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Sanitizer

Bacteria Isolated from  
Conifers

Review on the Therapeutics  
Implication

Productivity and Professionalism  
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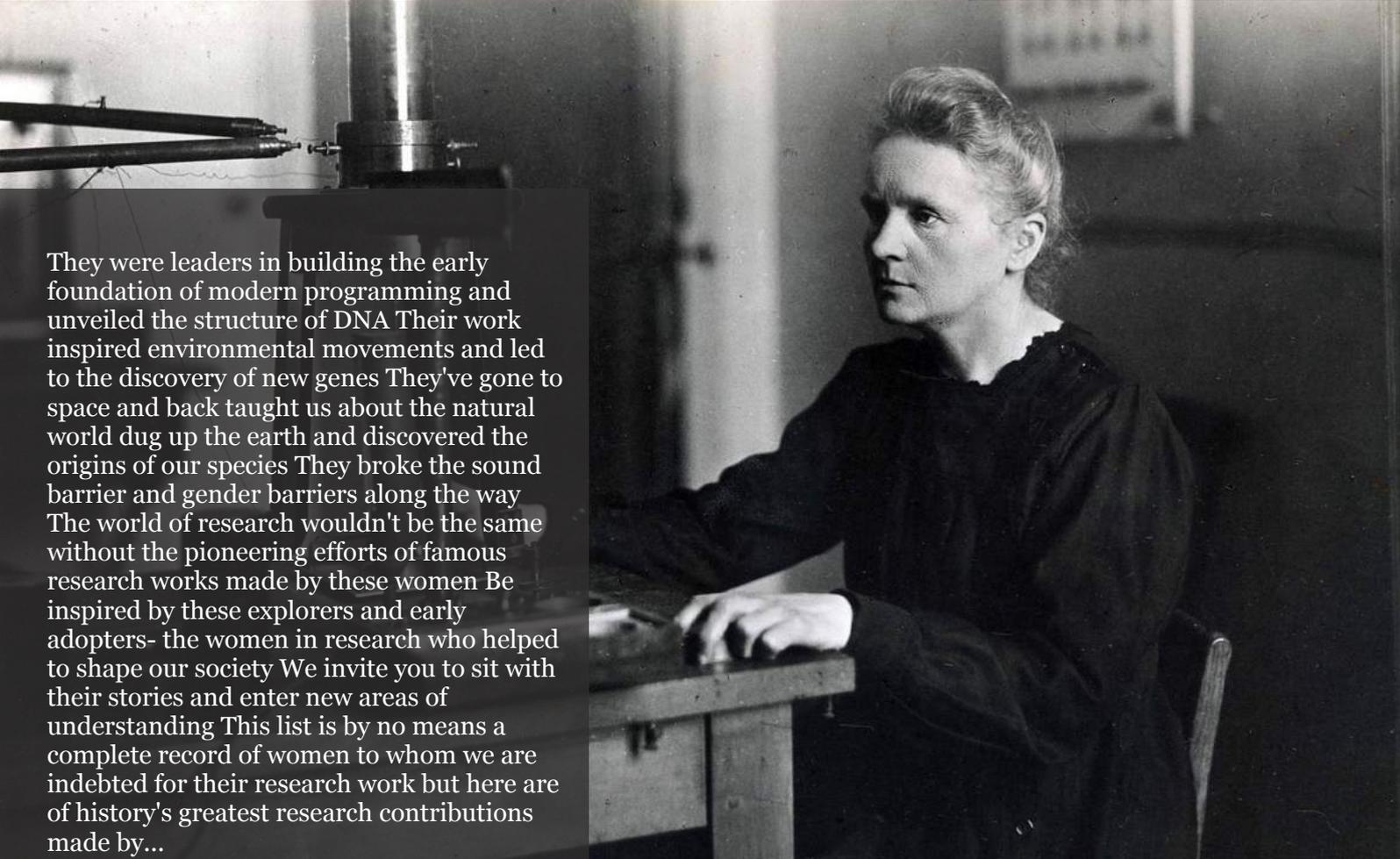
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# A Decisive Review Contemplating the Nutritional, Prophylactic and Therapeutic Efficacy of *Asl* (Honey) in the Context of Traditional Prophetic Medicine

*Syeda Ayeman Mazhar, Rubi Anjum, Ammar Ibne Anwar & Abdul Aziz Khan*

*Aligarh Muslim University*

## ABSTRACT

Honey is a remarkable viscous liquid, prepared by bees from nectars of various plants. It has occupied a prominent place in traditional medicines throughout history. The ancient Egyptians, Assyrians, Chinese, Greeks and Romans employed honey for different diseases. The Noble Qur'an and many Prophetic narrations refer to honey as a great healer of disease. Allah, Almighty, says (what means): "And your Lord inspired the bee, saying: 'Take you habitations in the mountains and in the trees and in what they erect. Then, eat of all fruits, and follow the ways of your Lord made easy (for you).' There comes forth from their bellies, a drink of varying colour wherein is healing for men. Verily, in this is indeed a sign for people who think." [Al-Qur'an 16:68-69]

**Objective:** To explore the various narrations of Prophet Muhammad (PBUH) in authentic scriptures about honey and to rule out its efficacy on the basis of scientific studies.

