCl solution. For the diffusion study skin was remove and mounted between the donor and receptor compartment of the diffusion cell in such a way the dermal side of skin was facing receptor compartment. The drug loaded transdermal matrix film placed over the membrane and receptor compartment filled with 13 mL of pH 5.8 buffer. The temperature of diffusion medium maintained at 37 ± 2^0C. This whole assembly kept on a magnetic stirrer and solution in the receiver compartment constantly and continuously stirred using magnetic bead. The samples were withdrawn (2 ml, each time) at different time interval and an equal amount of pH 5.8 buffer replaced each time, absorbance of the sample measured using UV spectrophotometer at λmax 272 nm for thymol. The amount of drug permeated per square centimeter at each time interval was calculated and plotted against time. The regression analysis of steady state data and release rate was calculated.

Biodegradability test of the Film

In these test place the 1cm * 1cm of the film in side the slight cut of the apple. Place the apple in the cool place and observe the film after every 24 hrs. and report the results.

Water vapor transmission [1]

The water vapour transmission test of the formulated film was taken by checking the permeation of water vapour through the film.

Place the film in between two diffusion cells with packed through all the sides that only vapours can directly come in contact with film. Heat the surface in which water is present allow to heat for 1 hr and then check the weight of the film and weight or volume loss of water through the proper surface area of film which comes in contact with open part.

Animal study [12]

The animal study was carried out on the excision cut wound method on wister male rats in 6 groups. A group of animal contains 3 animals and total no. of animals taken are 21 animals and groups were divided as shown in the following table 3No. of animals required - 21
No. of animal sacrificed - 21
Drug used for the anesthesia - Di - Methyl Ether
Drug used for the killing rats - Chloroform
Tissue stored – Formaline: Water (10: 90)

Table 2: No. of animals used

Name of group	No. of animals in group
Control	3
Thymol loaded hydrogel	3
Plain thymol	3
Plain gum acacia and carbopol film	3
Plain gum acacia	3
Marketed formulation	3

3. Result and Discussion

Preformulation study of thymol

Thymol is extracted from the leaf, fruits and flowers of *TrachyspermumAmmi* Linn Sprague. Fam. *Umbelliferae* significantly reported to have antimicrobial, antifungal, antibacterial, wound healing activity, anti - inflammatory, antimalarial, analgesic, hypoglycemic, hepatoprotective, immuneostimulant, antidermatophytic, antioxidant, antiviral and anticancer properties. The pure drug thymol and various other excipients such as Gum Acacia and Carbopol 934. were subjected to various preformulation parameters such as organoleptic characteristic study, melting point determination, solubility study, wavelength (λmax) determination, calibration curve, identification of drug thymol by FT - IR study. The colour of the thymol was visualized YELLOWISH WHITE with a faint characteristic odour having yellowish orange crystalline powder appearance (Table 3).

Organoleptic Characteristics of thymol

Table 3: Organoleptic characteristics of thymol

Parameter	Observed Result
Colour	Yellowish white
Odour	Odourless or a faint characteristic odour
Appearance	Yellowish white crystal

Determination of melting point of thymol

Melting point of Thymol was determined by capillary method by using melting point apparatus and was found to be in range of 48 - 52°C which was close to reference standard value of 49 - 51°C.

Determination of wavelength max (λmax) of thymol

The U. V spectrum of thymol was obtained by scanning the solution in the range of 200 - 400 nm. The maximum absorbance was occurred at the 272 nm.

