Review Paper

Effectiveness of traditional medicinal vegetables (ulam) against pathogenic microorganisms –A review

ABSTRACT

Ulam indicate some traditional Malaysian medicinal plants which are consumed raw in meal. Antimicrobial properties of ulam are one of the most significant current discussions among public and scientist. It is always a contradiction among public belief and scientific data about the pharmacological effect of ulam. Hence, various research was anticipated to scientifically prove the medicinal benefit of different ulam. In addition, the factors found to be influencing the antimicrobial activities have been explored in several studies. Hence, this review aims to collect scattered information on antimicrobial effects of ulam that might be beneficial for further isolation of the biologically active compound of this ulam in future.

Keywords: Ulam, antimicrobial, medicinal plant

INTRODUCTION

WHO reported that 80% of the world population still depends on herbal remedies for treatment even in this modernizes culture[1]. Malaysia is rich of flora and fauna because of favourable climate that is suitable for plant growth. This climate enhances growth of many types of plants including ulam. Ulam refer to medicinal plant which is consumed raw during meal. During ancient time, ulam is famous raw food among Malay ethnic. However, recent trend shows that ulam is gaining attention from all ethnics in Malaysia due to its beneficial health effects.

There are various studies that have linked ulam and its pharmacological effect such as anti-hyperglycemic effect, blood pressure lowering activity, cardiac protective activity, anti-cancer activity, asthma relief and anti-microbial activity.

Major cause of premature death worldwide is infectious disease due to microbial infection[2]. The emergence of this infectious disease remains to be a serious issue and cause economical loss to the government for the treatment. These infectious diseases are primarily by the infection of pathogenic microorganisms such as *Escherichia coli, Salmonela spp., Staphylococcus aureus* and *Candida albicans*[3]. The antimicrobial effect of herbal plant against this microbial species is gaining attention in modern community today as they provide lesser side effect compared to conventional medicine in treatment of infectious disease[4]. Antibiotics were also linked to some adverse effect such as hypersensitivity, immunosuppressant and allergic reactions[5]. In addition, resistance developed by microorganism against antibiotic is an alarming issue, hence there is an urgent necessity for discovery of alternative treatment using herbal remedies to treat microbial infection.

Alternanthera (Kermak)

Alternanthera is a genus of Amaranthaceae that can be found in America ("Alternanthera in Flora of North America @ Efloras.Org"), Asia, Africa and Australia[6]. Detailed investigation on the antimicrobial activity of *Alternanthera* by Johnson et al showed good antibacterial activity against gram positive and gram negative organisms[7]. Aqueous extract of *Alternanthera* leaves, inter-nodes, leave and inter-nodal segments were proven to be active against *Proteus vulgaris, Streptococcus pyogenes, Bacillus subtilis* and *Salmonella typhi*[7].

Anacardium occidentale (Pucuk gajus)

Cashew tree botanically named as *Anacadium occidentale* is a common edible plant originated from North-east of Brazil and now rooted at various part of the world. Cashew has medicinal, industrial and economic values to most of the countries which makes it so valuable in disease treatment. Researchers had reported that cashew leaves exhibit antibacterial activity against common oral pathogens, gram positive and gram negative bacteria at low MIC concentrations[8]. Ethanol extract of *A. occidentale* leaves was found to exhibit significant antimicrobial and antifungal activity due to the presence of tannin[9]. Chabi et al also pointed out that ethanol leave extract exhibited high bacteriostatic and bactericidal activity against *Staphylococcus sp* [10]. This finding is supported by Gisele & Juliana who reported stable antimicrobial activity against tested *Staphylococcus sp*. with ethanol leave extract[11]. These data supports the consideration of the usage of *A. occidentale* leave extract for wide range of pharmaceutical application.