**Keywords:** anti-inflammatory, anti-oxidant, nutritional value, Prophetic narrations, traditional medicines.

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# A Decisive Review Contemplating the Nutritional, Prophylactic and Therapeutic Efficacy of Asl (Honey) in the Context of Traditional Prophetic Medicine

Syeda Ayeman Mazhar<sup>a</sup>, Rubi Anjum<sup>o</sup>, Ammar Ibne Anwar<sup>p</sup> & Abdul Aziz Khan<sup>co</sup>

## ABSTRACT

*Honey is a remarkable viscous liquid, prepared by bees from nectars of various plants. It has occupied a prominent place in traditional medicines throughout history. The ancient Egyptians, Assyrians, Chinese, Greeks and Romans employed honey for different diseases. The Noble Qur'an and many Prophetic narrations refer to honey as a great healer of disease. Allah, Almighty, says (what means): "And your Lord inspired the bee, saying: 'Take you habitations in the mountains and in the trees and in what they erect. Then, eat of all fruits, and follow the ways of your Lord made easy (for you).' There comes forth from their bellies, a drink of varying colour wherein is healing for men. Verily, in this is indeed a sign for people who think." [Al-Qur'an 16:68-69]*

*Objective: To explore the various narrations of Prophet Muhammad (PBUH) in authentic scriptures about honey and to rule out its efficacy on the basis of scientific studies.*

*Methods: Thorough literature review including Ahadith and various scientific studies and several online databases including Web of Science, Science Direct, and PubMed were explored to suffice the objective.*

**Keywords:** anti-inflammatory, anti-oxidant, nutritional value, Prophetic narrations, traditional medicines.

**Author** <sup>a</sup> <sup>o</sup> <sup>p</sup> <sup>co</sup>: PG Scholar, Professor & Chairperson, Assistant Professors; Dept. of *Tahaffuzi wa Samaji Tib*, Faculty of Unani Medicine, Aligarh Muslim University, India.

## I. HISTORICAL BACKGROUND

The use of traditional medicine to treat infection has been practiced since the origin of mankind, and honey produced by honeybee (*Apis mellifera*) is one among the oldest traditional medicines considered to be important for the treatment of several human ailments. For an extended time in human history, honey was a crucial source of carbohydrates and therefore the only widely available sweetener <sup>[1]</sup>.

Yet the traditional physicians were conscious of differences within the therapeutic value of the honeys available to them: Aristotle (384-322 BC), discussing differences in honeys, mentioned pale honey being "good as a salve for sore eyes and wounds"; and Dioscorides (c.50 AD) stated that a straw honey from Attica was the simplest, being "good for all rotten and hollow ulcers". <sup>[2]</sup>

Over four thousand years ago, honey was used as a standard Ayurvedic medicine, where it had been thought to be effective at treating material imbalances within the body.

Honey has had an extended history in human consumption, and is employed in various foods and beverages as a sweetener and flavouring. It also features a role in religion and symbolism.

Medicinal importance of honey has been documented within the world's oldest medical literatures, and since the traditional times, it's been known to possess antimicrobial property also as wound-healing activity <sup>[10-16]</sup>.

In most ancient cultures honey has been used for both nutritional and medical purposes. The assumption that honey may be a nutrient, a drug

and an ointment has been carried into our days, and thus, an alternate medicine branch, called apitherapy, has been developed in recent years.

The first written regard to honey, a Sumerian tablet writing, dating back to 2100-2000 BC, mentions honey's use as a drug and an ointment. Aristotle (384-322 BC), when discussing different honeys, mentioned pale honey as being "good as a salve for sore eyes and wounds".

- ❖ Sumerian civilization (fragments of pottery, 2100-2000 BC)
- ❖ Ancient Egyptian civilization (The Edwin Smith Papyrus, 2600-2200 BC) gives the recipe for a honey ointment and instructions how to use it.
- ❖ Ayurveda and Chinese medicine
- ❖ Ancient Greek civilization (Dioscorides "*de materia medica*", for treating fistulising wounds; Hippocrates).
- ❖ Arabo-Persian Medicine: Ibn-e-Sina recommended honey mixed with onion juice, clover, or wheat grass for the eyes. Being anti-oxidant it also helps to stop the process of aging. Zakaria Razi in *Al-Havi Fit Tibb* (10th Volume) described various properties of honey
- ❖ Ancient Rome civilization (Pliny, for treating infected wounds)
- ❖ Mentions in the Bible and in the Quran

#### *Asl as Prophetic Medicine*

The Noble Quran is crammed with scientific statements and notions. What's most amazing is that each one of those scientific statements and notions had been proven to be in perfect agreement with science and our modern-day scientific discoveries. <sup>[11]</sup>

Honey has also been mentioned in Holy Quran, wherein it's stated, "There comes from their (honeybees) bellies a drink of the many colours during which there's healing for mankind...." (Surah Nahl-The Bee, verse 69).