Table 4: Calibration curve of thymol

CONC (µg/ml)	ABS
5	0.113
10	0.243
15	0.359
20	0.483
25	0.667
30	0.783

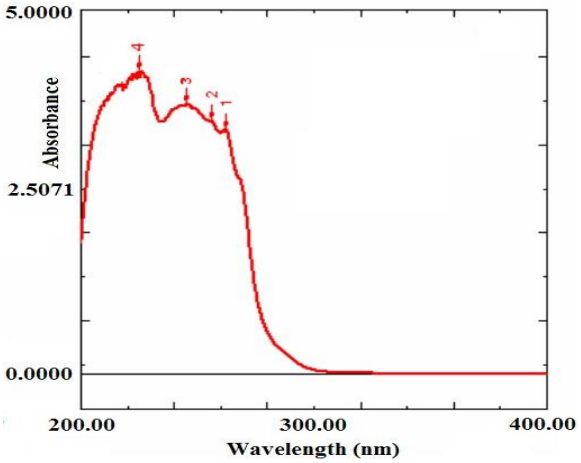
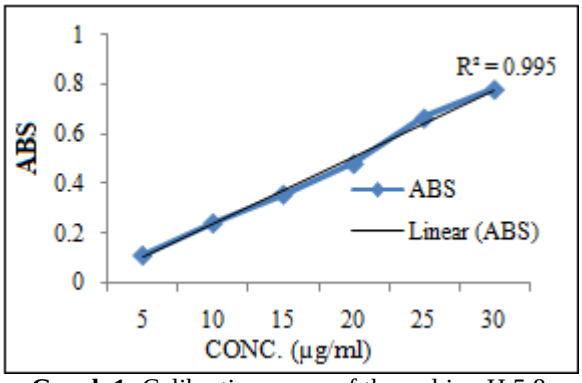


Figure 2: Spectra of thymol at 272 nm



Graph 1: Calibration curve of thymol in pH 5.8

Identification of drug - thymol by FT - IR Spectroscopy

FT - IR spectrum of thymol was obtained by scanning the sample in the range of 400–4000 cm $^{-1}$. The characteristic peaks of thymol were observed at several regions which correspond to the functional group present in the structure of the drug. From the interpretation the drug was identified and confirmed as shown in the table 5.

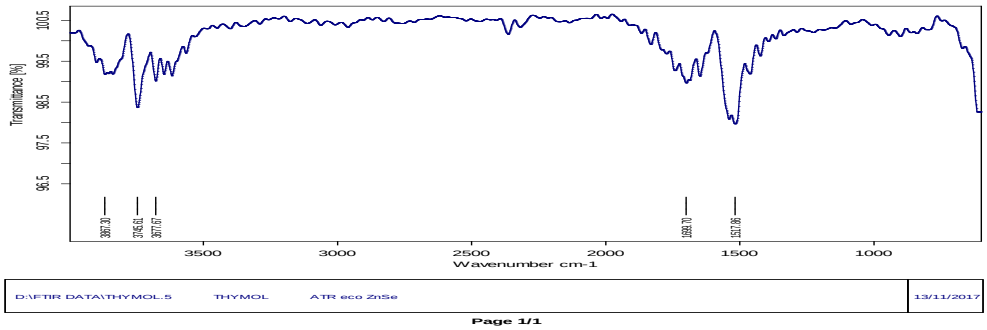


Figure 3: FTIR peaks of Thymol

Table 5: FT - IR peaks of Thymol

Observed peaks (cm $^{-1}$)	Interpretation of chemical group
3867.30	**- O - H** group
3745.61	**- C - H** group
3677.67	**- C - H** group
1699.70	**C=C** stretching
1517.86	**C - O** stretching

Drug – excipient compatibility study

Drug - excipients Compatibility Study by FT - IR:

The FT - IR spectrum of standard drug thymol, Gum - Acacia and carbopol 934 shows same peak, functional group at the different frequency shown in figure and table 7. The spectrum of pure thymol was equivalent to the spectra obtained by the addition of polymers. The results revealed no changes seen in the IR peaks of thymol, when mixed with polymers. These observations indicated compatibility of polymers with thymol.