Barringtonia racemosa (Pucuk putat)

Barringtonia racemosa (B. racemosa) is a tropical higher plant of Lecythidaceae family native to East Africa, South East Asia and Pacific Islands[12]. Previous study had reported that the roots of *B. racemosa* exhibit antibacterial activity against several Gram positive and Gram negative bacteria and are a rich source of phytomedicine[13]. Besides, *B. racemosa* also have been proven for its antifungal properties in a research conducted by Hussin and team[14]. The antifungal activity of *B. racemosa* may be attributed by the various phytochemical constituents such as phenolic acid and flavonoids present in the crude extract. The study proven that methanolic

extract of *B.racemosa* leaf has the strongest inhibitory effect against *Fusarium sp.* (53.45%), *Ganoderma lucidum* (34.57%), *Aspergillus sp*. (32.27%) and *Tricoderma koningii* (20.99%). Boiling water extraction of *B. racemosa* leaf also showing remarkable inhibitory effect against *Fusarium sp.* (51.72%) [14].

Carica papaya (Betik)

Carica papaya (Family Caricaceae), is a common tropical fruit with high nutritional and medicinal values. The papaya plant has been used traditionally for the treatment of common infectious and non-infectious conditions[15]. Tannins, saponins, glycosides and phenols are found to be the main bioactive constituents within the leaves, fruit and seeds of *Carica papaya*[16]. A considerable amount of study have proved that methanol extracts of carica leaves, mainly the yellow leaves shows good bactericidal activity against gram negative bacteria[17]. Dawkins et al conducted a study to compare the antimicrobial activity of the various stages of fruit maturity and the seeds[18]. It was reported that seed extract shows better inhibitory effect against gram-positive and gram-negative organisms. Seed extract from the fruit showed inhibition in the following order: *B cereus* > *E coli* > *S faecalis* > *S aureus* > *P vulgaris* > *S flexneri* . The observed activity was independent of the maturity stage of the fruits. This finding is supported by Yismaw and team that proven as papaya seed could be used as an effective antibacterial agent for the tested organisms from the clinical samples[19].

Colocasia esculenta (Kemahang)

Colocasia esculenta (araceae) was originated from the tropical region between India and Indonesia for hundreds of years. *Colocasia esculenta* was evaluated for preliminary of its antimicrobial activity against Gram positive and Gram negative bacteria[20]. Recent evidence suggests that Aracaea has considerable anti-bacterial and antifungal activity. Chloroform and

Methanolic extract of the Aracaea have been proven to have maximum inhibition against *Staphylococcus aureus, Bacillus subtillis, Escherichia coli, Proteus vulgaris, Candida albicans* and *Aspergillus flavon*[20].

Pluchea indica Less (L.) (Beluntas)

Pluchea indica Less (L.) is a native plant of Asia and Australia. *Pluchea indica L.* leaves have been identified to contain chemical properties such as tannins, flavonoids, polifenolat, and essential oils that are known to have antibacterial effect[21]. Purnomo points out that *Pluchea indica L.* leaves exhibit antibacterial effects against *Staphylococcus sp*, *Propinobacterium sp*, and *Corynobacterium*[22].

Psophocarpus tetragonolobus (Kacang kelisa)

Psophocarpus tetragonolobus and locally known as kacang kelisa is found throughout Malaysia[23]. Study conducted on *P. tetragonolobus* pods showed that the crude ethanolic extract of *P. tetragonolobus* pods shows significant antimicrobial activities against eight tested yeast and bacteria species. The extract shows dose response antimicrobial effect on microorganism tested namely *Bacillus cereus, Bacillus subtilis, Staphylococcus aureus, Escherichia coli, Klebsiella pneumoniae, Pseudomonas aeruginosa, Proteus mirabilis, Salmonella typhi, Candida albicans* and *Rhodotorula rubra.* The antimicrobial effect was assessed using disc diffusion assay and compared with vancomycin (30 µg/disc), tetracycline (30 µg/disc) and nystatin (30 µg/disc). The inhibitory effect of *P. tetragonolobus* for all the strain increased with increase concentration from 10 to 20 µL [24].

