

Anti-microbial Activity of Herbal Plant Extracts

Shivang Tripathi^{1*}, Vishal Gupta²

Abstract

The Microbial resistance to major antibiotics due to overuse of them and problem observed rapidly during treatment of infectious diseases having a big challenge in health sector. Recently many researchers have been finding the solutions for come out these problems. There are many photochemical have been available, they have potential antimicrobial property against microbial species which occurs resistance against antibiotics. The present study is therefore an attempt for review on Antimicrobial property of herbal plant extracts obtained by variety of extraction process with variety of solvents in which extract can able to come out. Dried extracts after solvent evaporation employed either alone or in combination with variety of concentrations. Polyherbal extract means use of more than one herbal extract; those combinations have to exert additive effects. Herbal Extracts having options to incorporate into different kind of formulations along with different concentrations evaluated effectively against various numbers of microbial species; they were inoculated into prepared culture medium. The effective zone of inhibition showed and measures it in mm. Some herbal extracts or formulation containing herbal extracts exerts similar inhibition as compare to marketed standard as positive control.

Keywords: Herbal plant extract, gel formulation, extraction method, culture media, zone of inhibition, antimicrobial property, drug resistance

INTRODUCTION

Herbal Plant extracts or formulation containing herbal drugs using herbal remedies to treat the various sick [1]. It has been used for thousands of years and they have benefits for curing various type of dermatological disorder. Herbal medicines have great demand in the developed world for primary health care due to its availability in plenty of amount at reasonable prices, biodegradable, eco-friendly, better compatible, give therapeutic benefits and showed broad-spectrum activities against different microorganism with minimal side effects. Antimicrobial properties of different plant extracts or plant parts which act in a low dose [2]. The WHO has accepted the significance of herbal medicines and recommended traditional medicines as the safest remedies for therapy of microbial based diseases.. No modern medicines are available for age related disorders such like memory loss, osteoporosis, and immune disorder etc. herbal medicines offers therapeutically greater benefits against such disorder. India has been large biodiversity and export crude extract and drugs worldwide due to rich traditional

knowledge. They are greater acceptable by majority of peoples all over the world due to its better compatibility with the human body. It is seen that their major application enhanced in the developed world. 80% of the world population depends directly or indirectly on some form of herbal or traditional medicines [3]. In india, herbal nutraceuticals whose current market is estimated approx \$ 80. Patients finding the alternate and belief in herbal therapy are growing day by day. Recent finding shows that all herbal medicines may not be safer. Some herbal drugs reported severe outcomes. There are thousand years of traditional use which

*Author for Correspondence

Shivang Tripathi

E-mail: tripathishivang08@gmail.com

¹Associate Professor, Faculty of Pharmacy, Mansarovar Global University, Sehore, Madhya Pradesh, India

²Dean, Faculty of Pharmacy, Mansarovar Global University, Sehore, Madhya Pradesh, India

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can provide us valuable guidelines for selection, identification, preparation and application of herbal formulation [4].

Antibiotics, its use for the treatment of microbial infections. When over the use of those medicines has become the major part for occurrence of resistance against various species of microorganisms. Multiple drug resistance occurrence strains of *E.coli* and *K.pneumoniae* are widely spread in hospitals and isolation of the community is being increasingly observed. Rapid spread of microbial resistance globally, needs to develop new antimicrobial agents. For this reasons researchers having interest in herbal products, there have been lead to develop better drug product of herbal source which may be effective against multidrug resistance microbial strains [5].

Table 1. Summary of the articles considered for discussion in the present review.

S. N.	Author details	Plant extract	No of formulation or Concentration	Medium used	Microorganisms	Zone of inhibition (mm)		Conclusion
1	[6] Bilal Mohd. <i>et al.</i> 2023	Ethanollic extract of <i>Aloe vera</i> by using maceration method	F1 (2.5%), F2 (5%) and F3 (10%)	Agar diffusion method	<i>Propionibacterium acne</i>	F1 (8.8), F2 (9.8) and F3 (12.9)		10% aloe vera ethanolic extract gives best inhibitory results
2	[7] Chellathurai B.J. <i>et al.</i> 2023	Pulp of <i>Aloe barbadensis</i> and then homogenized and Ethanolic extract of <i>Vigna radiata</i> by Soxhlet method	Three formulations (F1 to F3)	Agar diffusion method	<i>Staphylococcus aureus</i> , <i>Escherichia coli</i> and <i>Candida albicans</i>	F1 (12.3) F2 (13.2) F3 (12.4)		Formulation have significant effect along with additive effect of Aloe Vera
3	[8] Babu B. <i>et al.</i> 2023	Methanolic extract of <i>Nigella sativa</i> seeds by soxhlation method	Different dilutions 1:5 1:10 1:20 1:40	Punch well method	<i>Staphylococcus aureus</i> and <i>Enterococcus faecalis</i>	MSS A 13.8 11.0 8.1 1.5	MR SA 15.7 10.8 8.7 2.0	It was found that the antibacterial activity of <i>N. sativa</i> seeds against <i>S. aureus</i> But limited or no activity against <i>Enterobacteriaceae</i> members and <i>E. faecalis</i> , isolated from wound infection patients
4	[9] Hemdan B.A. <i>et al.</i> 2023	Methanolic extract of <i>Azadirachta indica</i> and <i>Melia azedarach</i> were seperately soaked by cold extraction method	<i>A. indica</i> leaves * <i>M.azedarach</i> leaves #	Disc diffusion method *well diffusion method	<i>E.coli</i> <i>Salmonella enterica</i> <i>Pseudomonas aeruginosa</i> <i>Listeria monocytogenes</i> <i>Staphylococcus aureus</i> <i>Enterococcus faecalis</i>	#18 16 14 12 11 13	21* 17 18 16 12 13	The zone of inhibition around disc was lower than those around wells. The extract's inhibitory efficiency was greater than that of two marketed antibiotics

