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Antibacterial Activity of Black Tea on some Selected Bacteria

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ABSTRACT

The antibacterial potential of black tea (Lipton® and Highland tea) on some pathogenic organisms including Staphylococcus aureus, Streptococcus species, Escherichia coli and Klebsiella specie using agar well diffusion technique was investigated. The result showed that the aqueous extract of black tea contains bioactive compounds that are active against all the tested organisms. Lipton tea extract showed maximum inhibition zones of 34 mm against Staphylococcus aureus, followed by Streptococcus sp. with 32 mm, E. coli had 20 mm while Klebsiella sp was the least with 18 mm. Also, Highland tea extract showed zones of inhibition of 21mm, 20 mm, 19 mm and 14 mm on Staphylococcus aureus, Streptococcus sp., E. coli and Klebsiella sp. respectively. Additionally, Lipton tea extract was observed to have more potency on all the organisms used in this study when compared to that of Highland tea. However, there was no significant difference between the two brands of black tea ($p>0.05$). Hence, individuals are encouraged in daily intake of black tea especially Lipton® and extracts from such teas should be used in the formulation of therapeutic agents against the diseases caused by these organisms under study.

Keywords: Antibacterial activity, Aqueous extract, Black tea, *Diseases*, *Pathogenic organisms.*

INTRODUCTION

An infusion Produced from young leaves of *Camellia sinensis* L. (Kuntz), made by steeping processed leaves, buds or twigs of tea bush in hot water for several minutes, after which it is drunk is called Tea [1]. Tea came into English language from Chinese word of tea which is pronounced "te" in the Min Nan spoken variant. Tea is one of the most widely consumed fluids after water. Therefore, tea is designated as a "health drink" [2, 3]. The Leaf buds and young leaves are used in making tea, the age of the leaves determines the taste and name of a particular commercial variety. Based on the methods of processing used, tea is designated as black (fermented), Oolong (semi-fermented), green (unfermented), or white (unfermented), although all come from the same plant [4]. The manufacturing process of tea involves three basic steps called withering, fixing and rolling. The process of withering reduces the moisture content of the tea leaves and it allows the flavour compounds to develop. Fixing refers to the process by which enzymatic browning of the wilted leaves is controlled through the application of heat. During the manufacture of green tea, the fermentation of tea leaves is prevented by applying heat. With no fermentation, green tea leaves retain their green colour and almost all of their original polyphenol content. White tea is minimally processed and is obtained from the unopened buds or from the first shoot of the plant [5]. The different processes of manufacturing give the various teas their characteristic

colours and flavours. Oolong tea has an excellent characteristic combining the freshness of green tea and the fragrance of black tea [6]. Owing to different processing methods, each tea sample has a unique character, taste, and chemical profile [7]. Black tea is consumed primarily in western countries and in South Asian countries such as India and Sri Lanka, whereas green and oolong teas are consumed mainly in East Asian countries such as China, Japan, and Taiwan [8]. Being one of the most popular beverages worldwide, it is cultivated in more than 30 countries worldwide, and of the total amount of tea produced and consumed in the world, 78% is black, 20% is green, and 2% is oolong [9,10].

Teas have been proved to enhance insulin activity, helps in treating asthma, retard cataract, maintains fluid balance, bone and dental health, improves mean body mass index (BMI) and body weight, prevents cellular DNA damage, inhibits HIV, lowers stress hormone levels, etc. [11]. Drinking black tea may improve blood vessel function, improve blood flow in the brain, and lower the risk of cognitive impairment [12]. Furthermore, theaflavins in black tea have also attracted considerable interest, as they are shown to have various physiological actions, including antioxidant, anticancer, anti-atherosclerotic, anti-inflammatory, antiviral, and anti-periodontitis [13, 14, 15, 16,17]. Theaflavins are a group of polyphenols unique to black tea. They are formed during the fermentation process and comprise 3-6% of all polyphenols in black tea. Tea polyphenols are known for their antibacterial activity. A study conducted by [18] revealed that the tea leaves produce organic compounds that may be involved in the defense of the plants against invading pathogens including insects, bacteria, fungi, and viruses. These metabolites include polyphenolic compounds, the six so-called catechins, and the methyl-xanthine alkaloids caffeine, theobromine, and theophylline. These substances impart the black color to Black Tea. Mc Naught, a major in the British Army Medical Corps first demonstrated the anti-microbial activity of tea. He showed that black tea infusion killed *Salmonella typhi* and *Brucella melitensis*. He suggested that the troops should carry tea in their bottles to prevent the outbreak of infections caused by these organisms [19]. However proper scientific investigation of the antimicrobial activity of tea began only in the late 1980's and studies have verified that tea can kill and inhibit a wide range of pathogenic bacteria [20]. The aim of the present study is to evaluate the antibacterial activity of black tea extract against some clinical strains of Gram positive and Gram negative bacteria.