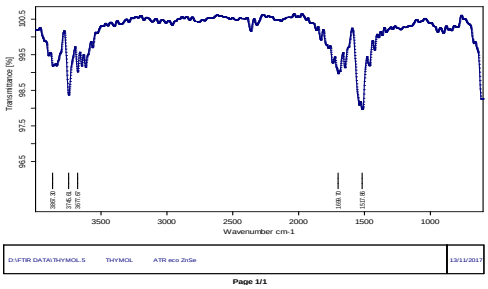


Figure 4 (a): FT - IR of drug Thymol

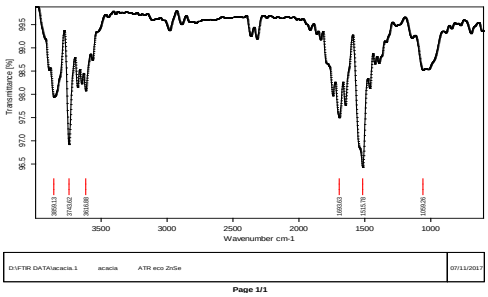


Figure 4 (b): Gum – Acacia

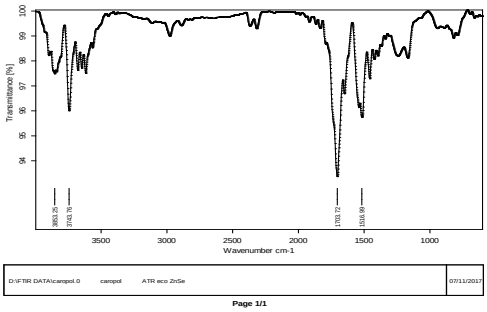


Figure 4 (c): FTIR of Carbopol 934

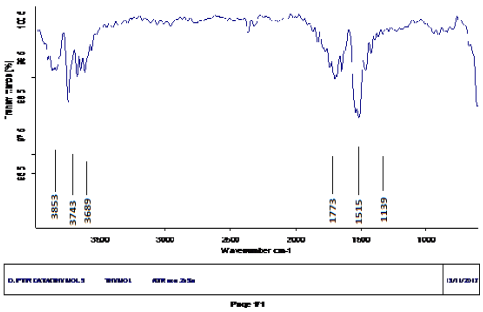


Figure 4 (d): FT - IR of thymol loaded hydrogel

Table 6: FT - IR peaks of thymol, Gum - Acacia, carbopol and formulation

Observed peaks (cm^{-1})			Interpretation of chemical group
Thymol	Gum-Acacia	Carbopol 934	
3867	3859	3853	O - H stretching
3745	3743	3743	C=O stretching
3677	3616		Aromatic ring
1699	1693	1709	Aromatic C = C stretching/ Carboxylic acid
1517	1515	1516	C - HX vibration
			Acid C - O stretching
			O - H bending & C - O stretching
	1059		C=O ester

The first step in optimizing the hydrogel formulation destined for wound treatment is to have a reproducible and simple method for determination of the texture properties of the gel, as bio- adhesivness and viscosity affect the retention time at the applications site, and the retention time is directly correlated to the efficiency of the therapy. Insight on the texture properties would shorten the optimization of formulation process.

Crosslinking examination of final batch by NMR

The crosslinking of hydrogel in which the thymol, Gum - Acacia and carbopol was present was checked by the both FTIR and NMR. The drug and exepient relation was explained in the above co relation and the confirmation of the crosslinking was done by checking the NMR data of the Acacia and hydrogel by C^{13} NMR as shown in the table and diagram