Abu Sa'id al-Khudri, (May Allah be pleased with him), related: A man came to the Prophet, (peace be upon him), and said: "My brother has some abdominal trouble." The Prophet, (peace be upon him), said to him, "Let him drink honey." The man returned to the Prophet, (peace be upon him), and said: "O Messenger of Allah! I let him

drink honey, but it caused him more pain." The Prophet, (peace be upon him), said to him: "Go and let him drink honey!" The man went and let his brother drink honey then returned back and said: "O Messenger of Allah, it did not cause him except more pains." The Prophet, (peace be upon him), then said: "Allah has said the truth, but your brother's abdomen has told a lie. Let him drink honey." So he made him drink honey and he was cured. [Al-Bukhari and Muslim]

This was confirmed by scientists who assembled during the International Apiculture Conference held from 20-26 September 1993 in China. During the conference, treatments with honey derivatives were discussed. American scientists especially said that honey secretion, pollen and propolis (bee resin) cure many diseases. A Romanian doctor stated that he tried honey on cataract patients, and 2002 out of his 2094 patients recovered completely. Polish doctors also informed the conference that bee resin helps to cure many diseases like haemorrhoids, skin problems, gynaecological diseases and lots of other disorders.

#### *Other Prophetic narrations about asl*

- ✓ So he (Prophet) gave him honey to eat again then he was cured (when a particular man complained his brother's stomach upset. (Narrated Abu Sa'id Khudri; Bukhari, Muslim)
- ✓ The Prophet did indeed like to eat sweetmeats and honey. (Narrated Ayesha; Bukhari, Muslim)
- ✓ The Prophet said, "You have the simplest remedy in scarification and eating honey." (Narrated Jabir bin'Abdullah; Bukhari, Muslim)
- ✓ The Prophet said, "There are three remedies-use of honey, scarification and cauterization. I counsel my followers against cautery." (Narrated Ibn'Abbas; Bukhari, Muslim)
- ✓ I offered (to the Prophet) the drink made from honey extract of currants and milk. (Narrated Anas bin Malik; Muslim).
- ✓ The Prophet used to drink honey with water daily in the morning. (Dhabi)

### 1.1 Nutritional Benefits of Honey

For an extended time in human history, honey was a crucial source of carbohydrates and therefore the only widely available sweetener [1].

One of the foremost encouraging honey nutrition facts - this natural sweetener is rich in phenolic acids and flavonoids, which are a source of natural antioxidants and is freed from fat and cholesterol.

Honey as nutrition. [2]

Serving size: 1 tablespoon

Calories: 64

Total fat: 0g

Sodium: 0 mg

Total Carbohydrates: 17g

Sugars: 16g

Protein: 0g

## II. HONEY AS ENERGY SOURCE

- Honey may be a natural source of readily available carbohydrates providing 64 calories per tablespoon [3]
- Main sugars of honey are monosaccharides, fructose and glucose. During digestion the principal carbohydrates fructose and glucose are quickly transported into the blood and may be utilized for energy requirements of the physical body.
- Honey may be as effective as glucose for carbohydrate replacement during endurance exercise [3].
- Honey is the best source of carbohydrate i.e. a mixture of glucose and fructose, which give great energy to the physical body. It's a perfect energy food for endurance because it is stored within the liver. It's laxative effect on the gastrointestinal system. It's even been shown to be low in calories and useful as a, people with heart condition or those overweight. [14]
- Honey contains natural minerals and vitamins which help the metabolizing of undesirable cholesterol and carboxylic acid on the organs and tissues into the system, hence preventing obesity and promoting better health for us. [4]
- Honey contains about 0.1 to 0.6% proteins, mainly enzymes and amino acids. [5,6]

- Honey contains a variety of other trace elements [3].
- It also contains trace amounts of several minerals and vitamins. Niacin, calcium, copper, riboflavin, iron, magnesium, potassium and zinc in honey. [2]
- From the nutritional point of view the minerals chrome, manganese and selenium are of nutritional importance [7,8]
- Honey contains choline and acetylcholine. [9] Choline is an important for cardiovascular and brain function, and for cellular membrane composition and repair, while acetylcholine acts as a neurotransmitter. [10]
- It contains vitamins B1, B2, C, B6, B5 and B3 all of which change consistent with the qualities of the nectar and pollen. [11]
- Honey has been rightly termed by modern dieticians because it is the elixir of life. Some years back a jar of honey was found during a Tomb, built BC. Scientists were surprised to seek out that the honey was in perfect condition and would be utilized in diet. Honey provides quick energy and, therefore, in international athletic meets like Olympics, athletes are advised to require it regularly. Honey is definitely digestible and contains both vitamins and minerals for energy.