Polygonum minus (Kesum)

This plant is commonly found in Asian country such as Malaysia, Thailand, Indonesia and Vietnam[25]. Study performed by Musa et al. indicated that aqueous extract of *P. minus* do not have any antimicrobial against tested 9 isolated pathogenic fish bacteria namely *Aeromonas hydrophila, Citrobacter freundii, Escherichia coli, Staphylococcus aureus, Streptococcus agalatiae, Streptococcus aginosus, Vibrio alginolyticus, Vibrio parahaemolyticus* and *Vibrio vulfinificus*. Another study showed that water extract of *P. minus* did not show any activity on *Bacillus subtilis* and *Escherichia coli.* However, ethanolic and methanolic extracts showed activity against *B. subtilis* and no activity against *E. coli*. Conversely Hashim et al. reported that *P. minus* water extract showed activity on *E. coli* but did not show any activity on *B. subtilis* and *S. aureus* while ethanol and methanol extracts showed good activity on *B. subtilis, S. aureus* and *E. coli*. Overall study indicates that *P.minus* is a potent antimicrobial agent which can be used to treat mild microbial infection[25].

Artocarpus communis (Nangka)

Artocarpus communis known by local people as breadfruit tree since the edible fruits look as bread. The methanolic bark extract of *A. communis* showed that it could inhibit the growth of all tested microbial species namely *Providencia stuartii, Pseudomonas aeruginosa, Klebsiella pneumoniae, Staphylococcus aureus*, *Salmonella typhi, Escherichia coli* and *Candida albicans*. The minimal inhibitory concentration of extracts against all the strains was performed using INT colorimetric assay. The results showed that the lowest MIC value (64 µg/ml) recorded for the crude extract against two microbial strains namely *S. aureus* and *E. coli* ATCC8739. This present data support the usage of *A. communis* to treat infections related with tested microorganisms[26].

Kaempferia galangal (Cekur)

Kaempferia galanga (*K. galanga*) is one of the valuable herbal plants in Zingiberaceae family. The rhizome of *K. galanga* finds an important place in ayurvedic medicine[27]. Ethanolic extract of *K. galanga* showed significant antibacterial and antifungal properties[28].The component Ethyl p-methoxycinnamate (EPMC) and ethyl p-hydroxycinnamate (EPHC) are found to be the main chemical constituent that attribute to the microbial activity within the extract. Another comparative study carried by Omar et al, have found that EPHC has better antimicrobial and antifungal effect against common bacteria namely S. *aureus, B. cereus, P. aeruginosa, E. coli* and fungus like *Trichophyton rubrum, Trichophyton mentagrophytes* and *Microsporum gypseum*[29]. These justify the indigenous usage of *K. galanga* extracts as antidermatophytic agent as well[30].

Morinda citrifolia (Pucuk mengkudu)

Morinda citrifolia (M. citrofilia) is a plant of the Rubiaceae family. It is found in Southeast Asia and used widely in Polynesian traditional medicine. Over the past decade, most research in the natural products has emphasized on the antimicrobial activities of *M. citrofilia*[31]. Previous research has indicated that the juice of *M. citrofilia* is widely used in complementary medicine due to its probable antioxidant, anti-inflammatory and antitumor effects[32]. It has been demonstrated that ethanolic extract of *M. citrofilia* has antimicrobial activity by inhibiting the growth of both Gram positive and Gram negative bacteria[33]. These data corroborate others authors report that the antimicrobial activity of the ethanolic extract of *M. citrofilia*. This showed that its compounds may exhibit potent antibiotic activity against human pathogens such as *S. aureus, Bacillus subtilis, Escherichia coli, Pseudomonas aeruginosa, Salmonella* and *Shigella*[34].

Parkia speciosa (Petai)

Extensive research had indicated that antibacterial property of *P. speciosa* seed is contributed by their bioactive compounds which are hexathionine and trithiolane and two cyclic polysulfide compounds[35]. Musa et al had reported that aqueous suspension of *P. speciosa* is capable in retarding growth of certain microbial species such as *Aeromonas hydrophila, Staphylococcus aureus, Streptococcus agalactiae, Streptococcus anginosus*, and *Vibrio parahaemolyticus*[36]. Previous study by Sakunpak et al demonstrated the promising antimicrobial activity of *P. speciosa* methanolic seed extract against *H. pylori* and *E. coli (ethyl acetate extract)* [37].

