iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 6 **Issue:** I **Month of publication:** January 2018

DOI: http://doi.org/10.22214/ijraset.2018.1106

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor :6.887
Volume 6 Issue I, January 2018- Available at www.ijraset.com

Sustained Release Dental Implants

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I. AIM

To Formulate and evaluate the prepared sustained release Metronidazole dental implants.

II. REQUIREMENTS

Ethyl cellulose, HPMC, dibutylphthlate, dichloromethane: chloroform (1:1), methanol, Metronidazole.

III. THEORY

Dental implant is a pharmaceutical device in the form of strip with very small loading and size of 0.25 sq cm. The recognition that destructive periodontal diseases may be caused by specific microorganisms in periodontal pockets has led to an increased interest in and usage of antibacterial agents in periodontal therapy. Local chemotherapy by sustained delivery systems has been recently developed which may prolong the effect. However these devices have some limitations that, the polymer strip must be removed from the periodontal pocket after the release of the agent has been completed and might also cause local mechanical irritation and disturb periodontal repair. The drug concentration in gingival crevicular fluid(GCF) was determined to evaluate the usefulness of the dental implant in periodontal chemotherapy. For chemotherapy of periodontal diseases an effective concentration of the chemotherapeutic agent in the periodontal tissues and hence in gingival crevicular fluid must be maintained for an adequate duration of time to inhibit the growth of various periodontopathic organisms. For site specific one time continuous delivery of Metronidazole an antimicrobial compound with excellent activity against anaerobic microorganism. the intramuscular , sub dermal , intracranial or other organ specific depots are largely based on implants which either limit high drug concentrations to the immediate area surrounding the pathology.[1,2]

Implant systems are recommended when chronic therapy is indicated. Different kinds of implants are available like parenteral implants, dental implants, hormonal implants etc. During drug release various mechanisms such as diffusion, dissolution, vapor pressure, osmosis, ion exchange etc are involved. Solid implants typically exhibit biphasic release kinetics, with an initial burst of drug followed by a slower release. The initial burst is due to the surface drug release. The drug release is controlled by the polymer concentrations[3,4,5]

IV. EXPERIMENTAL PROCEDURE

A. Method Of Preparation

The formulation is done by solvent casting technique.

The required amount of ethyl cellulose (8% and 9 %) and copolymer HPMC(0.25% and 2.5%),were dissolved in chloroform: dichloromethane (1:1) ratio solvent. Dibutylphthalate (50% of polymer) was added to the mixture as plasticizer with constant stirring by magnetic stirrer. Required amount of Metronidazole was added to 10 ml methanol for complete dissolving. Then it was added to the polymer mixture with constant stirring. After complete mixing10 ml of the resulting solution was poured in a clean Petri dish placed on a horizontal plane. The solvent were allowed to evaporated slowly by inverting glass funnel with a cotton plug closed in the stem of the funnel on Petri dish at 24ºc for 24 hour. [1]

B. Evaluation

1) For standard graph

a) A weight of accurately 100 mg of Metronidazole powder was taken & dissolved in 100 ml of 0.1 N Hcl < solution A >

b) From the solution A 10 ml was pip petted out & diluted to 100 ml in a volumetric flask with 0.1 N Hcl < solution B >

c) From solution B different volumes of 0.2 ml, 0.4 ml, 0.6 ml, 0.8 ml, & 1 ml were taken & diluted up to 10 ml with 0.1 N Hcl solutions.

d) The absorbance was measured at 277 nm in U V spectrophotometer against a blank.

e) A graph was plotted by taking concentration VS absorbance

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2) *Content uniformity* : Content uniformity was estimated by dissolving three implants individually in 10 ml dichloromethane. This was extracted with two successive quantities, each of 10 ml of isotonic phosphate buffered saline pH 7.2, in a separating funnel. The aqueous phases were separated and absorbance's were determined at 277 nm after suitable dilution using shimadzu UV-Visible spectrophotometer. The necessary calculations were applied to estimate the drug content. [1,5]

3) *Percentage Moisture Loss :* Individual weights of ten strips were noted on an electronic single pan balance and was determined by keeping the implant in a desiccators containing anhydrous calcium chloride. After three days the implants were taken out and reweighed; the percentage moisture loss was calculated using formula[1,2] (Initial weight – final weight/ initial weight) x 100.

4) *Thickness measurement :* Thickness of three strips each from each formulations (controlled, F1, F2) were measured using screw gauge. The mean thickness was calculated. [1]

5) *In vitro drug release studies:* In vitro drug release was performed by taking five implants with the drug (separate formulation) in three separate beaker containing 5 ml of isotonic phosphate buffered saline (IPBS) each .one ml of IPBS was withdrawn from 1st to 5th day and immediately replaced with 1 ml fresh IPBS. The drug content was estimated by measuring the absorbance after suitable dilutions at 277 nm.