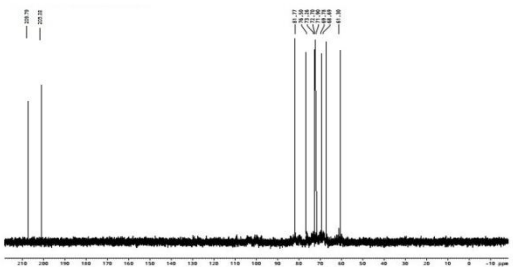


Figure 5 (a): NMR data of acacia

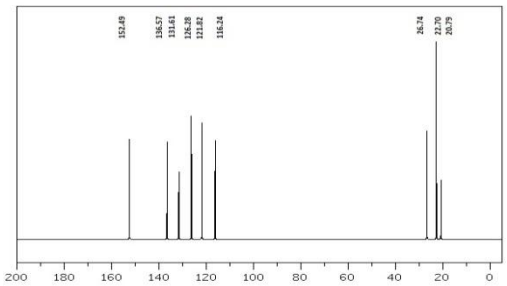


Figure 5 (b): NMR of Thymol

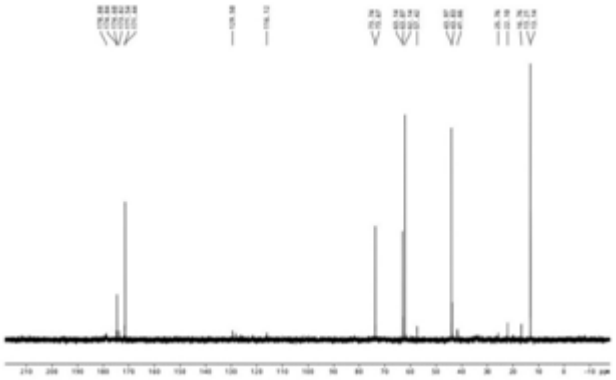


Figure 5 (c): NMR data of thymol loaded hydrogel

Table 7: NMR interaction of formulation

Observed peaks			Interpretation of chemical group
Thymol	Gum - Acacia	Hydrogel	
	209	178	C=O aromatic ring
	205	174	COOH aromatic ring
152		173	C=C aromatic ring
136		171	C=C aromatic ring
126		129	C=C aromatic ring
116		116	C=C aromatic ring
	81		C=C starching non aromatic
	76		C - C stretching
	73	73	C - C stretching
	72	63	C - C stretching
	69	62	C - OH stretching
	65	57	C=O non aromatic
	61	43	C - CH_2 - CH_3
40 - 10		40 - 10	- CH_3

The above table justify the complete crosslinking of Gum Acacia, Carbopol and thymol in which the principal groups of the thymol and acacia which shows pharmacological activity remains unchanged.

The C13 NMR was also shows that the excipients and drug was compatable in which shows unchanged functional groups and principal groups. Also the crosslinking was confirmed.

Trial batches and optimization of hydrogels

Optimization of the hydrogel was done by checking the mucoadhesive strength of the gel. Formulation hydrogel was carried out by the taking different concentration of the Acacia and carbopol and constant amount of the N, N - Methylene Bis - Acrylamide and Ammonium Ammonium persulfate as shown in the table 8.

Table 8: Batches and Texture profile Analysis

Batches	Gum Acacia (Gm)	Carbopol (Gm)	N, N - Methylene Bis - Acrylamide (Gm)	Ammonium persulfate (Gm)	Mucoadhesive property (MJ)	Tensile strength (mm)
F1	1	4	0.124	0.125	- - - -	78
F2	2	3	0.124	0.125	35	50.07
F3	2.5	2.5	0.124	0.125	27	43.50
F4	3	2	0.124	0.125	20	38.65
F5	4	1	0.124	0.125	- - - -	30.01

In the above table the complete texture profile analysis was done. Batch F2 was selected as optimized batch. F2 batch shows the optimum MUCOADHESIVE property and also good in tensile strength. F2 batch contains sufficient amount of the Acacia which has the antimicrobial property and due to these F2 batch is selected as optimized batch

Texture profile analysis

The texture of film was taken by checking the tensile strength of the formulation on Brookfield texture analyzer. Method used to check the strength of film is *TPA tension method* in which the film was hold in between the two clips and tension was applied on the other side of the film the strength was calculated at point at which the film gets break. The optimization of batch was seen by having proper tensile strength as shown in following table 9.