S. N.	Author details	Plant extract	No of formulation or Concentration	Medium used	Microorganisms	Zone of inhibition (mm)	Conclusion
5	[10] Ahmed J. et al 2023	Methanolic extract of <i>Punica grnatum</i> fruits peels	25 mg/ml	Disc diffusion method	Effective against <i>E.coli</i>	18	Methanolic extract of <i>Punica granatum</i> was highest efficacy against <i>E.coli</i> ,
			50 mg/ml			24	
			100 mg/ml			25.33	
			125 mg/ml			30.33	
			250 mg/ml			32.5	
			500 mg/ml			36	
		Methanolic extract of <i>N.sativa</i> seeds	25 mg/ml		Effective against <i>K. pneumoniae</i>	12	Methanolic extract of <i>N.sativa</i> was highest efficacy against <i>K. pneumoniae</i>
			50 mg/ml			14.2	
			100 mg/ml			16	
			125 mg/ml			17	
			250 mg/ml			18.5	
			500 mg/ml			21	
		Methanolic extract of <i>E. kebericho</i> roots	25 mg/ml		Effective against <i>E.coli</i> and <i>P.aeruginosa</i>	9.5	Methanolic extract of <i>E. kebericho</i> was highest efficacy against <i>E.coli</i> and <i>K. pneumoniae</i>
			50 mg/ml			15	
			100 mg/ml			16.5	
			125 mg/ml			17.5	
			250 mg/ml			18.2	
			500 mg/ml			21	
6	[11] Neglo D. et al 2022	70% Ethanolic extract of <i>Azadirachta indica</i> cold maceration method.	40%w/v	Agar well diffusion method	MRSA (Methicillin resistant <i>staphylococcus aureus</i>) and fluconazole resistance <i>Candida albicans</i>	19, 19	both extracts were significantly inhibit the growth of MRSA and <i>C.albicans</i> , hence having antimicrobial property against <i>S. aureus</i> .
			20%w/v			13, 13.67	
			10%w/v			10.67, 0.67	
		70% Ethanolic extract of <i>Catharanthus roseus</i> by cold maceration method.	40%w/v			17.67, 16.67	
			20%w/v			11, 14.33	
			10%w/v			6.67, 9.67	
S. N.	Author details	Plant extract	No of formulation or Concentration	Medium used	Microorganisms	Zone of inhibition (mm)	Conclusion
7	[12] Chauhan A. et al 2022	Citrus sinensis oil, <i>Aloe barbadensis</i> extract, Tea tree oil and ethanolic extraction of <i>Curcuma longa</i> by soxhlet apparatus	Seven formulations (F1 to F7)	Well diffusion method	<i>Staphylococcus aureus</i> and <i>Staphylococcus epidermidis</i>	F5 showed maximum activity 44mm against <i>S. aureus</i>	Formulation 5 (F5) had stronger antibacterial activity, zone of inhibition 44mm for <i>S. aureus</i> .
8	[13] Gizaw A. et al 2022	Methanolic (1:4 ratio) extract of <i>Brucea antidysenterica</i> , <i>Aloe vera</i> and <i>Justicia Schimperiana</i> by maceration method	<i>Brucea antidysenterica</i> and <i>Justicia Schimperiana</i> 200mg/ml concentration	Agar well diffusion method	<i>Candida albicans</i>	15.5±0.5	<i>Brucea antidysenterica</i> and <i>Justicia Schimperiana</i> showed higher antifungal activities against <i>Candida albicans</i> While <i>Aloe vera</i> plant extract showed antifungal
			<i>Aloe vera</i> 200mg/ml concentration		<i>Aspergillus niger</i>	15.3±0.58	