Concentration(µg/ml)	Absorbance
2	0.175
4	0.258
6	0.284
8	0.349
10	0.409

Table-1: Preparation of standard graph

formulations	absorbance	mean content uniformity (gm) n=5 (x ±s.d)	mean thickness (mm) n=3 (x ±s.d)
Control	0.064	0.36±0.08	4.5±0.47
F1	1.121	0.70±0.04	3.9±0.09
F2	0.894	0.54±0.74	3.48±0.06

Table-2: For drug content and mean thickness

Obs no	control			Formulation F1			Formulation F2		
	Initial (mg)	Final (mg)	%moisture loss	Initial (mg)	Final (mg)	%moisture loss	Initial (mg)	Final (mg)	%moisture loss
1	21	11	47.6	26	14	46.15	13	6	53.84
2	20	10	50	23	15	34.78	11	5	54.54
3	22	11	50	22	12	42.72	15	7	53.33
4	21	10	52	27	14	48.14	17	9	47.05
5	23	9	60.8	24	13	45.83	13	6	53.84
6	19	12	36	22	16	27.27	13	7	46.15
7	20	11	45	27	13	49.62	15	6	60.00
8	17	9	47.05	23	11	52.17	12	7	41.66
9	22	12	45.45	25	14	44	16	9	43.75
10	23	11	52.17	26	10	61.53	10	4	60

Table-3: For percentage moisture loss

Time (day)	absorbance	Concentration (µg/ml)	Concentration (mg/5ml)	% drug release	Cumulative % drug release
1	0.250	4.382	2.191	33.50	33.50
2	0.241	4.060	2.030	31.03	64.53
3	0.203	2.703	1.351	20.65	85.18

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4	0.201	2.632	1.316	20.12	105.30
5	0.194	2.382	1.191	18.21	123.51

Table-4: Drug release profile of controlled formulation

Time (day)	absorbance	Concentration (µg/ml)	Concentration (mg/5ml)	% drug release	Cumulative% drug release
1	0.219	3.275	1.637	25.03	25.03
2	0.210	2.953	1.476	22.56	47.59
3	0.202	2.667	1.333	20.38	67.97
4	0.151	0.846	0.423	6.46	74.43
5	0.140	0.453	0.226	3.45	77.88

Table-5: Drug release profile of F1 formulation

Time (day)	absorbance	Concentration (µg/ml)	Concentration (mg/5ml)	% drug release	Cumulative% drug release
1	0.178	1.180	0.905	13.83	13.83
2	0.173	1.632	0.816	12.47	26.30
3	0.166	1.382	0.691	10.56	36.86
4	0.161	1.203	0.601	9.18	46.04
5	0.143	0.560	0.280	4.28	50.32

Table-6: Drug release profile of F2 formulation

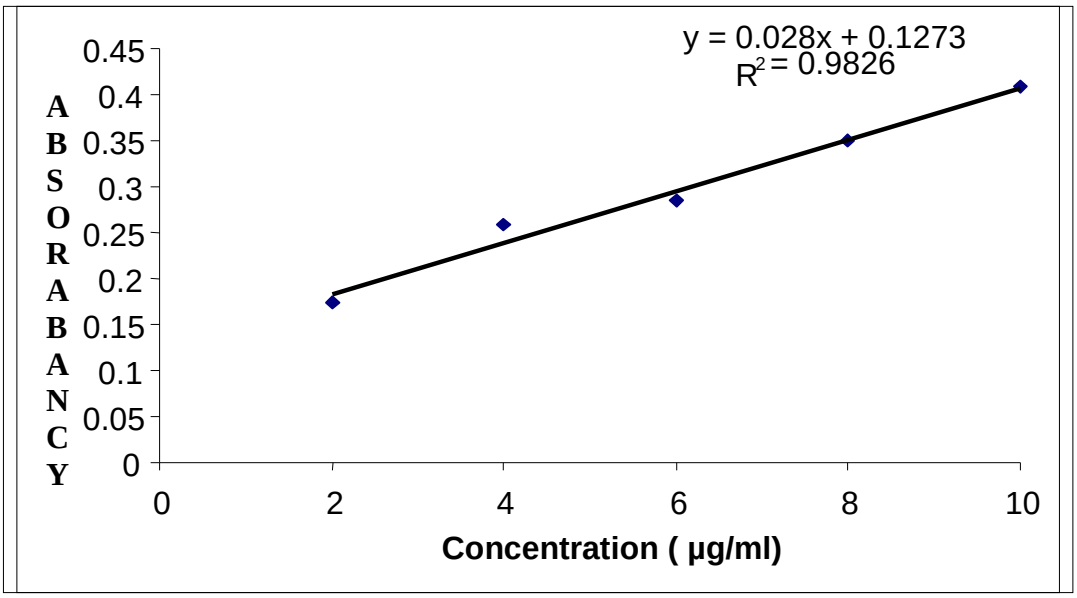

Figure-1: Standard graph of Metronidazole

6) Calculations

a) Content uniformity: For control formulation

The absorbance was found as = 0.641

Concentration calculated by using standard graph = 18.346 µg/ml

=0.36 mg/20ml =36 mg%

The content uniformity for F1=0.70 mg/20ml =70 mg%

F2=0.54mg/20ml =54 mg% were calculated by following the same line of calculation as above.