Table 9: Optimization of formulation by TPA

Batches	Gum Acacia (Gm)	Carbopol (Gm)	N, N - Methylene Bis – Acrylamide (Gm)	Ammonium persulfate (Gm)	Hardness work done	Tensile strength (mm)
F1	1	4	0.124	0.125	2568	78
F2	2	3	0.124	0.125	1920	50.07
F3	2.5	2.5	0.124	0.125	1104	43.50
F4	3	2	0.124	0.125	1012	38.65
F5	4	1	0.124	0.125	826	30.01

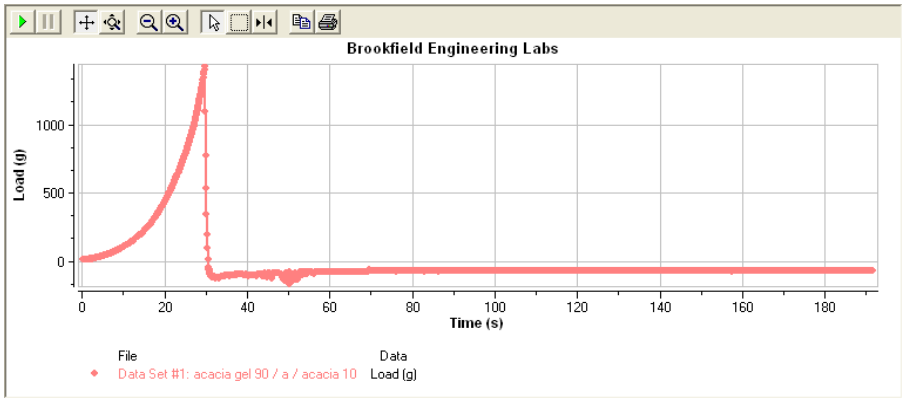


Figure 6: Texture profile analysis

- Hardness: 1920g
- Hardness work: 5.7 mJ
- Adhesive force: 107g
- Adhesiveness: 61.8 mJ
- Tensile strength: 29.38mm

The above graph shows the texture profile analysis of the optimized batch F2. In which the quantity of Gum acacia and Carbopol is in proportion due to which it gives desired activity of acacia and also Carbopol.

Drug release profile:

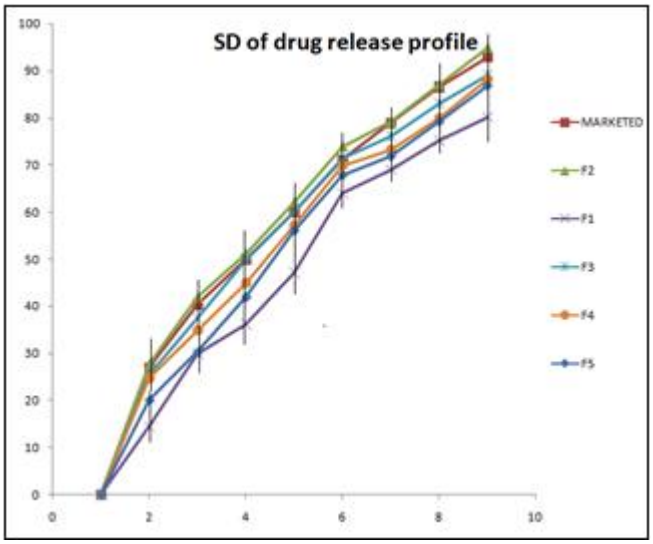
Drug release profile is mainly responsible for the release of drug from formulation and also helps in the optimization of the batch for the better results. The drug release profile of formulation was compared all the batches with marketed formulation and the batch selected as a optimized batch.

From the above data then F2 batch was selected as optimized batch. F2 batch shows approximate same drug release as the marketed because Thymol which was freely

available in the polymer complex and dose not interferes in the crosslinking of Acacia and Carbopol so F2 batch shows higher drug release.

Table 10: Drug release profile

Time	F1	F2	F3	F4	F5	Marketed
0	0	0	0	0	0	0
1 HR	14.507	27.765	25.371	24.782	20.091	26.893
2 HR	29.886	41.97	37.41	34.86	30.256	40.41
3 HR	36.169	51.127	49.891	44.891	41.961	49.964
4 HR	47.053	62.083	60.009	57.063	56.039	60.007
5 HR	63.934	73.901	71.39	69.834	67.873	71.093
6 HR	69.03	79.076	76.08	73.091	71.83	78.892
7 HR	75.087	87.048	83.091	79.82	79.201	86.493
8 HR	80.08	94.782	89.087	88.087	86.83	92.82



Graph 2: Graphical arrangement of drug release profile

Other thing in F1 batch higher amount of carbopol is present which control the drug release and while in F3, F4, F5 batches contains comparatively less carbopol so thymol gel crosslinked with the acacia so the release of thymol is low.