### ❖ Prophylactic and Therapeutic Benefits

In recent days, honey is becoming acceptable as a reputable and effective therapeutic agent. Its beneficial role has been endorsed to its antimicrobial, anti-inflammatory and antioxidant activities also as boosting of the system [1]

### ❖ For Gastro-intestinal System

Honey is reported to possess effects of preventing and treating gastrointestinal disorders like peptic ulcers, gastritis, and gastroenteritis. Honey may be a potent inhibitor of the causing agent of peptic ulcers and gastritis, *Helicobacter pylori*. [12]

Honey has prebiotic effects: increasing the population of bacterial microflora important for the health of the alimentary canal. [13]

Clinical trials are reported during which honey was found to be effective for the treatment of peptic ulcers and diarrhoea. [2]

#### ❖ For Cardiovascular System

Honey provides a crucial part of the energy needed by the body for blood formation. Additionally, it helps in cleansing the blood. It's some positive effects in regulating and facilitating blood circulation. It also functions as a protection against capillary problems and arteriosclerosis. [11]

It is believed that a moderate quantity of honey and pomegranate (*anar*) is sweet for people with heart trouble or heart weaknesses. [2]

#### ❖ For Wound Healing:

Honey facilitates the healing process and prevents scarring. Honey has an anti-inflammatory action, which reduces the swelling around a wound. This improves circulation and thus hastens the healing process. It also reduces pain. Honey doesn't stick with the underlying wound tissues, so there's no tearing away of newly formed tissue, and no pain, when dressings are changed. [11] Honey also can be used externally to market healing when applied to wounds, even postoperative wounds. Honey has also been effective in its use to treat burns. [14]

#### ❖ For Joint Pain

Studies conducted at some western universities have reinforced the centuries old knowledge that honey is effective against arthritis. Taking a tablespoon of honey and half teaspoon cinnamon powder has helped arthritic patients walk without pain. Honey with lukewarm water and a touch of cinnamon powder made into a paste and applied to the joints also helped in quick recovery (within minutes) from pain. [2]

#### ❖ Against Chronic Illnesses

Researchers believe food products rich in antioxidants may prevent heart problems and cancer. Strong antioxidants are present in honey which inhibit destructive chemical reactions that cause many chronic illnesses. [11]

It has been claimed that honey taken in regulated doses for the aim of energy, doesn't raise blood glucose level. Some dieticians even recommend honey to patients of diabetes. Honey is extremely useful for the skin when used as a facial pack. In

cases of persistent cough and pharyngitis, use of honey is very beneficial. Honey is diuretic, a laxative, and an honest cure for phlegm caused distempers. When given during childbirth honey helps in reducing birth pangs. Recent researches have shown that honey is very efficacious in tuberculosis, appetite loss and neurological disorders including insomnia. Honey strengthens the body during convalescence. The utilization of honey has been recommended in various eye ointments, meant for sore eyes, trachoma and cataracts. [15]

#### ❖ For Enhancing Immunity

Flavonoids and polyphenols present in honey act as antioxidants that protect the structural integrity of cells and tissues and have the power to neutralize free radicals, preventing damage to immune cells. Antioxidants help in neutralizing the free radicals within the body. Research by the Michigan State University says that honey "is a system builder [with] antioxidant, anti-bacterial and anti-tumour properties." [16]

Honey is additionally known to enrich T and B lymphocytes, antibodies, eosinophils, neutrophils, monocytes, and natural killer cells generation during primary and secondary immune responses in tissue culture. Consistent with research by the Department of Immunogenetics, BuAli Research Institute, Mashhad University of Medical Sciences, in Iran, "A sugar, nigeroligosaccharides, present in honey has been observed to possess immuno-potentiating effects. Non-sugar ingredients of honey also are liable for immunomodulation." [16]

### III. MAA-UL-ASL OR HYDROMEL OR HONEY WATER

*Maa-ul-Asl* is defined as honey mixed in water in the ratio of 1:4.

Oral administration of honey water (*maa ul asl*) is usually recommended in *zaatul janb* (pleurisy)

Dietary recommendation in *warm e kabid safravi* (bilious hepatitis) and Phlegmatic hepatitis (*Waram-e- kabid Balghami*) [17]

Almost every classicist from Hippocrates to later, also as contemporary scholars of Unani medicine advocated the use of Hydromel [honey water / mentioned as *Maa'ul Asl* in Unani] for the initial rehabilitative phase of stroke. There must be some great therapeutic potential in hydromel because it's suggested extensively and exclusively during a malady as challenging as stroke. Hydromel, when evaluated with contemporary therapeutic markers and modern scientific parameters, was found to boost immunity in conjunction with sort of other actions which can be helpful in achieving sensory also as motor functional enhancement and thereby alleviating acute attacks of stroke. [18]

Use of cold water and other drinks (*mashroob*) reduces body temperature, while use of easily digestible and *jayyadul kemoos* diet like *maul asl*, *ma'ul shaer*, *kashak-us-shaer*, *aash-e-jau* etc. are given in small amounts, just to provide strength to *tabi'at* and to avoid further increase in morbid matter. [19]

Honey (*Apis indica*) is one of the sole drugs which performs nephroprotective activity are claimed to possess actions of *Mudirr-e-Baul* (Diuretic), *Mufattit-e-Hasat* (Lithotriptic), *Kasir-e- Riyah* (Carminative); *Taqwiyat-e-Gurda* (Renal tonic) are described by Zakaria Razi in *Al-Havi Fit Tibb* 10th Volume [20]

*Maa-ul-asl (honey water)*: Honey is boiled with water or sometimes with herbal decoction. It's useful in fever, irritation, thirst, and dry cough. [21]

Pharmacological actions of *Asl* (Honey) [22]