								activity against <i>Aspergillus niger</i>
9	[14] Shafodin o F.S. et al 2022	Different solvents (ethanolic, n-hexane, methanol and aqueous) extract of <i>Nigella Sativa</i> seeds obtained by maceration and soxhlet method	Undiluted hexane and absolute alcoholic extract of <i>N. sativa</i> seeds	Nutrient agar	<i>B.subtilis</i>	12.83	12.33	Zone of inihition activity of undiluted hexane extracts of <i>N. sativa</i> seeds, the order of inhibition sequence as <i>B. subtilis</i> > <i>S. aureus</i> > <i>E.coli</i> > <i>P. aeruginosa</i> . and similar activity
			<i>S. aureus</i>		13.06	11.62		
			<i>E.coli</i>		8.92	7.99		
			<i>P.aeruginosa</i>		6.86	6.58		
			Undiluted methanol extract of <i>N. sativa</i> seeds		<i>P.aeruginosa</i>	7.94		undiluted methanolic extract inhibitory activity unlike to other extracts. The order of inihition sequence <i>P. aeruginosa</i> > <i>E.coli</i> > <i>B. subtilis</i> > <i>S. aureus</i>
			<i>E.coli</i>		7.85			
			<i>B.subtilis</i>		7.77			
			<i>S. aureus</i>		7.57			
S. N.	Author details	Plant extract	No of formulation or Concentration	Medium used	Microorganisms	Zone of inhibition (mm)	Conclusion	
10	[15] Lekshmy M. et al 2022	<i>Rubia cordifolia</i> L., <i>Salmalia malabarica</i> , <i>Berberis aristate</i> , <i>Aloe barbadensis</i> , <i>Glycyrrhiza glabra</i> L., Except <i>aloe barbadensis</i> , all drugs were extracted by soxhlet apparatus, <i>Aloe barbadensis</i> extract by aqueous extraction.	Two formulations such as 10% and 5%	Nutrient agar medium	<i>Propionibacteriu m acnes</i>	10% showed 10mm and 5% showed 7mm	10% hydrogels showed better results as compare to 5% hydrogel	
11	[16] Borotova P. et al 2022	<i>Melaleuca alternifolia</i> oil, common name <i>teatree</i> oil	Dominant constituent was terpinen-4-ol with 40.3%	Disk diffusion method	Gram positive, Gram negative bacterias and yeast	The maximum antimicrobial activity was observed against <i>Enterococcus faecalis</i> and <i>Candida albicans</i> with 10.67mm inhibition of zone	Highest antimicrobial activity was against <i>Enterococcus faecalis</i> and <i>Candida albicans</i> with inhibition zone of 10.67mm.	
12	[17] Mate A. et al 2021	Methanolic extract of <i>Citrus sinensis</i> (orange) peels, dried gel of <i>aloe vera</i> , <i>Curcuma longa</i> mixed n-hexane then with acetone	Four Formulations (F1 to F4)	Liquid agar Medium	<i>Staphylococcus aureus</i> , <i>Staphylococcus epidermidis</i> , <i>Propionibacteriu m acne</i> and <i>Escherichia coli</i>	F2 showed 36mm against <i>Staphylococcus aureus</i> and 44mm against <i>Staphylococcus epidermidis</i>	F2 shows better antibacterial activity	

S. N.	Author details	Plant extract	No of formulation or Concentration	Medium used	Microorganisms	Zone of inhibition (mm)		Conclusion
13	[18] Oyekanmi A.A. et al 2021	Ethanollic extract of 5% neem leaves by reciprocating shaker and seaweed aqueous extract. Gamma irradiated seaweed-neem (SWN) films. Antimicrobial irradiated seaweed-neem biocomposite films	SWN	Agar diffusion method	<i>Staphylococcus aureus</i> and <i>Bacillus subtilis</i>	<i>S.aureus</i>	<i>B.subtilis</i>	Seaweed-neem films at different dosages exhibited inhibitory action against <i>S. aureus</i> and <i>B. subtilis</i>
			SWN0.5			12.6	8.92	
			SWN1.0			13.28	11.67	
			SWN1.5			16.40	17.23	
			SWN2.0			24.03	23.54	
14	[19] Nabia V.K. et al 2020	70% Ethanollic extract of <i>Aloe vera</i> by using maceration method	6.25%	Disk diffusion method	<i>Candida albicans</i>	12.45mm		Greater concentration of <i>Aloe vera</i> extract, greater the zone of inhibition
			12.5%			13.98mm		
			25%			15.65mm		
			50%					
						17.23mm		
15	[20] Rahat I. et al 2020	Extract of <i>Nigella sativa</i> and <i>Achyranthes aspera</i> seeds by soaking method, (soak individually)	Two formulations (F1 and F2)	Liquid agar media	<i>Staphylococcus aureus</i> and <i>Propionibacterium acnes</i>	F1 showed 8.6mm and F2 showed 10.2mm		F2 shows maximum zone of inhibition activity
S. N.	Author details	Plant extract	No of formulation or Concentration	Medium used	Microorganisms	Zone of inhibition (mm)		Conclusion
16	[21] Bhatia V.et al 2020	Methanolic extract of <i>Azadirachta indica</i> and <i>Curcuma longa</i> by soxhlet extraction method	F1	Agar well diffusion method	<i>P. acne</i>	concentration such as 20ppm showed (18%) while 100 ppm showed (61.5%) inhibition		Both extracts (<i>A. indica</i> and <i>C. longa</i>) showed significant anti inflammatory activity against microbial species <i>P. acnes</i> .
			F2					
			F3					
			F4					
			F5					
			F6					
17	[22] Dange V.N. et al 2020	Extract of <i>lantana camara</i> leaves by microwave extraction method	Extract form	Disc diffusion method	<i>S. aureus</i>	10		gel formulation containing leaf extract showed 16mm against <i>S.aureus</i> and 19mm against <i>S. epidermidis</i> .
			Gel form			16		
			Extract form		<i>S. eidermidis</i>	12		
			Gel form			19		
18	[23] Nawarathne N.W. et al 2019	Dried seeds of <i>N.sativa</i> initially soaked in hexane, ethyl acetate and methanol	F1	Mueller-Hinton Disc diffusion	<i>S. aureus</i>	10.6		Among the three crude extracts, ethyl acetate extract perormed highest activity against <i>S.aureus</i> .
			F2		<i>Propionibacterium acnes</i>	9		
			F3					