MATERIALS AND METHODS

Study Area

Bali local government area of Taraba State lies between latitude 7°46 N and 7°54 N of the equator and longitude 10° 30 E and 11° 00 E of the prime meridian (Bureau for land and survey Jalingo, 2019). It is found in dry guinea savannah. It is the largest local Government in Taraba State, with an estimated land area of 11,540 km^2. It has some mountains like Gazabu, Dakka, Maihula, Bagoni, among others. Bali local Government had a population of about 211,024 persons (NPC, 2006). It has a tropical climate marked by two seasons; dry and rainy seasons. The rainy season starts around April and ends November occasionally, with 1350 – 1500mm rainfall annually. The dry season is from December to March. Daily temperature varies from 37 to 40°C during the hottest months of March/April. It also varies from 32 to 37°C during the coldest months of December/January. The relative humidity is about 23.00 % during the hot dry weather and can reach 80.00 % during the peak of wet season in July/August [21, 22]. The major ethnic groups in the area include; Jibawa, Tiv, Chamba, Fulani, Hausa, Itchen etc. The major occupation of the inhabitants is farming, fishing and nomadism. In addition, Public servants, traders and artisans also inhabit the area. Their water sources for domestic and agricultural uses are River Taraba, Borehole, ponds and wells.

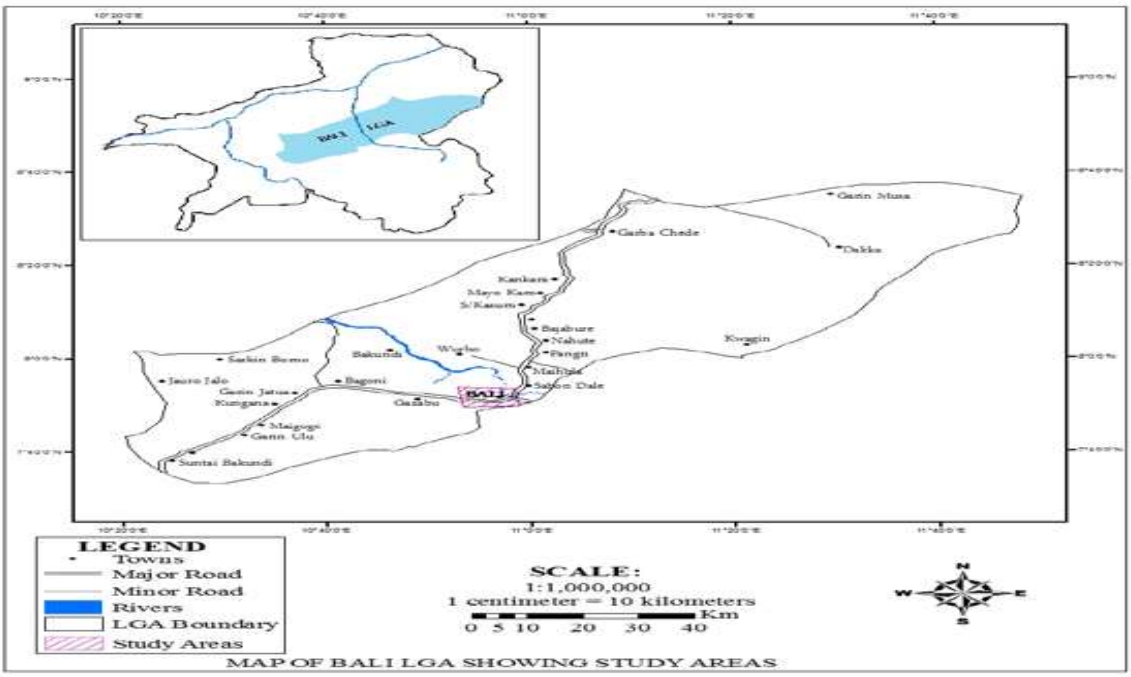

Figure 1: Map of the study Area
(Source: Bureau for land and survey Jalingo, Taraba State, 2019)

Sample Collection

Black teas (Lipton tea and Highland tea) were purchased randomly from the supermarkets and shops in Bali town in the month of November, 2024. The tea samples were taken to the Biology laboratory, Department of Science Laboratory Technology, Federal Polytechnic Bali for analysis.