Drug content in F2 batch:
The drug content of film was calculated in F2 batch has been checked to get the uniformity of the drug throughout the patch. The drug content was taken in the pH solution 5.8 as per the approximate pH of wound fluid.

The drug content was calculated by following formula

drug content=abs-intercept/slope*dilution factor

The 100 ml of hydrogel contains 2000mg of the drug and the volume of hydrogel which was used for the film formulation was 25 ml so the drug contant was found to be 500 mg in 72 cm^2 of the patch.

Surface pH of formulation F2
To maintain the formulation was compared and comparative study of the surface pH was taken as follows

Table 11: pH of Hydrogel

Formulation	Surface pH
2% thymol loaded hydrogel	6.8
Only hydrogel	12.7
Plane acacia	7.01
Marketed formulation	6.9

Thymol used in the formulation maintains pH of the hydrogel which was seen to be 6.8. The plain hydrogel shows the 12.7 which was slightly alkaline and after addition of thymol the pH maintains up to 6.8 which is approximate equal to the wound fluid.

Folding endurance of the patch
The folding endurance also helps in the checking the flexibility and strength of the patch. In our project the folding endurance was taken of formulation in several steps as shown in the table.

Table 12: Folding endurance of formulation

Formulation	Folds
Plane acacia and carbopol hydrogel patch without TEC	79 folds
2% thymol loaded hydrogel	89 folds
Plane acacia and carbopol hydrogel patch with TEC	125 folds
2% thymol loaded hydrogel patch with TEC	134 folds
Marketed patch	130 folds

Addition of the Tri - Ethyl Citrate increases the plasticity and the strength of the film. So the addition of tri - ethyl citrate was done to increase the plasticity of the film.

Water vapour transmission
The water vapour transmission study is recorder to get the transmission of water across the film and amount of water traps in the film. These test also helps to study the % weight gain of the path and % water transmitted across the film in 1 hr.

Calculation results (1 Hr)
- Weight of film before test – 0.8198 gm
- Volume of water before test – 3 ml
- Weight of film after test - 1.39 gm
- Volume of water after test - 1.8 ml
- % increase in weight of patch - 62.23%
- % water remains in tube after examination - 60 %
- % water transmitted and trapped in film - 40%

(A) (B)
Figure 7: A - Amount of water before test
B - Amount of water after test

Thus the water transmitted across the film shows that the healing of wound becomes faster and rapid. The presenc of

water increases the irritation and growth of Pus in the wound. But after the socking and transmission of water the process of wound healing get faster.

Anti - microbial study of formulation

Anti - microbial study of the formulation comes under 2 types

- Zone of inhibition of the thymol loaded hydrogel
- Microbial Penetration test.

A) Zone of inhibition of thymol loaded hydrogel

Zone of Inhibition of hydrogel was checked against the *Pseudomonas aeruginosa*and *Staphylococcus aureus*on nutrient broth medium and results were checked in MM. Zone of inhibition was taken of both thymol loaded hydrogel, plain hydrogel, and thymol was compared.

(A) (B) (C) (D)

Figure 8: Zone of Inhibition

A - 0% thymol loaded hydrogel
B - 2% thymol loaded hydrogel
C - 2% Thymol
D - Plain DMSO

Table13: Zone of Inhibition

Type of sample	ZOI (MM)
2% Thymol Loaded Hydrogel	32
2% Thymol	20
0 % thymol loaded hydrogel	12
DMSO control	0

The zone of inhibition of hydrogel was compared and checked against *Pseudomonas aeruginosa* and *Staphylococcus aureus* shows the zone as shown in the table 13.