- *Muhallil-e-Waram* (Anti-inflammatory)
- *Musakkin-e-Auja'a* (Pain killer)
- *Mughazzi* (Nutrient)
- *Jali* (Detergent)
- *Mufatteh Sudad* (Deobstruent)
- *Mufattit e Hisa't* (Lithotryptic)
- *Muqawwi e Meda* (Tonic for stomach)
- *Mushtahi* (Appetizer)
- *Muqawwi e Bah* (Aphrodisiac)
- *Dafe Taffun* (Antiseptic)
- *Hazim* (Digestive)
- *Munaffith e Balgham* (Expectorant)
- *Musaffi e Dam* (Blood purifier)
- *Mundamil-e-Qurooh* (Wounds Healer)

Therapeutic uses [22]

- *Istisqa* (Ascites),
- Oligouria
- *Laqwa* (Bell's palsy)
- *Falij* (Paraplegia)

*Sual e Balghami* (Productive cough)

- Cataract
- Epiphora
- Otitis media
- *Waja al Uzn* (Earache)
- *Qurooh* (Wounds)
- Chloasma
- Ringworm
- *Waram e Lauzatain* (Tonsillitis)
- Insect bite
- *Yaraqan* (Jaundice)
- *Azm e Tihal* (Enlargement of spleen)
- *Khushunat e Halaq* (Sore throat)
- *Amraz e Ria* (Chest diseases)
- *Hisat e Kuliya* (Renal calculi)
- *Deedan e Ama* (Intestinal worms)
- *Amraz e Qalb* (Heart diseases)
- *Juzam* (Leprosy).

## V. CONCLUSION

Uncontaminated honey is a healthy, readily digestible, natural and energy rich food. It contains carbohydrates, proteins, lipids, enzymes and vitamins. One tablespoon of honey provides 60 calories and contains 11g of carbohydrates. 1mg of calcium, 0.2mg of iron, 0.1mg of vitamin B and 1 mg of vitamin C. Along with its nutritional value, honey exhibits antibacterial and antifungal properties, anti-diarrhoea, wound-healing and anti-inflammatory properties and antitussive and expectorant properties.

Currently, many researchers have reported the antibacterial activity of honey and found that natural unheated honey has some broad-spectrum antibacterial activity when tested against pathogenic bacteria, oral bacteria also as food spoilage bacteria. For cure of poor digestion, mix honey with apple cider vinegar approx. 50/50 and dilute it to taste with water. This aids digestion. Also reported to be wonderful for the joints. It is an effective remedy for many eye diseases. If used as a cosmetic, honey is a superb aid to take care of the complexion and glow of skin and hair.

Nowadays, apiculture and bee products have opened a replacement branch for research in countries advanced in science.

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# Workplace Ethics, Productivity and Professionalism in Library Organizations in Nigeria

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## ABSTRACT

This study investigates workplace ethics, productivity and professionalism in the library organizations in Nigeria. The researchers employed the conventional content analysis approach (desk research method). They have adopted the analysis of existing documents that contain the information about the phenomenon under study. Information needed to actualize this paper was gathered from secondary sources such as textbooks, journal articles, conference papers, online sources. This involved reading meaning into materials consulted for purpose of achieving a reliable conclusion. The main objective of this study is to investigate the imperative of ethical behaviour to productivity and professionalism of workers in the library organizations in Nigeria. The study revealed that, library organizations experience increased productivity and huge success whenever management actively works to improve culture by improving attitudes, quality of work life, and job satisfaction of employees.

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## ABSTRACT

*This study investigates workplace ethics, productivity and professionalism in the library organizations in Nigeria. The researchers employed the conventional content analysis approach (desk research method). They have adopted the analysis of existing documents that contain the information about the phenomenon under study. Information needed to actualize this paper was gathered from secondary sources such as textbooks, journal articles, conference papers, online sources. This involved reading meaning into materials consulted for purpose of achieving a reliable conclusion. The main objective of this study is to investigate the imperative of ethical behaviour to productivity and professionalism of workers in the library organizations in Nigeria. The study revealed that, library organizations experience increased productivity and huge success whenever management actively works to improve culture by improving attitudes, quality of work life, and job satisfaction of employees.*

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## I. INTRODUCTION

Nigeria faces crises not only of development and governance but also crises of ethical issues capable of providing damaging principles for

politics and business. According to Muhammed and Umar in Sev (2015), this explains why predatory use of state power and fraudulent business practices have been such recurrent phenomena at almost all periods of Nigeria's history. Predatory habits of political and administrative office-holders manifest themselves in the exhibition of nonchalant attitude towards users/prospective users or customers. This manifests in the library organizations in Nigeria.

The perceived deterioration in workplace ethics is evidenced in the violation of integrity by many employees in our contemporary work organizations (Adelabu,2008). This behaviour manifest itself in a number of frauds ranging from cutting costs, fraudulent price hike to outright embezzlement of funds. Notable scholars are of the opinion that to remain or become industry champion, ethical behaviour must be institutionalized (Sey, 2015; Osibanjo 2014).

