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High Potential Activity of Garlic on Some Physiological Characteristics of Bacteria: Review

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ABSTRACT: In history, various cultures and civilizations had been applied garlic to prevent infections throughout many centuries. It could be used as raw juice, powders and capsules by means of dietary complements, so it differs from elements of food or conventional foods. It displays antibiotics activities against microorganisms, especially bacterial strains which have become resistant to antibiotics. Therefore, natural origins of antibiotics resemble cheap and effective choice for resistant strains. Because of garlic impressive antimicrobial effectiveness against multiple microbial infections, it is necessary to highlight its role in reduction of some physiological characteristics of bacteria that can cause many infections.

KEYWORDS: Allicin; Biofilm; Garlic; Quorum sensing; Virulence factors.

INTRODUCTION

Garlic (*Allium sativum*) is known to be one of plants that are belonging to the family Liliaceae, and it was used as food and for medical purposes [1]. Biological activities of Fructans had been known as polysaccharides that are non digestible or dietary fiber [2], and were used as substrates that can stimulate the growth of probiotic bacteria, in addition to their usage in immunomodulation processes[3]. Additionally, immune cells of intestinal tract had been suggested to have direct interaction with fructans [4]. Fight of infections had been applied for centuries by using garlic, such as treating of diarrhea, headache, fever, flu, sore throat, by Egyptians. It was used in treatment of flu, fever, abdominal discomfort, extra-intestinal diseases, , otitis media and respiratory tract infections [5,6].

Historically, garlic had been found to possess many therapeutic properties such as antimicrobial, anti-cardio vascular, anti-diabetic hyperlipidemia, antineoplastic, anti -hypertensive immuno-stimulatory and hypoglycaemic activities [7,8]. In addition, it had been used to relief diseases that are caused by bacteria such as rheumatism, pile and cough, diseases of cardiovascular, tumor alleviation and finally ageing [9]. Compounds of organosulfur that are oil in nature or soluble in water which give its specific flavor and odor are ascribed for most of garlic therapeutic and prophylactic effects [10]. Hence, thiosulfates compounds play an essential role in the garlic antibiotic activity which was shown to be completely obliterated as the thiosulfates (as in allicin) are abolished from the garlic extract. In addition, it was found that the diallyl disulfide (DADS) that is a result of allicin reduction, resulted in great abolishing of the aqueous garlic extract antibacterial activity [11]. As it was appeared, allicin represents the active ingredient of garlic and has been reported to have a range of potential targets. In a study carried out by Durairaj, *et al*.,(2010), it was showed that the allicin can exhibit its antimicrobial activity mainly by RNA synthesis total inhibition, blocking the vital bacterial enzymes, fungi and viruses such as acetate kinase, phosphotransacetyl-CoA synthetase, cysteine proteinases, alcohol dehydrogenases, thioredoxin reductase [12], while partial inhibition of DNA and protein syntheses are occurred as a result of inhibition of acetyl CoA forming system, which elicited that the primary target for action of allicin is RNA [13]. In another word, bacterial strains have differences in their structures that can play an important role in their sensitivity to garlic components. Because of the severe side effects of antibiotics used for prolonged time for those individuals with a recurrent infections, and resistance in bacteria against antibiotics elicit an increasing level, the use of alternative strategies such as garlic consumption become more important use for preventing such infections [14,15]. Garlic has been known for its cidal effect towards fungi and viruses [16]. Also, it has a great activity against different kinds of bacteria such as on *Escherichia, Klebsiella, Staphylococcus, Salmonella, Helicobacter, Proteus, Enterococcus aerogenes, Streptococcus, Mycobacterium,* and *Trichomonas vaginalis* [17,18].

Virulence of many important pathogens are regulated via Quorum sensing, which is a strategy of bacteria in which communication between cells occurs by using specific signal molecules [19,20]. This strategy is known to play very important role in many bacterial behaviors such as formation of bacterial biofilm, pathogenicity and several virulence factors of different pathogenic bacteria [21,22].