B) Microbial Penetretion test

The formulated film was packed on the mouth of the test tube and incubated for the 24 hrs at 37^0C

Day 1 Day 2

Figure 9: Microbial penetration test

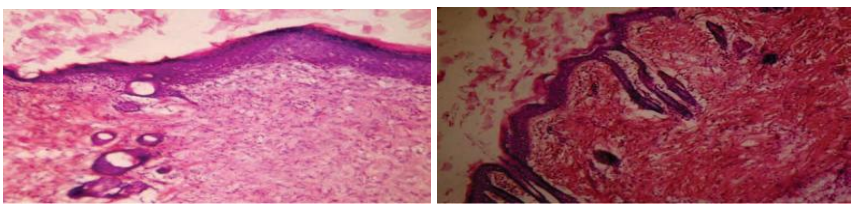
There no turbidity in the test tube which indicates the film resists the entery of the microorganisms across the film.

Animal Study

The animal study of the formulation was done on the wister male rats. The study was done by the external cut method and the study was evaluated by the % wound healing in 15 days and the wound healing tissue histopath study of formulation. The area of wound healing was compaired and explained in the groups was stated in the figure and table 15.

Table 15: % wound closer of the wound

Post Wounded Days	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6
1	0	0	0	0	0	0
3	43.57	18.94	22.25	19.09	52.49	16
7	98.88	63.08	75.48	62.21	98.79	35.2
10	100	84.96	81.37	80.54	100	49.5
15	100	94.73	98.48	89.7	100	61.75



(A) (B)

Figure 10: (A) skin of control rat with wounded structure (B) Skin of Thymol loaded hydrogel wound dressing treated rat

The above figures and table explains that Thymol loaded htdrogel wound dressings shows the positive wound healing in the 7 - 8 days and reliable to use in the wound care management. The formulated Film is prominent in the trapping the entery of Pathogen also avoids the inflammation

and heal the wound site. The formulated film also promote the regeneration of the tissue at the site.

Biodegradability of Film

Formulated film shows the novel neture that it is partial degradable so the test of degradability was performed to check the duration of biodegradable nature of novel dressing.

These test was performed in the apple because the pH of wound fluid and apple juice was nearly same.

Day 1 Day 3 Day 7

Figure 11: Biodegradability of the film in 7 Days

From the above test the degradability of the patch was seen but in the Gum Acacia was degraded. But the part of Carbopol gets swells and remains unchanged so the film dose passes the degradability test. But aftef the wound healing the layer of Acacia was degraded and carbopol was water washed which is convenient to use rather than trending other dressings.

4. Summary

The aim of the project is to replace the traditional wound dressings by the novel and naturally occurring wound care products for the convenience of the society. The thymol used in the formulation was extracted from the natural sources and the property of gum acacia was also proven for the wound care management.

The formulation batches were prepared and the optimized batch was chosen for the complete study. The novel wound dressing was prepared by the crosslinking the Gum Acacia and Carbopol with the help of the crosslinking agent and reaction initiator. The complete crosslinking process takes place in 24 Hrs. in hot air Oven at 50^0 C. The Crosslinking of the hydrogel was confirmed by the FTIR and NMR study. The incorporation of thymol was done by dissolving thymol in the part of the alcohol and added the solution to hydrogel with constant stirring at 100 RPM. The formulation of film was carried out by the solution casting method.

The evaluation was film was done by checking physical properties, texture profile analysis, drug release profile, animal study, biodegradable study, etc. and which proves the novelty of the dressing.

5. Conclusion

The aim of the present study was based on the replacement of the traditional wond dressings by the novel wound dressings. The novel thymol loaded hydrogel wound dressing was prepared and evaluated. The formulated dressing were flexible and elastic in nature which has more then 90% of drug release and also has a potency to heal wound in 7 - 8 days. The formulated novel wound dressing shows the degradability of the acacia and due to these it is convenient to use and apply at the wound site for rapid healing.

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