S. N.	Author details	Plant extract	No of formulation or Concentration	Medium used	Microorganisms	Zone of inhibition (mm)	Conclusion
19	[24] Jain K.L. et al 2017	Hydroalcoholic extract (water: methanol, 50:50) of <i>Butea Monosperma</i> flower, <i>Vitex agnus catus</i> leaves and <i>Nigella sativa</i> seeds by soxhlet apparatus	F1	Nutrient agar medium	<i>Propionibacterium acnes</i>	NA	F2 shows bacteriostatic activity and F4 shows more effective as comparable to standard Ciprofloxin
			F2			2	
			F3			23	
			F4			32	
20	[25] Bhalani U., Shah K. 2015	methanolic extract of <i>Nigella sativa</i> seeds by cold maceration method	Gel contained 10% <i>Nigella sativa</i> seeds extract	Microdilution broth	<i>Propionibacterium acnes</i>	The zone of inhibition for standard drug Ampicillin gave similar results.	Extract showed same zone of inhibition as standard
21	[26] Sharma M and Rathore V. 2014	Hydroalcoholic extract of <i>A. indica</i> and leaves of <i>ocimum sanctum</i> , <i>Aloe vera</i> powder and tea tree oil.	F1 to F19	Modified agar well diffusion	<i>S. aureus</i>	1-7	F1 (7mm) and F4 (6mm) shows better antibacterial activity
S. N.	Author details	Plant extract	No of formulation or Concentration	Medium used	Microorganisms	Zone of inhibition (mm)	Conclusion
22	[27] Farjana A. et al 2014	water, oil and methanolic extract of guava (<i>Psidium guajava</i>), green tea (<i>Camellia sinensis</i>), neem (<i>Azadirachta indica</i>) and marigold (<i>Calendula officinalis</i>)	Boiled water extract of guava leaf	Agar well diffusion method	<i>Vibrio parahaemolyticus</i>	22 mm	Leaves of guava, green tea, neem and marigold showed zone of inhibition. Out of all, Boiled water guava leaf showed greatest zone of inhibition (22mm) against <i>V. parahaemolyticus</i>
			Boiled water extract of green tea leaf		<i>Vibrio parahaemolyticus</i>	17.5	
			Boiled water extract of neem leaf extract		<i>S.aureus</i>	19	
			Water and oil extract of marigold		<i>E.coli</i>	10	
			Methanolic extracts of both guava and green tea leaves		<i>Klebsiella species</i>	11	
			Methanolic extract of neem leaf		against all microbes	0	
			Methanolic extract of marigold leaf		<i>Psudomonas spp.</i>	18	
					<i>Klebsiella species</i>	16	
					<i>Vibrio cholerae</i>	14	
					<i>S.aureus</i>	18	
					<i>Klebsiella species</i>	12	

