



SYNTHESIS AND ANTIMICROBIAL ACTIVITY OF METALLIC SOAPS OF LOWER CARBOXYLIC ACIDS

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Abstract: Metallic soaps of gadolinium with lower carboxylic acids (Butyric, Valeric, Caproic & Caprylic) have been synthesized and characterized with the help of elemental analysis and IR spectral data. IR spectra indicate that the fatty acids exist with dimeric structure through hydrogen bonding between the carboxyl groups of acid molecules whereas the metal soaps have an ionic character. All the metallic soaps have been screened for their antimicrobial activity against fungi viz. *A. niger*, *A. flavous*, *P. triticena*, *F. species* and bacteria viz. *E. coli*, *B. subtilis*, *S. typhi*, *S. aureus*. The results of antimicrobial activity show that metallic soap of butyric acid have more potency towards experimental fungi and bacteria. It also shows that metallic soap of butyric acid is more toxic against bacteria *B. subtilis*.

Keywords: Gadolinium metal; lower carboxylic acid; antimicrobial studies; IR spectra; elemental analysis;

I. Introduction

The literature¹⁻⁶ survey reveals that the synthesis, physico-chemical properties, thermal studies and antimicrobial activities of gadolinium soaps have not yet been thoroughly investigated, inspite of their considerable industrial applications. The effect of temperature on the stability of metal soaps of dicarboxylic acids studied by Ikhuoria E U⁷. The Study of Calcium and magnesium soaps are used as corrosion inhibitors in non-polar media; lead, manganese, cobalt and zinc soaps are used in paints to accelerate drying while copper soap exhibits fungicidal properties by Salager⁸. Metallic soaps are also used as optical polymer fibers⁹, coating pigment in paper industry¹⁰, preparation of nanofilms¹¹ fungicides and pesticides⁸. Robinet et al¹² has synthesized and characterized the lead metallic soaps with lower carboxylic acids. It is well known that the metallic soaps of carboxylic acids are more biologically active than the carboxylic acids^{13,14}. The present manuscript deals with the synthesis of gadolinium metallic soaps of lower carboxylic acids and screening of their antimicrobial activities.

II. Experimental

All the chemicals used were of AR grade and purified by standard methods. The Gadolinium soaps were prepared by the direct metathesis of corresponding sodium soaps (Butyrate, Valerate, Caproate and Caprylate) by pouring a slight stoichiometric excess of aqueous metal salt solution into the clear dispersion at raised temperature with vigorous stirring. After initial drying in an air oven 50-60°C, final drying was carried out under reduced pressure. The precipitates was filtered off and washed with hot distilled water and acetone. The soaps were purified by recrystallization and analyzed.

Biological Experimental

The biological experiments for determining antimicrobial activity of carboxylic acids and their metallic soaps have been done by serial dilution method¹⁵. In this technique the solutions of different concentrations (viz. 250 ppm, 500 ppm, 750 ppm and 1000 ppm) were prepared in dimethyl formamide. The graded dilution of the test compounds in a suitable nutrient (agar) and PDA medium were inoculated with the organisms under examination using aseptic techniques in an incubator at 37 °C. The antibacterial and antifungal activity of carboxylic acids and their metallic soaps have been screened in vitro, against bacteria (*Bacillus subtilis*, *Staphylococcus aureus*, *Escherichia coli* and *Salmonella typhi*) and fungi (*Aspergillus flavous*, *Aspergillus niger*, *Penicillium triticena* and *Fusarium species*).

The percentage of growth inhibition was calculated by measuring the diameter of the microbial colony in the control and test plates by the following expression-

$$\% \text{ inhibition} = \frac{C - T}{C} \times 100$$

Where C = diameter of microbial colony in millimeter in control plate.

T = diameter of microbial colony in treated (test) plate.

Analytical and Physical Measurement:-

The purity of metallic soaps were confirmed by running their T.L.C. on silica gel- G. The IR spectra in KBr matrix were recorded on Perkin- Elmer 842- spectro photometer and elemental analysis of C, H, N, were carried out at IIT Roorki.

III. Results and Discussion

The analytical and physical data given in table I.