Preparation of Extract

Aqueous extraction methods of Chan *et al.* (2010), was employed. 25 teabags were extracted exhaustively with 500 ml of hot water (infusion) three times, with continuous agitation at 2 hours intervals. The infusion was evaporated to dryness in a water bath at a temperature of 40°C. The extracts (crude extract) were stored in airtight bottles (at 4°C) until required for further analysis.

Test Organisms

Four clinical isolates of bacteria namely; *Escherichia coli*, *Klebsiella* sp., *Streptococcus* sp. and *Staphylococcus aureus* were obtained from Optimum Laboratories, Yola Adamawa State, Nigeria. The Identity of organisms were further confirmed using standard biochemical tests including Gram staining, coagulase test, catalase test and motility test among others as described by [3].

Antibacterial Susceptibility Testing

The agar well diffusion technique as described by [23], with little modification was employed. The Nutrient agar plates were inoculated with the test organism using a sterile cotton swab, four equidistance wells (6 mm in diameter and about 2cm apart) were punched into the surface of the medium in each plate using a sterile cork borer. An aliquot (100 µl) of the extract was dispensed into three wells using an automatic pipette. The same quantity of sterile water was dispensed into the remaining well which serves as a negative control after which the plates were incubated in an upright position at 37 °C for 18-24 hours. After incubation, the diameter zone of inhibition was measured (in mm) using a meter rule. This procedure was repeated in duplicate for each bacteria isolate and the mean of the duplicate results for each isolate was recorded.

Data Analysis

The data obtained were subjected to descriptive statistics and presented in table. Chi-square (x^2) was used to determine the level of significance between the two brands of black tea in the study area. $P<0.05$ was considered statistically significant.

RESULTS AND DISCUSSION

RESULTS

Table 1: Antibacterial activity of black tea on some selected bacteria

Brands of Black Tea	Zones of Inhibition (mm)			
	S. aureus	*E. coli*	*Klebsiella* sp.	*Streptococcus* sp.
Lipton Tea	34	20	18	32
Highland Tea	21	19	14	20
	*	*	*	*

Key: mm= Millimeter

X^2 calculated = 1.36; X^2 tabulated = 3.84; df= 1; $p>0.05$; ** = Statistically insignificant

DISCUSSION

In this present study, the antibacterial activity of black tea extracts exhibited antibacterial effect against all the test organisms. Lipton® tea extract showed maximum inhibition zones of 34 mm against *Staphylococcus aureus*, followed by *Streptococcus* Sp. with 32 mm, *E. coli* had 20 mm while *Klebsiella* sp was the least with 18 mm. On the other hand, Highland tea extract showed zones of inhibition of 21 mm, 20 mm, 19 mm and 14mm on *Staphylococcus aureus*, *Streptococcus* Sp., *E. coli* and *Klebsiella* sp. respectively. Lipton® tea extract had more antibacterial effect on all the organisms when compared to that of Highland tea. However, no statistically significant difference was observed among the two brands of black tea ($P > 0.05$) (Table 1). The antibacterial activity observed in this study corroborates the findings of [23], who observed that black tea extract showed sufficient antibacterial activity against *S. mutans*, *S. aureus*, *L. acidophilus*, *Klebsiella* spp. and *E. coli*. Also, the findings of this study is similar with the reports of [24], who found that the anti-*Streptococcus mutans* activity of Iranian black tea is more than that of green tea.

The effectiveness of this extract could be attributed to the presence of bioactive compounds such as polyphenols which have more pronounced antimicrobial activity and therefore, exert their action by perturbing the membrane of bacteria [23, 24]. The high activity exhibited by the extract of Lipton tea on these organisms when compared to that of Highland tea as observed in this study could be attributed to the high polyphenols content present in lipton tea as opined by [24], that tea polyphenols are known for their antibacterial activity against a wide range of pathogenic bacteria.

CONCLUSION

The present investigation revealed that black tea such as Lipton® and Highland tea contains bioactive compounds that possess antibacterial potency and demonstrated a broad-spectrum of activity against both gram-positive and gram-negative bacteria used in this study. Additionally, the extract's wide spectrum of activity against different bacteria types makes it a promising therapeutic agent. Hence, daily intake of black tea especially Lipton tea is encouraged.

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