23	[28] Yamini K. et al 2013	Hydroalcoholic extract of <i>Azadirachta indica</i> and <i>Myristica fragrance</i>	Fifteen formulations were prepared	Nutrients agar plate	<i>Propionibacterium acnes</i>	F4 showed 7mm	Among all fifteen formulations, F4 batch showed better zone of inhibition than other batches.
S. N.	Author details	Plant extract	No of formulation or Concentration	Medium used	Microorganisms	Zone of inhibition (mm)	Conclusion
24	[29] Khan U.A. et al 2013	Cold and hot Aqueous plants extracts such as <i>Bergenia ciliata</i> , <i>Jasminium officinale</i> and <i>Santalum album</i>	Extraction was done cold and hot water extraction	Agar well diffusion method	<i>Staphylococcus aureus</i> , <i>Bacillus subtilis</i> , <i>Proteus vulgaris</i>	Significant results of zone of inhibition	Among the three plants, <i>Bergenia ciliate</i> showed the potential activity against bacterial pathogens
25	[30] Sawarkar H.A. et al 2010	Hydroalcoholic extract of <i>Ocimum sanctum</i> , ethanolic extract of <i>Tabernaemontana divariata</i> by soxhlet extraction, Aloe vera gel powder and tea tree oil.	Five formulations were prepared	Agar well diffusion method	<i>Propionibacterium acnes</i>	>16 mm of Formulation 5	Formulation no 5 batch has greater antibacterial activity (>16 mm) but less as compare to standard tetracycline (>17 mm).
26	[31] Bhaskar G. et al 2009	Aqueous extracts of <i>Garcinia mangostana</i> and <i>Aloe vera</i>	Six Formulations were prepared	Nutrients agar plate	<i>Propionibacterium acnes</i> and <i>Staphylococcus aureus</i>	F6 showed good results	Among all six formulation, F6 showed better results
27	[32] Ghosh A. et al 2008	Hot aqueous and methanolic extracts prepared from plants such <i>Terminallia chebula</i> , <i>Terminallia bellerica</i> , <i>Phyllanthus emblica</i> , <i>Punica granatum</i> , <i>Lawsonia alba</i> and <i>Mikania micrantha</i>	methanolic extracts of <i>Terminallia chebula</i>	Sensitivity test disks method	<i>Staphylococcus aureus</i> , <i>Bacillus subtilis</i> , <i>Escherichia coli</i> , <i>Proteus vulgaris</i> and <i>Enterobacter aerogenes</i>	Methanolic extracts of <i>T.chebula</i> leaf have best inhibition activity	The methanolic extracts of <i>T.chebula</i> leaf have same potent as most effective antibiotics and exhibit highest antibacterial potentiality, followed by aqueous extract of <i>T.bellerica</i> fruit

DISCUSSION

In the previous time, the application and extraction of natural occurrence medicines or herbal medicines has been reported. They have been appeared to be effective in the control of many different type of skin related infection or diseases caused by microorganism.

The present review was tried to summarize the existing published literature (from year 2007 to 2023) related to zone of inhibition of plant extract against microbial species [33] (Table 1).

Bilal Mohd. et al., 2023 has prepared gel formulation containing ethanolic extract of Aloe vera by using maceration method. The formulations (F1 to F3) of different concentrations (2.5%, 5% and 10%) were prepared. *Propionibacterium acne* was employed as test microbe by agar diffusion method for finding zone of inhibition. The 10% aloe vera ethanolic extract showed best inhibitory results against *P.acne* [6].

Chellathurai B.J. et al., 2023 has studied on Pulp of Aloe barbadensis and then homogenized and Ethanolic extract of Vigna radiata by using Soxhlet method. The three formulations (F 1 to F3) were prepared and evaluated their antimicrobial properties against *Staphylococcus aureus*, *Escherichia coli* and *Candida albicans*. Antimicrobial agents such as gentamycin and fluconazole were used as the standard. Formulation showed significant effect against microbes along with additive effect of aloe vera [7].

Babu B. et al., 2023 has studied on antibacterial property of methanolic extract of *Nigella sativa* seeds by soxhlet method (thymoquinone, active component of *N.sativa* seeds). Samples of wound cases received over a period of six months. Punch well method was employed to determine the antibacterial effect of seeds of *N. sativa*. 60 isolates were collected from 60 samples of wound infection. Thymoquinone showed effectivity against *S.aureus* but they are limited effective against *Enterobacteriaceae* members and *E. faecalis*, who were isolated from wound infection patients. Different dilutions of *N. sativa* seed extracts showed antibacterial activity against methicillin sensitive *staphylococcus aureus* (MSSA) and MRSA, there was no much difference in the antibacterial property of crude methanolic extract against MRSA and MSSA by punch well method. It was found that the antibacterial activity of *N. sativa* was only against *S. aureus* and there was no antibacterial effect against gram negative bacteria and *E. faecalis* [8].

Hemdan B.A. et al 2023 has studied on methanolic extract of *Azadirachta indica* and *Melia azedarach* leaves. Extraction was done by cold extraction method in which both leaves were soaked separately into methanolic solvent. Vancomycin and ciprofloxacin were used as standard drug as positive control. Microbial species these were used for testing of antimicrobial studies such as *E.coli*, *S. enteica*, *P. aeruginosa*, *L. monocytogenes*, *S. aureus*, *E. faecalis*. For antimicrobial studies, Disc diffusion and well diffusion method were used for estimation of zone of inhibition studies. The zone of inhibition around disc was lower than those around wells. The inhibitory efficiency was greater than those results obtained by both antibiotics such as vancomycin and ciprofloxacin [9].