Musa troglodytarum (Pisang muda)

Musa troglodytarum or locally known as banana or pisang muda is a familiar ulam among community. Different extract of *M. troglodytarum* (hexane, ethyl acetate and methanol) were subjected to agar well diffusion assay to determine the antimicrobial activity against different microorganisms such as *Escherichia coli, Pseudomonas aeruginosa, Enterobacter aerogenes, Klebsiella pneumoneae, Proteus mirabilis, Shigella flexneri, Citrobacter sp*.,. *M. troglodytarum* showed inhibitory effect in tested microorganism (Methycillin resistant *Staphylococcus aureus* and *Enterococcus faecalis*) with highest inhibitory activity against *E.coli* and *P.aeruginosa*. Agar well diffusion method was used to determine the minimum inhibitory concentration (MIC) of *M. troglodytarum*. The most sensitive bacterial pathogen against *M. troglodytarum* is *E.coli* with lowest MIC of 61.53 µg/ml and *P. aeruginosa* with MIC value of 31.25 µg/ml. The present study also exhibits that ethyl acetate extract give most prominent result as compared to other extract. Karuppiah et al. concluded that *M. troglodytarum* possess potent antibacterial effect[38].

Solanum torvum (Terung pipit)

This plant is widely distributed in Malaysia, China, Philippines, Thailand and Tropical America. The antimicrobial activity assay of *Solanum torvum* fruit methanolic extract indicate that the this plant is potential antimicrobial agent against several microbial strain such as *A. pyogenes, B. subtilis, P. aeruginosa, S. aureus, S. pyogenes, A. niger and C. albicans.* The MIC value was determined using micro broth dilution assay. The extract showed potent MIC values against *M. tuberculosis*[39]. Present study clearly highlighted the medicinal benefit of *S. torvum* species in traditional medicine to treat various microbial infections.

CONCLUSION

It is interesting to note that ulam have been proven to help promoting health condition. The various studies make several noteworthy contributions to the antimicrobial activity of the medicinal plants. However, it is unfortunate that the current findings do not examined the antibacterial effect *in vivo*. It is suggested that the association of these factors is investigated on animals in future research for better understanding on the systemic effects. Further studies which take these variables into account will need to be undertaken for important implications of future practice.

REFERENCES

1. WHO (World Health Organization). Geneva. Switzerland 1993.
2. Piddock KJV, Wise R, Mechanisms of resistance to quinolones and clinical perspective, *Journal of Antimicrobial Chemotherapy,* 23 (1989), 475-483.
3. Singh M, Chaudhry MA, Yadava JNS, Sanyal SC, The spectrum of antibiotic resistance in human and veterinary isolates of Escherichia coli collected from 1984–1986 in Northern India. Journal of Antimicrobial Chemotherapy, 29 (1992), 159-168.

