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Effectiveness of Traditional Medicinal Vegetables (ulam) against Pathogenic Microorganisms –A Review

A. Z. Nur[1*], S. Komathi[1] and M. Fazlina[2]

[1]Department of Microbiology, Faculty of Medicine, Asian Institute of Medical Sciences and Technology (AIMST) University, Kedah, Malaysia.
[2]Department of Pharmacology, Faculty of Pharmacy, Asian Institute of Medical Sciences and Technology (AIMST) University, Kedah, Malaysia.

Authors' contributions

This work was carried out in collaboration between all authors. Author MF drafted the review paper, Authors AZN and SK managed the literature searches. All authors read and approved the final manuscript.

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Review Article

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ABSTRACT

Ulam is a group of traditional Malaysian medicinal plants which are consumed raw in a 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 ofulam. 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.

**Corresponding author: E-mail: dilla.zaini@yahoo.com;*

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1. INTRODUCTION

World Health Organization reported that in 1993 that 80% of the world population still depend on herbal remedies for treatment even in this modern culture [1]. Malaysia is rich in flora and fauna because of favourable climate that is suitable for plant growth. This climate enhances the growth of many types of plants including ulam. Ulam refers to a medicinal plant which is consumed raw during the 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 a serious issue, and cause economical loss to the government for the treatment. These infectious diseases are primarily caused 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. This present review aimed to collect the scattered information on pharmacological effect of various ulam such as *Alternanthera, Anacardium occidentale, Barringtonia racemose, Carica papaya* and *Colocasia esculenta*. Many possible future studies on the potential of various ulam related to the pharmaceutical product could be successfully conducted with the details provided.

2. *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].

3. *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 parts of the world. Cashew has medicinal, industrial and economic values to most of the countries which makes it so valuable in disease treatment. Researchers have 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. [10] also pointed out that ethanol leave extract exhibited high bacteriostatic and bactericidal activity against *Staphylococcus sp*. This finding is supported by Gisele & Julianawho which reported stable antimicrobial activity against tested *Staphylococcus sp*. with ethanol leave extract [11]. These data support the consideration of the usage of *A. occidentale* leave extract for wide range of pharmaceutical application.

4. *Barringtonia racemosa* (Pucuk Putat)

Barringtonia racemosa (B. racemosa) is a tropical higher plant of Lecythidaceae family, native of 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%). Hot water extract of *B. racemosa* leaf also shows remarkable inhibitory effect against *Fusarium sp.* (51.72%) [14].

5. *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 of the leaves, fruit and seeds of *Carica papaya* [16]. A considerable amount of study has 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 teamthat proven as papaya seed could be used as an effective antibacterial agent for the tested organisms from the clinical samples [19].

6. *Colocasia esculenta (Kemahang)*

Colocasia esculenta (araceae) was originated from the tropical region between India and Indonesia for hundreds of years. *Colocasia esculenta* have been reported for 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].

7. *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 and essential oils that are known to possess antibacterial effect [21]. *Plucheaindica L.* leaves exhibit antibacterial effects against *Staphylococcus sp*, *Propinobacterium sp*, and *Corynobacterium [*22].

8. *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.* 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].

9. *Polygonum minus* (Kesum)

This plant is commonly found in Asian country such as Malaysia, Thailand, Indonesia and Vietnam [25]. However, it is unfortunate that the study performed by Musa et al. indicated that aqueous extract of *P. minus* do not have any antimicrobial against 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].

10. *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].

11. *Kaempferia galangal* (Cekur)

Kaempferia galangal (*K. galanga*) is one of the valuable herbal plants in Zingiberaceae family. The rhizome of *K. galangal* 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].

12. *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* possessed 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. citrofolia*. 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].

13. *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. [36] 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*. Previous study by Sakunpak et aldemonstrated the promising antimicrobial activity of *P. speciosa* methanolic seed extract against *H. pylori* and *E. coli* (ethyl acetate extract) [37].

14. *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 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].

15. *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]. Recent study clearly highlighted the medicinal benefit of *S. torvum* species in traditional medicine to treat various microbial infections.

16. 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.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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