Ahmed J.et al 2023 has studied Methanolic and ethanolic extracts of *Punica grnatum* fruits peels, *N.sativa* seeds and *Echinod kebericho* roots by maceration technique. Then preparing six dilutions (25, 50, 100, 125, 250 and 500mg/ml of methanolic extracts, the microbial species included *S. aureus*, *K. pneumoniae*, *P. mirabilis*, *E.coli* and *P. aeruginosa*. The antibacterial activity of different plants extract against different microbial species by applying extract on media such as Muller-Hinton disc diffusion method. Methanolic extract of Punica granatum was highest efficacy against *E.coli*, Methanolic extract of *N.sativa* was highest efficacy against *K. pneumonia* and Methanolic extract of *E. kebericho* was highest efficacy against *E.coli* and *K. pneumonia* [10].

Neglo D. et al 2022 has studied on 70%v/v ethanolic extract of *Azadirachta indica* and *Catharanthus roseus* by cold maceration method. The different concentrations such as 40%w/v, 20%w/v and 10%w/v of both extracts were studied by the agar well diffusion method against microbial species such MRSA (Methicillin resistant *staphylococcus aureus*) and fluconazole resistance *Candida albicans*. Both extracts were significantly inhibiting the growth of MRSA and *C. albicans*. The fluconazole was used as standard [11].

Chauhan A. et al 2022 has studied on oil of citrus sinensis, Aloe bardadensis extract, Tea tree oil and ethanolic extraction of Curcuma longa by soxhlet apparatus. The seven formulations (F1 to F7)

containing polyherbal extract were prepared and tested antimicrobial study against microbes *Staphylococcus aureus* and *Staphylococcus epidermidis* by using well diffusion method. Formulation number 5 had stronger antibacterial activity, zone of inhibition 44mm for *S.aureus* [12].

Gizaw A. et al 2022 has prepared methanolic extract (1:4) of plants such as *Brucea antidysenterica*, *Aloe vera* and *Justicia Schimperiana* by maceration method, The antifungal activity of methanolic extract were tested, 0.1ml of 200, 100 and 50 mg/ml concentrations of the crude extracts. Ketoconazole 15µg used as positive control. The extract of *Brucea antidysenterica* and *Justicia Schimperiana* showed higher antifungal activities against *Candida albicans* with zone of inhibition of 15.5 and 15.3mm respectively. While *Aloe vera* plant extract showed zone of inhibition 12.3mm against *Aspergillus niger* [13].

Shafodino F.S. et al 2022 has studied on different solvents (ethanolic, n-hexane, methanol and aqueous) extracts of *Nigella sativa* seeds obtained by maceration and soxhlet methods. The extracts of *N.sativa* seeds, oil extracted with hexane, oil extracted with absolute ethanol, methanol extract and aqueous extract used to check its antimicrobial property by using disc diffusion method. The microbial strains used during test such as *Escherichia coli*, *Pseudomonas aeruginosa*, *Staphylococcus aureus* and *Bacillus subtilis*. These microbial strains were insert on nutrient agar before application of extract. The streptomycin antibiotic was used as standard positive control. Different solvent extract and/or preparation of *N.sativa* seeds showed inhibition both gram positive (*S.aureus* and *B.subtilis*) and gram negative (*E.coli* and *P.aeruginosa*) bacteria in the disc diffusion method. Zone of inhibition activity of undiluted hexane extracts of *N. sativa* seeds, the order of inhibition sequence as *B. subtilis* > *S. aureus* > *E.coli* > *P. aeruginosa*. A similar sequence was observed with absolute alcohol. But undiluted methanols extract inhibitory activity unlike to other extracts. The order of inhibition sequence *P. aeruginosa* > *E.coli* > *B. subtilis* > *S. aureus*. The aqueous extract didn't showed inhibition action except microbe such as *B. subtilis* [14].

Lekshmy M. et al 2022 has studied *Rubia cordifolia* L., *Salmalia malabarica*, *Berberis aristate*, *Aloe barbadensis*, *Glycyrrhiza glabra* L., except *aloe barbadensis*, all drugs were extracted by soxhlet apparatus, *Aloe barbadensis* extract by aqueous extraction. Two formulations were prepared containing extract content such as 10% and 5%. The antimicrobial activity of the formulation containing extracts evaluated against *Propionibacterium acne*. Nutrient agar media was used for making the culture media. The 10% gel showed the better results and The prepared formulations showed the inhibitory effect but its antibacterial activity was less as compared with the standard positive control gentamycin [15].

Borotova P. et al 2022 has worked on essential oil of *Melaleuca alternifolia*, common name is tea tree oil. The dominant content in tea tree oil was terpinen-4-ol (40.3%). Other constituents of tea tree oil such as γ -Terpinene (11.7 %), 1,8-cineole (7.0%) and p-cymene (6.2%) were also identified. The Antimicrobial activity performed against microbial species of Gram positive, Gram negative bacteria and against yeasts as observed by disk diffusion method. The maximum antimicrobial activity was observed against *Enterococcus faecalis* and *Candida albicans* with 10.67mm inhibition of zone and resistance observed against yeast species [16].