Ethical behaviour and the prevailing system of employment relations in any work organisations is very crucial for national development, the production of goods and services for creation of national wealth, the attainment of political stability and the inclusive benefits of sustainable human development. In other words, how well organisations adhere to ethical standards, obviously, determines the well-being of all the stakeholders, the organisation's performance and subsequent profitability, as well as the macroeconomic growth and development of the nation (Adeyeye & Aina. 2012).

In practical terms, nations exist to provide security, safety and most importantly development to people who have surrendered

their sovereignty in exchange for the aforementioned necessities of life, using organisations and all human resources available to them. Indeed, organisations advance the fortunes of nations through efficiency, productivity, output level and performance as engendered by the institutional labour or a group of people known as workers. These workers are human beings with aspirations, hopes and feelings. They render their human efforts (labour) in exchange for equitable wages and salaries, good physical working environment and longevity of employment relationship, anchored on ethical standards and human resource best practices (Adeyeye, 2010).

Productivity is a concept that depends on the context in which it is employed. It does not have a singular definite criterion measure or operational definition. In most organisations, ethics in the workplace is linked to productivity. This is confirmed by studies made by Qiu & Peschek, (2013) and Abiodun, Osibanjo, Adenji & Iyere, (2014). Most Codes of Ethics in the libraries, world over, try to cover some important and fundamental aspects of operational laws, rules, and principles of professionalism for their members.

The Ethics Resource Centre (2003) pointed out that in African countries like Ethiopia, Egypt, Kenya and Ghana, codes of ethics are developed for the purpose of meeting the needs for the effectual communication of organizational ethics benchmark. The objectives include ensuring that every employee receives a copy of, or has easy access to, the code; that every employee understands their personal responsibility to abide by the provisions and standards laid out in the code; that the organization's commitment to the code is unambiguous and clear to every employee; and that employee are exposed to abundant cases of the code's utility, and how collective questions about its intent and application have been determined. Attitude is very essential and even more credible than facts and figures. Attitude can make or mar an organization if not properly monitored and handled (Anchor, 2009; Swindoll, 2012). That is why Organizations experience increased productivity and huge success whenever

management actively work to improve culture by improving attitudes, quality of work life, and job satisfaction of employees (Anchor, 2009). The most focal employee attitude is job satisfaction. That is why most successful organizations consider job satisfaction to be vital for work performance. This is because they believe that employees who demonstrate increasing levels of ability are influenced by commensurate increase in job satisfaction. These employees are passionate about their work and are always ready to make sacrifices at all times. Sequel to this development, Meyer (2002) opines that employee who are highly satisfied with the organisation hardly portray any form of negative attitude. This depicts that negative employee attitude stems from dissatisfaction and other concomitant variables. Job satisfaction is highly important because it is significant to the physical and mental well-being of employees as well as the organisation.

It is also the employee attitude that is most often related to organisational outcomes. It is highly unfortunate that Nigerians, both young and old have a poor attitude to work. Surprisingly, the rate at which employees exhibit lackadaisical attitudes in the libraries is heart-rending and disheartening. This has made this a subject matter of intense interest by professional scholars and researchers from different walks of life. This is proven by employees' non-challant attitudes towards their jobs. These non-challant attitudes to work of our employees are independent of geopolitical zones, religion, race, colour, educational qualification, sex and age. Workers at all levels in the libraries lack values, sense of accountability and commitment which are the basis on which effective attitudes is anchored. In the light of this study, myriads of factors have been considered to affect employees' job attitude. These factors include quality of work life, job perception, ability, effort, competence, motivation, and employee attitude and job satisfaction. This study aim is to investigate the effect of workplace ethics on the employee productivity and professionalism in the library organizations in Nigeria.

## II. OBJECTIVES OF THE STUDY

The main objective of this study is to investigate the imperative of ethical behaviour to productivity and professionalism of workers in the library organizations in Nigeria. The study shall also reveal the relationship between workplace ethics and work productivity as well as how workplace ethics is related to professionalism.

## III. STATEMENT OF THE PROBLEM

In librarianship, code of ethics of professionalism serves as the foundation upon which librarians operate and make decisions. A professional code of ethics demands that, librarians and libraries have an understanding and knowledge of what is expected from them in terms of behaviour towards library users, the parent organisation, co-workers, and the host community while being mindful of the productivity. Adeyanju (2014) notes that, librarians are obliged to obey certain ethical principles of library profession and organisational ethics, which include honesty, integrity, social responsibility, accountability and fairness. Most library organizations fail to practice this; more so that librarianship has become more complex and the borderline between what is legitimate and illegitimate become fuzzier thus bleeding unethical behaviours. This has a way of affecting the productivity in the library organisations. This makes the need for workplace ethics, productivity and professionalism in the libraries in Nigeria an imperative one.

## IV. METHOD OF STUDY

The researchers employed the conventional content analysis approach (desk research method). They have adopted the analysis of existing documents that contain the information about the phenomenon under study. Information needed to actualize this paper was gathered from secondary sources such as textbooks, journal articles, conference papers, online sources. This involves reading meaning into materials consulted for Purpose of achieving a reliable conclusion.

The choice of this approach became necessary because of the need to adequately expose the need for the awareness and interrelatedness of the concepts of workplace ethics, productivity and

professionalism as applied in the library organizations in Nigeria.

