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Review Article

ANTI-MICROBIAL PROPERTIES OF BLACK TEA, INDIA: A REVIEW

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Abstract: Tea is widely used beverage with medicinal benefits. Black tea is the complete fermented/oxidized form of tea leaves. Black tea contains polyphenol compounds complex flavonoids called theaflavins and the arubigins, which are responsible for a number of potential health benefits. Antioxidant, anticancerous, antidiabetic properties of theaflavins from black tea were discussed in this review. Tea flavonoids can act against food borne and other pathogenic bacteria, virulent protein toxins produced by bacteria, virulent bacteriophages, pathogenic viruses and fungi which includes the bioavalibility of the flavonoids and methylxanthine. Moreover, the sustenance of antimicrobial potential was also correlated with the shelf life of black tea. In this perspective, the focus of this review is to introspect the antibacterial, antiviral, antiprotozoal, antifungal activities of black tea.

Key words: Black tea, polyphenols, theaflavins, the arubigins, methylxanthine (caffeine, theobromine, and theophylline antimicrobial, antiviral, antiprotozoal, antifungal.

Introduction: Tea is the most widely used ancient beverage in the world with the observation of medicinal benefits. During the fermentation process, in which green tea oxidizes to form black tea usually caffeine content tends to remain constant, while the types of flavonoids present in the tea differ. Green tea usually contains simple flavonoids called catechins, while black tea contains complex flavonoids called theaflavins and the arubigins, which are responsible for a number of potential health benefits (Preedy, 2015). Methylxanthine (caffeine, theobromine, and theophylline) contents are p in three brews of four types of tea (black, oolong, green, and herbal) in both bags and loose leaf forms.. Now a days, it is found that, black tea is most widely consumed in Western countries, probably due to its good storage properties, which indirectly promotes active trade with tea-producing countries in Asia including India. Black tea represents over 90% of all tea sold in the West and the main tea beverage in India, Europe, Russia, North America, the Middle East, Indonesia, North Africa, Chile, Hong Kong, Australia, and New Zealand (Waugh

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et al., 2017). The therapeutic uses of black tea were mostly investigating its antioxidant properties and correlated with the brewing time (Nikniaz *et al*., 2016). It could therefore be interesting to review the therapeutic potential of black tea in relation to lifestyle and health effects from a microbiological perspective. In view of the perceived positive health effects of black tea, the body weight reduction by black tea was reported by Pan *et al*., (2016). Black tea is the fermented/oxidized form of tea. Tea leaves produce organic compounds which are involved in the defense of the plants against invading pathogens including insects, bacteria, fungi, viruses. Tea flavonoids can act against food borne and other pathogenic bacteria, virulent protein toxins produced by bacteria, virulent bacteriophages, pathogenic viruses and fungi which includes the bioavalibility of the flavonoids (Zhao and Shah, 2016). They had described concomitant ingestion of lactic acid bacteria and black tea synergistically enhances flavonoid bioavailability. Black tea shows its antioxidant property by inhibiting lipid peroxidation and chelating metal ions (Horie *et al*., 2017). The anticancerous (against ovarian cancer, lung cancer, colon cancer) effect of Black tea was already established (Bhattacharya *et al*., 2017; Zhan *et al*, 2017). The antidiabetic effects of Black tea were established as well. Anti-hyperglycemic effect of black tea was demonstrated by Fu *et al*., 2017. The Black tea infusions have antimicrobial effects as well. The aim of this review is to focus on the various aspects of antimicrobial effects of Black tea on different types of microorganisms including bacteria, virus, fungi, protozoa as well.

The amount of tea or coffee estimated from the number of cups consumed is frequently used as an indication of caffeine consumption in epidemiologic studies. However, this alone may be an inadequate indication of intake since drinking practices of tea varies. Three cups of tea brewed using three tea bags (Western culture) have approximately twice the amount of methylxanthines as the same volume prepared by three successive brews of loose tea leaves (Asian culture). These differences should be accounted for by the epidemiologic studies evaluating the effect of methylxanthines on health. The chemical methylxanthine, Theobromine and Theophylline stimulate compounds that can ward off the virus in a human with at least an average immune system. The main methylxanthine in tea is the stimulant caffeine. Other methylxanthines found in tea are two chemically similar compounds, theobromine and theophylline. The Tea plant creates these chemicals as a way to ward off insects and other microbes.