Mate A. et al 2021 has prepared Methanolic extract of *Citrus sinensis* (orange) peels, dried gel of *aloe vera*, *Curcuma longa* mixed n-hexane then with acetone. The Antimicrobial activity of Four gel formulations were prepared and evaluated against the microbial species *Staphylococcus aureus*, *Staphylococcus epidermidis*, *Propionibacterium acne* and *Escherichia coli* by using liquid agar media. All formulations showed antimicrobial activity along with this Second number formulation (F2) showed best results such as 36mm zone of inhibition *Staphylococcus aureus* and 44mm against *Staphylococcus epidermidis* [17].

Oyekanmi A.A. et al 2021 has prepared antimicrobial irradiated seaweed-neem biocomposite films. Ethanolic extract of Neem leaves 5% w/w conc. were added into the matrix of seaweed biopolymer and these were irradiated by gamma radiation with different dosage like 0.5, 1, 1.5 and 2kGy. The irradiation of the seaweed-neem films at different dosage showed significant antimicrobial inhibitory effect against microbial species such as *S. aureus* and *B. subtilis* [18].

Nabia V.K. et al 2020 has prepared 70% ethanolic extract of aloe vera by maceration method and dissolved in DMSO into multiple concentrations such as 6.25%, 12.5%, 25% and 50%. Aloe vera extract showed inhibitory activity against *Candida albicans*, zone of inhibition of each concentration 12.45mm (6.25%), 13.98mm (12.5%), 15.65mm (25%) and 17.23mm (50%) respectively. As enhance the concentration of aloe vera greater the zone of inhibition was showed [19].

Rahat I. et al. 2020 has prepared novel herbal gel by using extract of *Nigella sativa* and *Achyranthes aspera* seeds. The gel formulation F1 and F2 of different concentration were prepared. The liquid agar media was employed for media prepratin. The invitro microbial species used in such studies included *staphylococcus aureus* and *P. acne*. F2 formulation shows maximum zone of inhibition [20].

Bhatia V. et al 2020 has prepared Methanolic extract of *Azadirachta indica* and *Curcuma longa* by soxhlet extraction method. The gel formulations of six batches (F1 to F6) were prepared and evaluated invitro antimicrobial activity against the acne causing microbial species such as *Propionibacterium acnes* using agar diffusion method. All prepared formulation showed satisfactory antibacterial activities against test microbe. Thus it was concluded that the gel containing herbal extract can be effectively used for acne treatment [21].

Dange V.N. et al 2020 has prepared extract of *lantana camara* leaves by microwave extraction method. The antimicrobial study of *lantana camara* extract showed inhibitory activity using disc diffusion method against *Staphylococcus aureus* and *Staphylococcus epidermidis*. The gel formulation containing leaf extract showed 16mm against *S.aureus* and 19mm against *S. epidermidis* while only leaf extract showed less inhibition against both microbes as comparision to gel formulation [22].

Nawarathne N.W. et al. 2019. has prepared gel containing extract of *N. sativa* seeds, there were solvents such as hexane, ethyl acetate and methanol were employed for extraction with soaking method. Three formulations (F1 and F2) were formulated, F2 formulation was effective inhibition zone of against microbial species used such *S. aureus* and *P.acnes*. Among the three crude extract Ethylacetate extract had higher activity against *S. aureus* [23].

Jain K.L. et al 2017 has worked on Hydroalcoholic extract (water: methanol, 50:50) of *Butea Monosperma* flower, *Vitex agnus catus* leaves and *Nigella sativa* seeds by soxhlet extraction process. The gel formulations (F1 to F4) containing Polyherbal extracts were prepared using carbopol 940, gelling agent help to form gel like consistency. The antimicrobial evaluations of gel formulations were done against bacteria such as *Propinibacterium acnes* by using nutrient agar medium. The F4 showed best inhibition effect and more than the standard ciprofloxacin [24].

Bhalani U., Shah K. 2015 has worked on methanolic extract of *Nigella sativa* seeds by cold maceration method. The gel formulation contained 10% extract of *Nigella sativa* seeds and formulated by using carbopol 940. Thus gel was prepared and evaluated its antimicrobial activity against the acne causing bacterial species such as *Propionibacterium acnes*. The zone of inhibition for 10% extract contained gel formulation was significant results and zone of inhibition was similar activity as synthetic drug Ampicillin [25].

Sharma M and Rathore V. 2014 has prepared hydroalcoholic extract of *Azadirachta indica* and leaves of *Ocimum sanctum*; Aloe vera powder and tea tree essential oil. The Polyherbal gel formulation

containing extracts were prepared various number of batches (F1 to F19) by using different gelling agents like carbopol 934, carbopol 940 and HPMC K4M in varied concentrations and Prepared formulations were evaluated antimicrobial activity against *Staphylococcus aureus* by using agar well diffusion method. The zone of inhibition against bacteria observed from 1 to 7mm, formulation F1 (7mm) and F4 (6mm) showed better antibacterial activity [26].