## V. CONCEPTUAL CLARIFICATION WORKPLACE ETHICS

Ethics refer to a set of rules that describes acceptable conduct in society. Ethics serve as a guide to moral daily living and helps us judge whether our behaviour can be justified. Ethics refers to society's sense of the right way of living our daily lives (Anyam 2016). It does this by establishing rules, principles, and values on which we can base our conduct. The concepts most directly associated with ethics are truth, honesty, fairness, and equity. Workplace ethics therefore may be defined as a set of rules that describes acceptable conduct in the workplace. In the context of library establishments, ethics serve as a guide to moral daily living and helps us judge whether our behaviour can be justified.

Workplace ethics also known as ethics at work can be referred to the ways employees govern themselves and their work attitude, but it can also refer to the morality or lack thereof surrounding a workplace. Workplace ethics are not the same as work ethic. The work ethic you have is your personal standard for how you do your job. It is about how detail-oriented you are, what sort of quality you are intent on delivering for every project you do, whether you are punctual, how you treat your colleagues, if you take accountability for what you do and so much more. These are all things that can be taught, but they also come down to an employee's internal moral code.

Workplace ethics can go two ways. One is how the employee governs herself within the workplace, but the other is the ethics at play in the corporate culture and how the organization conducts itself both inside and also in the larger world. Each of these can affect morale, performance, loyalty, job turnover and even employee work ethic. They are ethical principles or standards that are used to define professional or workplace ethics. Typical values include honesty, integrity, compassion, courage, honor, responsibility, patriotism, respect and fairness (Adeyeye, 2010). Honesty can also be

linked with trust and confidence, strong belief in doing good always, reliability and belief in doing the right thing (ethics). Confidence is confiding in or telling one's secret or person who is trusted with private affairs of somebody, belief in oneself or what is said or done on behalf of others. Lawal (2018) averred that bank rely on public confidence which is the pivot and essence upon which financial intermediation revolves. This shows that, workplace ethics apply to banking business too and it has a way of ensuring efficiency, commitment, positive work attitude which translate into productivity.

## VI. PRODUCTIVITY IN THE LIBRARY

Employee productivity has been conceived differently by different people and different elements have been identified as being linked to employee productivity. According to Mathis and John (2016), productivity is a measure of the quantity and quality of work done, considering the cost of the resources used. The more productive an organization, the better its competitive advantage, because the costs to produce its goods and services are lower. Better productivity does not necessarily mean more is produced; perhaps fewer people (or less money or time) was used to produce the same amount. Anyam (2016) further states that, results are usually the final and specific outputs desired from the employee. Results are often expressed as products or services for an internal or external customer, but not always. They may be in terms of financial accomplishments, impact on a community; and some results are expressed in terms of cost, quality, quantity or time.

He further notes that measuring productivity involves determining the length of time that an average worker needs to generate a given level of production. You can also observe the amount of time that a group of employees spends on certain activities such as production, travel, or idle time spent waiting for materials or replacing broken equipment. The method can determine whether the employees are spending too much time away from production on other aspects of the job that can be controlled by the business. Employee productivity may be hard to measure, but it has a

direct bearing on a company's profits. An employer fills his staff with productivity in mind and can get a handle on a worker's capabilities during the initial job interview. However, there are several factors on the job that help maximize what an employee does on the job.

Employee productivity is the amount of goods and services that a worker produces in a given amount of time. Employee productivity can be measured for a firm, a process, an industry, or a country. It is often referred to as labor productivity because it was originally studied only with respect to the work of laborers as opposed to managers or professionals (Lester, 2010). According to Business Solution Consulting Group (2008), productivity pertains to how efficiently the resources of any organization are allocated and utilized. Basically, the relationship between the amount of goods or services produced and the resources utilized in production explains employee productivity. Thus, the central focus in the measurement of employee productivity is production efficiency or increase in quality by reduction in wastages. Kaplan and Norton (2017) suggest that there are three Es in productivity or performance management literature which are: Economy, Efficiency, and Effectiveness. Efficiency and effectiveness are critical benchmark for measuring organizations' performance. In addition, Anchor, (2009) noted that employee productivity is influenced by level of satisfaction which depends on a number of situational and environmental factors such as pay packages, working conditions, relationships and autonomy.

## VII. PROFESSIONALISM IN LIBRARIANSHIP

The term 'profession' was derived from a Latin word 'profiteor,' meaning to profess, which can also have the connotation of "making a formal commitment in the sense of taking a monastic oath". This root might suggest that a professional is someone who claims to possess knowledge of something and has a commitment to a particular code or set of values, both of which are fairly well-accepted characteristics of professions (Lester, 2010). According to Magali (2017), profession could be classified into four or more groups depending on the era when they began to

professionalize. Generally, these are: the ancient professions (the priesthood, university teaching, law and physicianship); the mediaeval trade occupations (including surgery, dentistry and architecture); the industrial-era professions (typified by engineering); and various groups that emerged or professionalized in the twentieth century (from teachers and social workers to accountants and personnel managers). From the classification above, librarianship can be grouped as part of ancient profession as we cannot isolate librarianship from the university teaching as it provides the needed organized knowledge for the teaching profession.