Antibacterial activities of Black tea

Chan *et al*., 2011 have found that the black tea inhibited the growth of Micrococcus luteus and Bacillus. cereus. The growth of Staphylococcus aureus was inhibited by Black tea as reported by Chopra and Greenwood, 2001. Naderi *et al*., (2011) have reported antibacterial activity of Black tea against Streptococcus mutans in in vitro studies. Mughal *et al*., 2007 have demonstrated the antibacterial activity of black tea along with the synergistic effects with Chloramphenicol, Tetracycline, Levofloxacin antibiotics. Patil *et al*., 2016 have demonstrated wide range of antibacterial activity of black tea against Gram positive organisms such as Bacillus cereus ATCC13061, Staphylococcus aureus ATCC6538p, Staphylococcus saprophyticus KCTC3345, Listeria monocytogenes ATCC7644 and Gram negative bacteria Proteus vulgaris KCTC2512, Pseudomonas aeruginosa KCTC2004, Pseudomonas putida ATCC49128 and Serratia marcescens KCTC42171. Obwoge, 2017 had reported the antimicrobial effects of black tea against Staphylococcus aureus, Streptococcus faecalis and Escherichia coli.

Antiviral activities of Black tea: Cantatore *et al.* 2013, have demonstrated the antiviral effects of Black tea against simplex virus-1 infection. Research had demonstrated that theaflavins of Black tea contain antiviral activity against Herpes simplex virus 1 & 2 (HSV-1 & HSV-2) and on the Sindbis virus (SINV) (Villagomez, 2017). Epigallocatechin gallate and the aflavin digallate (TF3) from black tea had inhibited the infectivity

of both influenza A virus, influenza B virus (Yang *et al*., 2014). Black tea extract (BTE), containing flavonoids theaflavins, could inhibit herpes simplex virus type-1 (HSV-1) infection in cultured A549 (human epithelial) and Vero cells inhibited by Cantatore *et al*., 2013. Quercetin from black tea can be as antiviral agent against Dengue virus DENV-2 strain (Rahaman, 2015) and found to inhibit Middle East Respiratory Syndrome (MERS) proteases invitro (Park *et al* 2017). Similarly, a recent study by Nabirotchkin *et al* (2020) reported that, quercetin may also have anti-corona virus properties. These differences should be accounted for by the epidemiologic studies evaluating the effect of methylxanthines on health. The chemical methylxanthine, Theobromine and Theophylline stimulate compounds that can ward off the virus in a human with at least an average immune system. The main methylxanthine in tea is the stimulant caffeine. Other methylxanthines found in tea are two chemically similar compounds, theobromine and theophylline. The Tea plant creates these chemicals as a way to ward off viruses and other insects and microbes. Methylxanthine, Theobromine and Theophylline are the compounds that would significantly decrease the impact of the COVID – 19 virus on the human body by increase the immunity system.

Antiprotozoal activities of Black tea

Antihemolytic, hepatoprotective and nephroprotection action of black tea against Plasmodium berghei was reported by Nakichat *et al*., 2017. Obwoge, 2017 had demonstrated the antiprorozoal activities of black tea against Entamoeba coli.

Antifungal activities of Black tea

Battikh *et al*., 2012 have demonstrated the antifungal effects of black tea against Candida sp. anti-Candida activity of tea polyphenols was demonstrated by Sitheeque, 2009. Obwoge, 2017 had demonstrated the antifungal activities of black tea against Candida albicans. In vitro antifungal activity against Candida species of Sri Lankan orthodox black tea belonging to different agro-climatic elevations was demonstrated by Ratnasooriya *et al*., 2017. The antifungal activities of black tea against Candida albicans ATCC 14053, Candida albicans ATCC 64548 and Candida krusei ATCC 6258 strains were done by Camargo *et al*., 2016.

Conclusion: Antimicrobial effects of Black tea extracts were observed against Pseudomonas Aeruginosa isolated from eye infections (Flayyih *et al*., 2013) and the antimicrobial capacities were compared with different antibiotics viz. Carbenicillin, Tetracycline, Cefotaxime. Olosunde *et al*., 2012 had also demonstrated the various aspects of the Black tea extracts on different microorganisms. The Minimum Inhibitory Concentrations were determined and the zone of inhibitions were measured with respect to different concentrations of Black tea extracts. The antimicrobial properties and activities along with Physicochemical, Biochemical parameters of Black tea were determined by Saha and Shyam Choudhury, 2016. Methylxanthine, Theobromine and Theophylline are the compounds that would significantly decrease the impact of the virus on the human body by activating the immunity system. The antimicrobial potential during storage in different packaging of tea, which established the superiority of Black tea is to retain the biochemical properties which are the responsible for the antimicrobial properties.

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