Farjana A. et al. 2014 has studied on antimicrobial activity of boiled water, oil and methanolic extract of guava, tea, neem leaf and marigold. The agar well diffusion method was employed for that study. Boiled water extract of guava leaves gave greater zone of inhibition (22mm) and boiled water extract of green tea leaf showed 17mm against *Vibrio parahaemolyticus*, 19mm against *S. aureus* bacteria. Boiled neem leaf extract showed 10mm against *E.coli* and 11mm against *Klebsiella* species. There was no inhibition of water and oil marigold extract against all tested microbial species. Methanolic extract of guava and green tea leaves showed inhibition 18mm and *Pseudomonas* species. Methanolic extract of neem leaf and marigold leaf showed antimicrobial property against *S.aureus* (18mm) and *Klebsiella* spp. (12mm). The finding shows that extract are effective they could be effective against bacterial species and can be preferred as alternative for bacterial infections [27].

Yamini K. et al 2013 has worked on gel containing hydroalcoholic extract of *Azadirachta indica* and *Myristica fragrance*. The formulation batches (F1 to F15) were prepared using polymer carbopol 934, 940 and HPMC K4M and evaluated for antimicrobial activity against acne causing microbial species *propionibacterium acnes* by using nutrient agar medium. The antimicrobial activity evaluated by measuring zone of inhibition (in mm). All developed formulations had an inhibitory activity against *P.acnes*. Among all formulations, F4 batch showed (7mm), comparatively more antimicrobial activity than other batches [28].

Khan U.A. et al 2013 has studied antimicrobial studies of herbal plants extracts (*Bergenia ciliata*, *Jasminum officinale* and *Santalum album*) by Cold and hot water extraction. The antimicrobial studies were done against the microbial species such as *Staphylococcus aureus*, *Bacillus subtilis*, *Proteus vulgaris*. The Ceftriaxone and Erythromycin were used as positive control (means standard). Among the three plants extract, *Bergenia ciliate* showed the potential results against bacterial pathogens [29].

Sawarkar H.A. et al 2010 has prepared gel formulation containing hydroalcoholic extract of of *Ocimum sanctum*, ethanolic extract of *Tabernaemontana divariacata* by soxhlet extraction, Aloe vera gel powder and tea tree oil. The developed five formulation batches were prepared and evaluated against bacterial species *Propionibacterium acnes* using agar well diffusion method. All formulations antimicrobial activity showed zone of inhibition in mm. Out of all formulation batches, batch 5 showed greater inhibition activity (more than 16mm) but less than standard tetracycline as positive control, it showed inhibition more than 17mm [30].

Bhaskar G. et al 2009 has developed topical herbal gel containing aqueous extracts of *Garcinia mangostana* and *Aloe vera* with 1%w/w aqueous based carbopol 934. Six formulations were prepared containing varying proportions of polymers and evaluated them for antimicrobial activity against *Propionibacterium acnes* and *Staphylococcus epidermidis* by using nutrient agar plate medium. Batch no. F6 showed good inhibitory effect against microbes as compare to other formulation batches [31].

Ghosh A. et al 2008 has studied on traditional folk medicines of india in which hot aqueous and metholic extract collected from six traditional plants such *Terminallia chebula*, *Terminallia bellerica*, *Phyllanthus emblica*, *Punica granatum*, *Lawsonia alba* and *Mikania micrantha*. Those extracts were screened against bacterial species such as *Staphylococcus aureus*, *Bacillus subtilis*, *Escherichia coli*, *Proteus vulgaris* and *Enterobacter aerogenes* by using sensitivity test disk method. Methanolic extract of *T. chebula* leaf was exhibit most effective results against microbial species. This Plant extract considered as effective as potent antibiotics followed by aqueous of *T. bellerica* fruit [32].

CONCLUSION

The extraction and application of natural or herbal medicines has been documented in the past time. They have been reported to be effective in the management of many different type of skin related diseases or infection caused by microorganism. In this study it was find that the researcher's mainly preferred solvents such as Methanolic, ethanolic and Hydroalcoholic (Water: Methanol) solvent for extraction of crude herbal plant parts. The methods observed mainly for extraction of plant materials were cold maceration or soxhlet extraction. The extracts obtained by these extraction methods observed higher percentages yield. The gel formulation containing herbal extract prepared by using gelling agents such as carbopol 940 or 934. Carbopol is a synthetic polymer used in development of gel formulation. Model used for antimicrobial evaluation was zone of inhibition study in which microbial species like *Propionibacterium acnes*, *Staphylococcus epidermidis* and *Staphylococcus aureus* and *Candida albicans* etc. used for antimicrobial evaluation in most of published literature. In present review paper, Most of herbal extract showed antimicrobial activity, they had significant zone of inhibition. Zone of inhibition of herbal plant extracts depends on their concentrations, as concentration of herbal extract increases, it gives best inhibition results. Some herbal extracts showed zone of inhibitions results were similar to standard marketed products (Antibiotics) refer as positive control.

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