Table I - Analytical & physical data of Gadolinium Soaps

Soaps	M.P. ^o C	Elemental analysis found (cal.) %		
		C	H	Metal
Caprylate - Gd	96.5	46.09 (47.76)	6.13 (7.46)	26.98 (28.86)
Caproate - Gd	94.5	41.29 (41.62)	4.98 (6.35)	32.84 (33.53)
Valerate - Gd	91	35.89 (37.73)	4.08 (5.66)	35.79 (36.48)
Butyrate - Gd	85.5	31.98 (33.10)	3.16 (4.80)	38.56 (40.00)

The antibacterial and antifungal activity of carboxylic acids and their metallic soaps were screening in vitro, against bacteria (*Bacillus subtilis*, *Staphylococcus aureus*, *Escherichia coli* and *Salmonella typhi*) and fungi (*Aspergillus flavous*, *Aspergillus niger*, *Penicillium triticena* and *Fusarium species*). The percentage of zone of inhibition against bacteria & fungi given in table II& III & Bar charts showing MIC for microbes used in our study are given in fig. 1-8.

The results of antimicrobial activities show that the percentage of zone of inhibition of 500 ppm concentration is the best. The percentage of growth inhibition capacities of metallic soaps follows the following order against different bacteria and fungi-

Bactericidal activities of metal-

E. coli : $(C_3H_7COO)_4 Gd > (C_4H_9COO)_4 Gd > (C_5H_{11}COO)_4 Gd \approx (C_7H_{15}COO)_4 Gd$
S. typhi : $(C_3H_7COO)_4 Gd > (C_4H_9COO)_4 Gd \approx (C_5H_{11}COO)_4 Gd > (C_7H_{15}COO)_4 Gd$
S. aureus : $(C_3H_7COO)_4 Gd > (C_4H_9COO)_4 Gd > (C_5H_{11}COO)_4 Gd > (C_7H_{15}COO)_4 Gd$
B. subtilis: $(C_3H_7COO)_4 Gd > (C_4H_9COO)_4 Gd > (C_5H_{11}COO)_4 Gd \approx (C_7H_{15}COO)_4 Gd$

Fungicidal activities of metal complexes-

A. flavous : $(C_3H_7COO)_4 Gd > (C_4H_9COO)_4 Gd \approx (C_5H_{11}COO)_4 Gd > (C_7H_{15}COO)_4 Gd$
A. niger : $(C_3H_7COO)_4 Gd > (C_4H_9COO)_4 Gd > (C_5H_{11}COO)_4 Gd \approx (C_7H_{15}COO)_4 Gd$
P. triticena : $(C_3H_7COO)_4 Gd > (C_4H_9COO)_4 Gd > (C_5H_{11}COO)_4 Gd > (C_7H_{15}COO)_4 Gd$
F. species : $(C_3H_7COO)_4 Gd > (C_4H_9COO)_4 Gd \approx (C_5H_{11}COO)_4 Gd > (C_7H_{15}COO)_4 Gd$

The results indicate that the gadolinium metallic soap of butyric acid is more toxic compared to other metallic soaps, as well as metallic soap of butyric acid is more effective towards bacteria *B. subtilis* compared to other microbes. The overall results obtained from the above studies confirm that with increase in the concentration of the metallic soaps the activity almost remains unchanged or is slightly increased.

Table II- Percentage of zone of inhibition of Gadolinium Metallic Soaps of against Bacteria

Soaps	E. coli				S. typhi				S. aureus				B. subtilis			
	% Conc. In ppm				% Conc. In ppm				% Conc. In ppm				% Conc. In ppm			
	250	500	750	1000	250	500	750	1000	250	500	750	1000	250	500	750	1000
Caprylic Acid	39.5	64	69.13	71.55	39.5	64	69.1	71.55	39.5	64	69.1	71.55	39.5	64	69.1	71.55
Caprylate - Gd	47.8	69.1	71.55	75	39.5	69.1	71.6	75	39.5	69.1	71.6	75	39.5	69.1	71.6	75
Caproic Acid	39.5	69.1	71.55	75	39.5	69.1	71.6	71.55	39.5	64	69.1	71.55	39.5	69.1	71.6	75
Caproate - Gd	39.5	69.1	71.55	75	39.5	64	69.1	71.55	47.8	69.1	71.6	75	39.5	64	69.1	71.55
Valeric Acid	39.5	64	69.13	71.55	39.5	69.1	71.6	75	39.5	69.1	71.6	75	39.5	69.1	69.1	71.55
Valerate - Gd	47.8	64	69.13	71.55	39.5	64	69.1	71.55	39.5	64	69.1	71.55	39.5	64	69.1	71.55
Butyric Acid	39.5	69.1	71.55	75	39.5	69.1	71.6	75	39.5	69.1	71.6	75	39.5	69.1	71.6	75
Butyrate - Gd	47.8	71.6	71.55	75	39.5	71.6	75	75	47.8	71.6	75	75	39.5	75	75	75