4. Mulligen ME, Kauffman CA. Yu VL, Methicillin resistant *Staphylococcus aureus*: A consensus review of the microbiology, pathogenesis, and epidemiology with implication for prevention and management. American Journal of Medicine, 94 (1993), 313-328.
5. Lopez A, Hudson JB, Towers GHN, Antiviral and antimicrobial activities of Colombian medicinal. *Journal of Ethnopharmacology*, 77 (2001), 189-196.
6. Sánchez-Del Pino, I., et al.. Molecular phylogenetics of *Alternanthera* (Gomphrenoideae, Amaranthaceae): resolving a complex taxonomic history caused by different interpretations of morphological characters in a lineage with C_4 and C_3–C_4 intermediate species. *Botanical Journal of the Linnean Society* 169(3) (2012) 493-517.
7. Johnson M, Wesely EG, Selvan N, Kavitha MS (2010). *In vivo* and *in vitro* antibacterial efficacy of Alternanthera sessilis (Linn). *International Journal of Periodontics and Restorative Dentistry*, 2(10) (2010) 72-82.
8. Jothi V, Vijay KT, Vasudev B, Giliyar SB, Antimicrobial effect of *Anacardium occidentale* leaf extract against pathogens causing periodontal disease. *Advances in Bioscience and Biotechnology*, (2013) 4(8).
9. Geethashri A, Manikandan R, Ravishankar B, Veena S. *In vitro* antimicrobial and cytotoxic effects of *Anacardium occidentale* and *Mangifera indica* in oral care. *J Pharm Bioallied Sci*ence 7(1) (2015) 69–74.
10. Chabi SK, Sina H, Adoukonou SH, Ahoton LE, Roko GO, Saidou A., et al. Antimicrobial activity of *Anacardium occidentale* L. leaves and barks extracts on pathogenic bacteria, *African Journal of Microbiology Research*, 8 (25) (2014) 2458-2467.
11. Gisele MSG, Juliana G, Antimicrobial effect of *Anacardium Occidentale* extract and cosmetic formulation development. *Brazilian Archives of Biological Technology*, 55(6) (2012) 28-35.
12. Deraniyagala SA, Ratnasooriya WD, Goonasekara CL, Antinociceptive effect and toxicological study of the aqueous bark extract of *Barringtonia racemosa* on rats. *Journal of Ethnopharmacology*, 86 (2003) 21- 26.
13. Hussin NM, Muse R, Ahmad S, Ramli J, Mahmood M, Sulaiman MR, Shukor MYA et al. Antifungal Activity of Extracts and Phenolic Compounds from *Barringtonia Racemosa* L. (Lecythidaceae)." *African Journal of Biotechnology* 8(12) (2009) 2835-2842.
14. Khan S, Jabbar A, Hasan CM, Rashid MA. Antibacterial activity of *Barringtonia racemosa. Fitoterapia*, 72 (2001) 162-164.
15. Femi FE, Vimala J, The Antibacterial Effect of *Carica papaya* L. Extracts and their synergistic effect with antibiotic and non-antibiotic drugs, *British Microbiology Research Journal*, 16(4) (2016) 1-11.
16. Parle M, Gurditta , Basketfull benefit of papaya, *International Research Journal of Pharmacy* 2(6) (2011), 2230-8407.
17. Brij B, Tewari, Gomathinayagam S, Rekha G. Antimicrobial Properties of *Carica papaya* (Papaya) Different Leaf Extract against *E. coli S. aureus* and *C. albicans* . *American Journal of Pharmacology and Pharmacotherapeutics*, 1 (2014) 2393-8862.
18. Dawkins G, Hewitt H, Wint Y, Obiefuna PC, Wint B, Antibacterial effects of *Carica papaya* fruit on common wound organisms. West Indian Medical Journal, 52(4), 290-292.