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V. RESULT AND DISCUSSIONS

The physicochemical evaluation data presented in table 2 indicates that the thickness of dental implant varies from3.48±0.06 to 4.50±0.47mm.

The percentage moisture loss for control, F1 and F2, were found 48.60± 9.32, 45.22 ± 9.32 and 51.41± 6.44 respectively, presented in table 3, indicating that the percentage moisture loss was decreased with increase of HPMC % (polymer)

The content uniformity for, F1 , F2 and control were found 70% ± 0.04 gm%, 54 ± 0.74 gm% and 36 ±0.08 gm%.

The in vitro drug release profile of the formulations confirmed ,the slow controlled zero order release, as represented in fig 2. The varying concentration of HPMC as polymer directly affects the controlled release pattern of the formulation. The increase in concentration of HPMC, give higher sustained release of drug.

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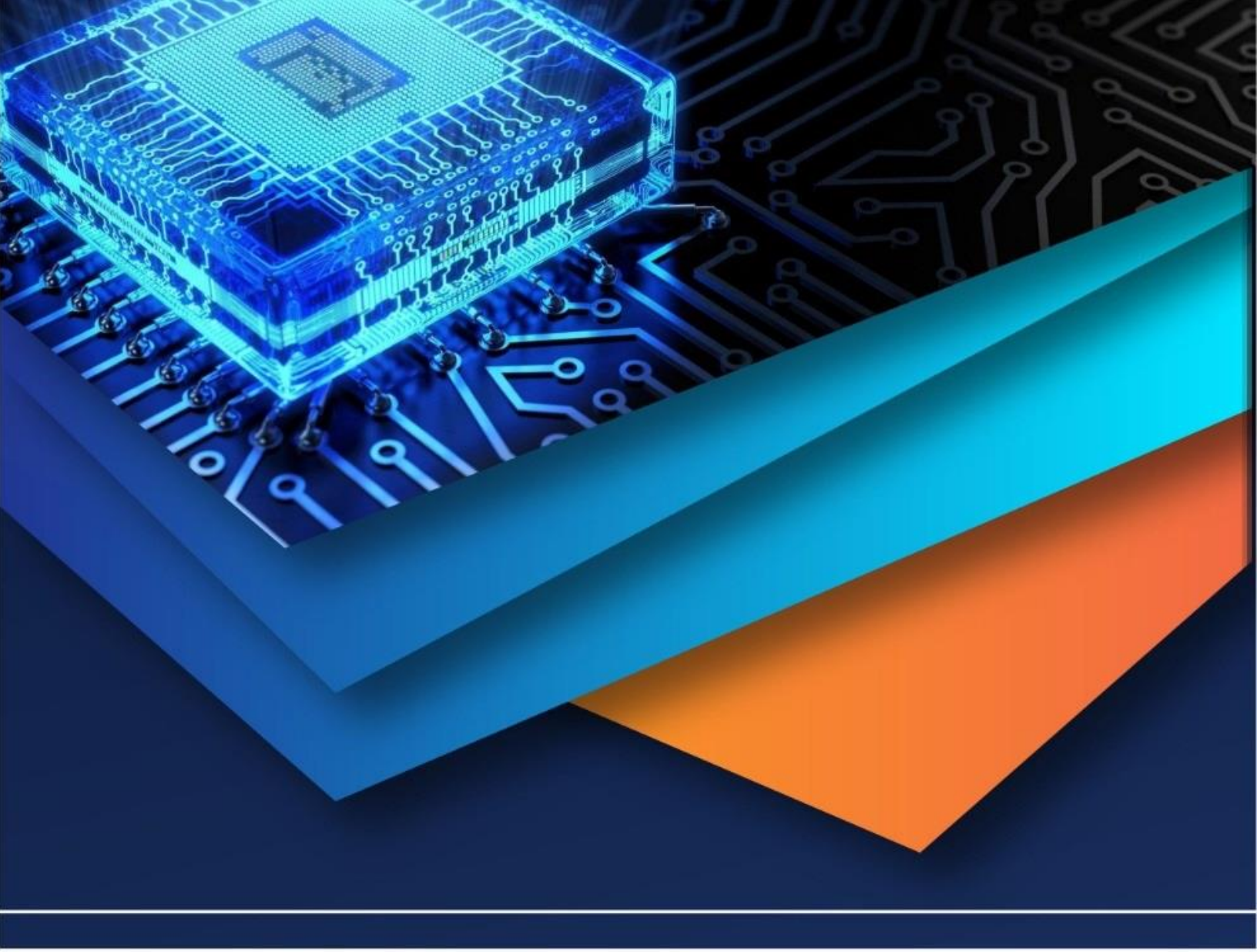

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