Table III- Percentage of zone of inhibition of Gadolinium Metallic Soaps of against Fungi

Soaps	A. flavous				A. niger				P. triticena				F. species			
	% Conc. In ppm				% Conc. In ppm				% Conc. In ppm				% Conc. In ppm			
	250	500	750	1000	250	500	750	1000	250	500	750	1000	250	500	750	1000
Caprylic Acid	39.50	64.00	69.13	71.55	39.5	64.0	69.1	71.5	39.5	62.6	69.1	71.5	47.8	64.0	69.1	71.5
Caprylate - Th	39.50	69.13	71.55	75	39.5	69.1	71.5	75	39.5	69.1	71.5	75	39.5	69.1	71.5	75
Caproic Acid	39.50	62.66	69.13	71.55	39.5	62.6	69.1	71.5	39.5	62.6	64.0	69.1	39.5	62.6	64.0	69.1
Caproate - Th	39.50	62.66	64.00	69.13	39.5	62.6	69.1	71.5	39.5	62.6	69.1	71.5	39.5	64.0	69.1	71.5
Valeric Acid	39.50	64.00	69.13	71.55	39.5	62.6	69.1	71.5	39.5	62.6	64.0	69.1	39.5	62.6	69.1	71.5
Valerate - Th	39.50	62.66	69.13	71.55	39.5	69.1	71.5	75	39.5	62.6	69.1	71.5	47.8	71.5	71.5	75.0
Butyric Acid	39.50	62.66	69.13	71.55	39.5	62.6	69.1	71.5	39.5	62.6	69.1	71.5	39.5	62.6	69.1	71.5
Butyrate - Th	47.84	71.55	71.55	75.00	47.8	71.5	71.5	75.0	47.8	71.5	71.5	75.0	47.8	71.5	71.5	75.0