19. Yismaw G, Tessema B, Mulu A, Tiruneh M. The *in-vitro* assessment of antibacterial effect of papaya seed extract against bacterial pathogens isolated from urine, wound and stool. *Ethiopian Medical J*ournal 46(1) (2008) 71-77.
20. Meenal SK, Khadabadi SS, Saboo S, Ghorpade DS, Modi AJ, *In vitro* antimicrobial activity of the crude extracts of *Colocasia esculenta* leaves (araceae)." *International Journal of Pharmaceutical Sciences and Research* 1(8) (2010) 25-31.
21. Jamal P, Karim IA, Abdullah E, Raus RA, Hashim YZ. Phytochemical screening for antibacterial activity of potential Malaysian medicinal plants. *African Journal of Biotechnology* 10 (2011) 18795-18799.
22. Purnomo M. Isolasi flavonoid dari daun beluntas(Pluchea Indica Less) yang mempunyai aktivitas antimikroba terhadap penyebab bau keringat secara bioautografi. Thesis. Surabaya: Universitas Airlangga; (2001) 47-49.
23. Burkill I.H., (1935). Dictionary of the economic products of the Malay Peninsula. London.
24. Lathaa LY, Sasidharan S, Zuraini Z, Suryania S , Shirley L, Sangetha S and Davaselvia M. Antimicrobial Activities and Toxicity of Crude Extract of The *Psophocarpus tetragonolobus* Pods. *African Journal of Traditional Complementary and Alternative Medicines,* 4 (1) (2007) 59 - 63.
25. Gor MC, Ismail I, Mustapha WAW, Zainal Z, Noor NM, Othman R, et al. Identification of cDNAs for jasmonic acid-responsive genes in *Polygonum minus* roots by suppression subtractive hybridization. *Acta Physiology Plant*, 33 (2011) 283-294.
26. Kuete V, Ango PY, Fotso GW, Kapche G, Dzoyem J, et al. Antimicrobial activities of the methanol extract and compounds from *Artocarpus communis* (Moraceae). *BMC Complementary and Alternative Medicine* (11) (2011) 42.
27. Sudipa N, Subrata M. Importance of ekangi (*kaempferia galanga l.*) as medicinal plants-a review. *International Journal of Innovative Research and Review* 3(1) (2015) 2347 – 4424.
28. Kochuthressia K, John PSB, Jaseentha MO, Rini R. *In vitro* antimicrobial evaluation of *Kaempferia galanga* L. rhizome extract. *American Journal of Biotechnology and Molecular Science* 2(1) (2012) 1-5.
29. Omar MN, Hasali NHM, Alfarra HYA, Yarmo MA, Zuberdi AM. Antimicrobial Activity and Microbial Transformation of Ethyl p-Methoxycinnamate Extracted from *Kaempferia galanga*. Oriental Journal of Chemistry 30(3) (2014) 38-42.
30. Sopa K, Supinya T, Sanan S, Antimicrobial activity of the ethanol extract and compounds from the rhizomes of *Kaempferia parviflora*, *Songklanakarin Journal of Science and Technology* 30(4) (2008), 463-466.
31. Wang MY, West BJ, Jensen CJ, Nowicki D, Su C, Palu AK, Anderson G. *Morinda citrifolia* (Noni): a literature review and recent advances in Noni research. *Acta Pharmacologica Sinica* 23 (12) (2002) 1127-1141.
32. Chan BY, Vaillant F, Perez AM, Reynes M, Brillouet J, Brat P, The fruit Noni (*Morinda citrifolia* L.), Journal of Food Composition Analysis (19) (2006) 645-654.
33. Candida, Thamyris et al. "Evaluation of antitumoral and antimicrobial activity of Morinda L citrifolia L. Grown In Southeast Brazil." *Acta Cirurgica Brasileira* 29(2) (2014) 10-14.

34. Suarez M, Haenni M, Canarelli S, Fisch F, Chodanowski P, Servis C, et al. Structure-function characterization and optimization of a plant-derived antibacterial peptide. *Antimicrob Agents Chemother*, (2005) (49) 3847-3857.
35. Gmelin RR, Susilo, Fenwick GR. Cyclic polysulphides from *P. speciosa, Phytochemistry*, 20(11) (1981) 2521– 2523.
36. Musa N, Wei LS, Seng CT, Wee W, Leong LK. Potential of edible plants as remedies of systemic bacterial disease infection in cultured fish. Global Journal of Pharmacology (2) (2008) 31-36.
37. Sakunpak A, Panichayupakaranant P. Antibacterial activity of Thai edible plants against gastrointestinal pathogenic bacteria and isolation of a new broad spectrum antibacterial polyisoprenylated benzophenone, chamuangone. *Food Chemistry*, 130(4) (2012) 826-831.
38. Karuppiah P, Mustaffa M. Antibacterial and antioxidant activities of Musa sp. leaf extracts against multidrug resistant clinical pathogens causing nosocomial infection. *Asian Pacific Journal of Tropical Biomedicine*. 3(9) (2013) 737-742.
39. Balachandran C, Duraipandiyan V, Al-Dhabi NA, Balakrishna K, Kalia NP, Rajput VS, et al. Antimicrobial and Antimycobacterial Activities of Methyl Caffeate Isolated from Solanum torvum Swartz. *Fruit. Indian Journal of Microbiology* 52(4) (2012) 676–681.