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Bacterial virulence and pathogenicity had been proved to be suppressed by inhibition of their quorum sensing. While, it was found that no inhibition of their growth was occurred. This appeared that inhibitors of quorum sensing are not the suitable choice for achieving resistant bacterial selection pressure. Previously, it was approved that quorum sensing inhibitors can be produced from many medicinal and edible plants [23].

Quorum quenching (QQ) is a naturally occurring phenomenon that interferences with QS. As QS induces noxious traits, the disruption of bacterial communication to prevent bacterial synchronized virulent behavior appears as a promising strategy. thus, QQ approaches can be applied in multiple and different fields [24].

Compounds of QQ can be natural products, such as polyphenols that can be isolated from ajoene from garlic, tea or honey, eugenol which can be produced from clove or fungi and marine habited organisms. For example, Ajoene, which is a a garlic sulfur-rich molecule is considered one of *Pseudomonas aeruginosa* QS inhibitors. This bacteria is an opportunistic human pathogen that cause infections which are particularly difficult to eradicate [25,26].

Biofilm fragility of *P. aeruginosa* had been noticed to be increased when treated with garlic extract [27]. This can be due to the capability of garlic on expression reduction of key quorum sensing regulated virulence factors which can be explained by suppressing of *P. aeruginosa* small regulatory RNAs (sRNA) and *Staphylococcus aureus*. Expression of sRNAs RsmY and RsmZ in *P. aeruginosa* and RNAIII in *S. aureus* by which key virulence factors expression is controlled, were lowered by ajoene, in addition to reduction of hemolysins and proteases production of the last bacteria [28]. On the other hand, it was found that production of pyocyanin, elastase, biofilm formation and swarming motility in *P. aeruginosa* PAO1 were decreased by an ingredient from garlic oil known as DADS but the growth of bacteria was not affected [29.26].

Activity of garlic extracts was also studied on adhesion of bacteria which is considered to be the first and decisive step in the microbial sequence of events in pathogenicity, which leads to colonization [30]. The effectivenes of garlic polyphenolic compounds were studied on the activity of enzymes such as glucosyltransferase that is considered to be very essential parameter of virulence that allows the bacterial adherence and colonization [31]. Bacterial treatment with garlic extract showed high effectiveness of bacterial adherence inhibition to epithelial cells of the host, that led to prevent pathogenic bacteria to cause pyelonephritis, urethritis and diarrhea [32].

Another physiological behavior of many pathogenic bacteria such as *Serratia* spp., *Salmonella* spp., *E. coli, Aeromonas* spp., *Bacillus spp, Yersinia* spp., *Pseudomonas* spp., *Vibrio* spp. and *P. mirabilis* is swarming motility [33]. *P. mirabilis* showed high ability to enhance host infection during rapid swarming; as it enhances cell migration through urinary tract and cause many infections. *P. mirabilis* swarming requires the sensing with intracellular, cell-to-cell and integration of a variety of environmental signals and encompasses a regulated gene expression leading to physiological and morphological changes [34]. It was suggested that compounds in garlic extracts serve as environmental stimulus to affect swarming of *P. mirabilis* and other Gram negative bacteria. In addition, it was known that the effect of aqueous garlic extract (AGE) on bacterial motility is interpreted by that it contains chemical compounds, which have been shown to inhibit the motility of several uropathogenes [15].

It was shown that allicin is efficiently inhibited *P. mirabilis* urease inside the intact bacteria which, in turn, revealed efficient diffuses of allicin into the cytoplasm and efficiently leads urease inhibition. An experiment indicated the easily passage of allicin through the biological membranes [35] which can be considered to be the most allicin advantage over the other inhibitors of urease. Additionally, high activity of allicin on streptolysin O (SLO) and pneumolysin O (PLY) was revealed. It was proved that allicin has the ability in SLO and PLY inhibition through its binding to the cysteinyl residue in their binding sites [36].

CONCLUSION

As a conclusion**,** garlic can be used not only as antimicrobial agents, but also can be used to affect several physiological behaviors of bacteria especially that can prevent many of their infections.

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