Fig. 1-% of Zone of Inhibition of Gd Metallic Soaps for E. Coli

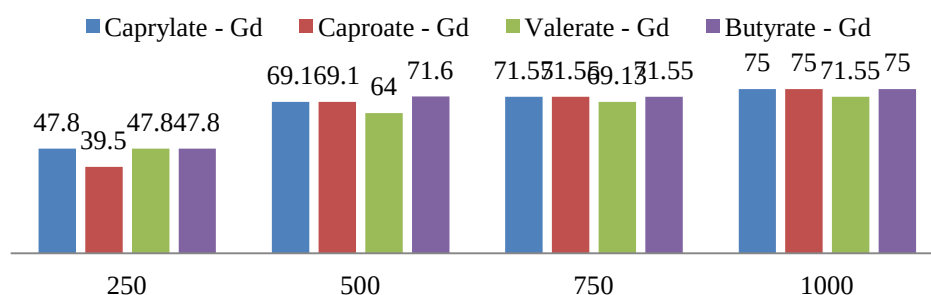


Fig. 2-% of Zone of Inhibition of Gd Metallic Soaps for S. typhi

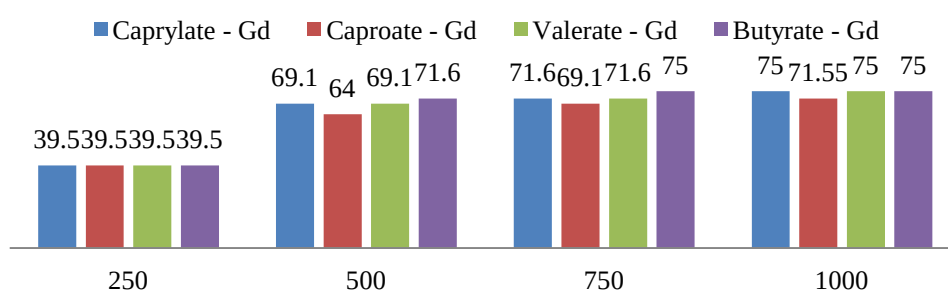
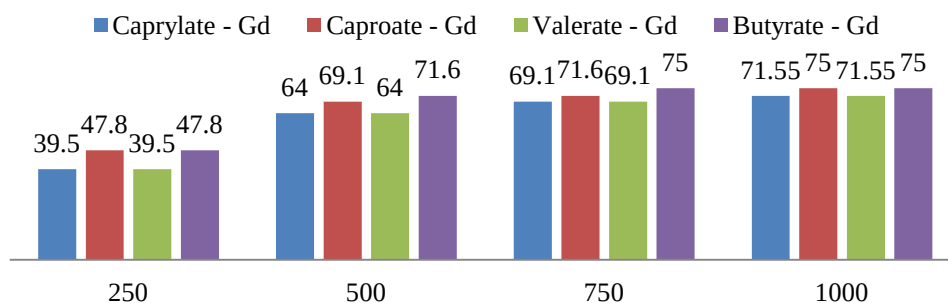
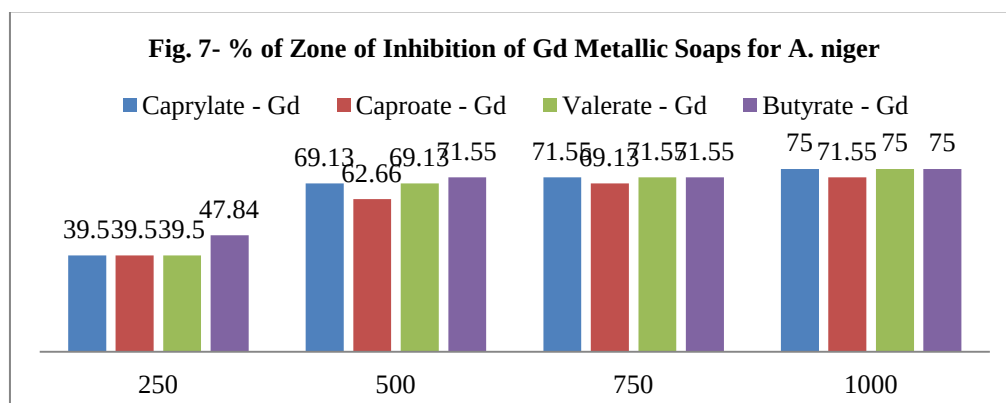
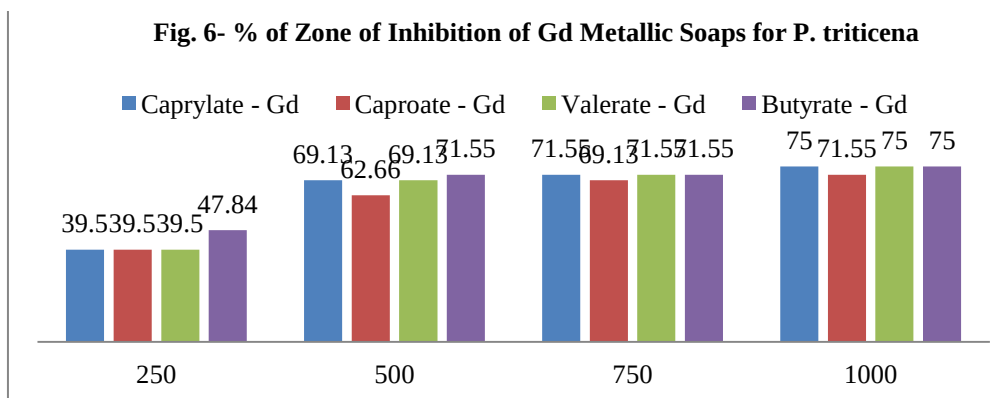
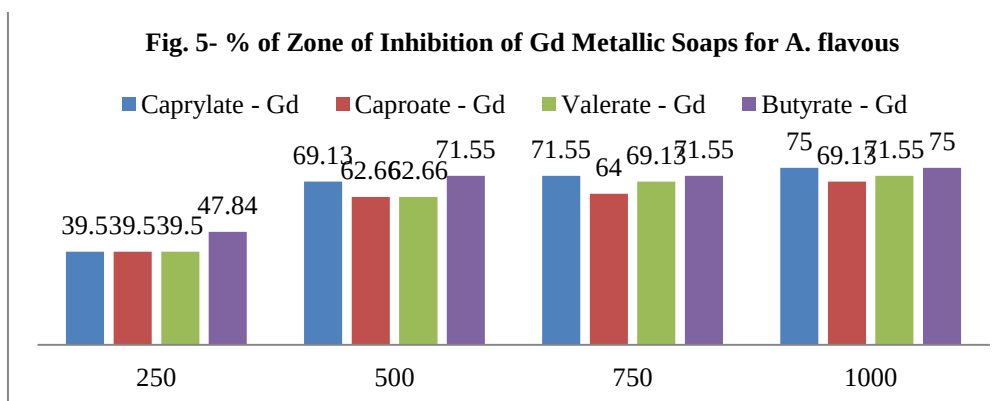
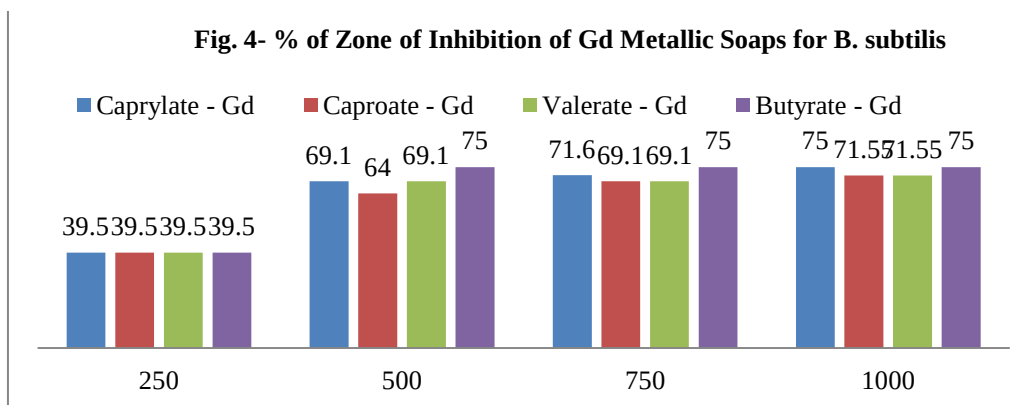
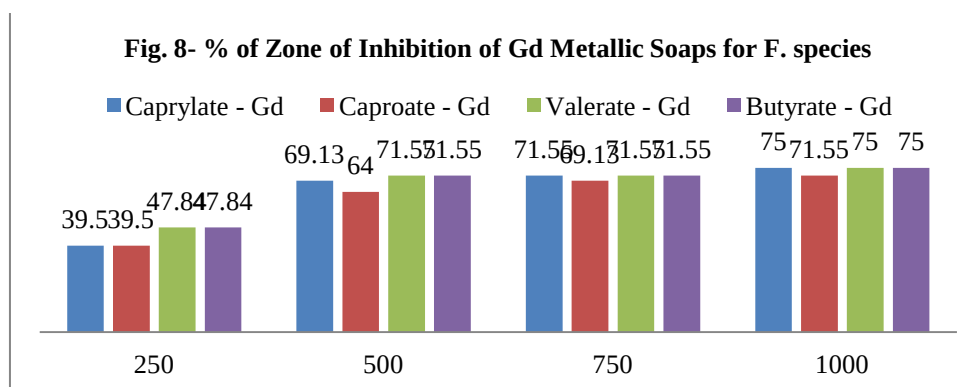


Fig. 3-% of Zone of Inhibition of Gd Metallic Soaps for S. aureus







VI. References

1. J. H. Skellon & W. J. Spence, J. Soc. Chem. Ind.,(London) 67,365(1948).
2. S. N. Mishra,T. N. Mishra & R. C. Mehrotra, J. Inorg. Nucl. Chem., 25, 195 – 201 (1963).
3. K. Wakabayashi & Richard A. Register, Polymer, vol. 47 (8) 2874 – 2883 (2006)
4. Remy van Gorkum & Elisabeth, vol. 240(17-18) 1709 – 1728 (2005).
5. L. Robinet & M. C. Corbeil, Study in conservation, vol. 48 (1) 23 – 40 (2003).
6. Marie- Claude Corbeil, Laurianne Robinet, vol. 17 (1) 52 – 60 (2002).
7. E U Ikhuoria, F E Okieimen and A I Algbodion *Journal of Applied Sciences & Environmental Management*, Vol. 9, No. 1, 2005, pp. 127- 130.
8. J. Salager, Surfactants: Types and uses. FIRP. <http://www.nanoparticles.org> (200
9. Q. Zhang, H. Ming and Y. Zhai, *J. Appl. Polym. Sci.*, 62, 887 (1996).
10. P. N. Nene, *Adv. Nat. Appl. Sci.*, 2(2), 73 (2008).
11. M. Gonen, S. Ozturk, D. Balkose, S. Okur and S.Ulku, *Ind. Eng. Chem. Res.*, 49(4), 1732 (2010).
12. L. Robinet and M. C. Corbeil, Studies in conservation, 48(1): 23(2003).
13. S. Kirschner, Y. K. Wei , D. Francis ,and J. G. Bergman, *J. Med. Chem.* , 9, 369 , (1966).
14. A. J. Thomson , R. J. P.Williams, and S. Reslova , *Structure and Bonding*, 11, 1, (1972) .
15. J. H. Quasted , *J. Gen. Microbial* ., 45, 14, (1966).

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