On the other hand, Yaya, & Adeeko 2015 citing Lester (2010) observed a professional as a person who embodies the idea inherent in 'profiteor'. A professional is a member of a profession. The term also describes the standards of education and training that prepare members of the profession with the particular knowledge and skills necessary to perform the role of that profession. In addition, most professionals are subject to strict codes of conduct enshrining rigorous ethical and moral obligations. Professional standards of practice and ethics for a particular field are typically agreed upon and maintained through widely recognized professional associations. Some definitions of "professional" limit this term to those professions that serve some important aspect of public interest (Yaya, & Adeeko 2015) and the general good of society. In some cultures, the term is used as shorthand to describe a particular social stratum of well educated workers who enjoy considerable work autonomy and who are commonly engaged in creative and intellectually challenging work.

Besides, professionalism can be regarded as the objectivity, rules and codes of practice of a profession. Professionalism consists of some professional standards (i.e. the skill, competence or character) expected of a member of a highly trained profession. Thus, librarianship as a profession has some set of rules and codes of ethics that regulate the activities and practice of its members in the society.

## VIII. LIBRARIANSHIP PROFESSIONAL ETHICS

The membership of librarianship profession is being guided by some numbers of professional ethics so as to add credibility to the profession and to prevent its members from engaging in any unholy activities in the society. In the United States, professional librarian ethics are codified in the ALA's Code of Ethics (Wikibooks, 2013); these are what we adapt for this paper. Therefore, the ALA's 2009 codes of ethics for librarianship include:

*Highest level of service to all users* – Librarians are to provide the highest level of service to all library users through appropriate and usefully organized resources (printed and electronic); equitable service policies; equitable access; and accurate, unbiased, and courteous responses to all requests (ALA, 2009). This implies that there should be no discrimination when providing library services to users. Every reader should be treated equally and justly.

*Intellectual freedom*– Librarians are to uphold the principles of intellectual freedom and resist all efforts to censor library resources (ALA, 2009). In support of this ethic, Yaya, Achonna and Osisanwo (2013) in their article "Censorship and the Challenges of Library Services in Nigeria" strongly opposed the censorship of any literary work; they advocated that intellectual resources should be made available to everyone and it should not be restricted in whatever form. Unfortunately, Intellectual freedom is a major area of conflict within libraries. Intellectual freedom is a goal that most library workers can agree on in theory, but situations in everyday library work can complicate this seemingly simple rule (Wikibooks, 2013).

*Privacy and confidentiality* – Librarians are to protect each library user's right to privacy and confidentiality with respect to information sought or received and resources consulted, borrowed, acquired or transmitted (ALA, 2009). As librarians, we should maintain privacy and confidentiality rights of our clientele; it implies that we should not divulge information that pertains to any of our user to the third party.

*Intellectual property rights*– Librarians are to recognize and respect intellectual property rights (ALA, 2009). However, Wikibooks (2013) painfully noted that Intellectual property rights are a difficult issue. They were of the view that while most of the rest of the ALA's Code of Ethics talks about how libraries should provide unrestricted access to information, copyright and other intellectual property rights can sometimes provide restrictions on this flow of information.

*Respecting fellow library workers* – Librarians are to treat co-workers and other colleagues with respect, fairness and good faith, and advocate conditions of employment that safeguard the rights and welfare of all employees of their institutions (ALA, 2009).

*Users Right and Dignity* - Librarians should have respect for the users right and dignity without prejudice to race, gender, religion, tribe, physical characteristics, age, place of origin, etc. Librarians should note that library users are human being like them that has blood, flesh, moods and feelings; so, their rights should be respected.

*Non-advancement of private interests* – Librarians should not advance private interest at the expense of library users, colleagues, or our employing institutions (ALA, 2009). This implies that the interest of library users should be paramount above every other personal interest. We should know that library is not a personal estate of anyone where it is being ruled by personal and selfish ideas; rather, library resources and personnel are being guided and controlled by the information policies that are set up by the library management. Therefore, advancement of personal or private interests should be jettisoned.

*Distinguishing between personal convictions and professional duties* – Librarians are to distinguish between their personal convictions and professional duties and should not allow their personal beliefs to interfere with fair representation of the aims of their institutions or the provision of access to their information resources (ALA, 2009).

### *The Nexus between Ethics and Productivity*

Productivity can be affected adversely when individuals are overwhelmed with laziness, negligence, irresponsibility, favouritism, self-interest and lack of self-determination. Apparently, if managers and employees are not self-disciplined, the organisation will become a lawless community which will eventually make increased Productivity far from sight.

A professional code of ethics sets a standard for which each member of the profession is expected to meet. It is a promise to act in a manner that protects the public's well-being. A professional code of ethics informs the public what to expect of one's doctor, lawyer, accountant, librarian or property manager. Each profession or trade has its own problem of ethics. The conduct of members must be judged by its consequences to the group itself and to the community. From the forgoing, it is clear that libraries must operate ethically; this is because duty demands that high ethical standards are required of them to earn the confidence of users/potential users and the parent organisation.

The work attitudes, integrity, self-discipline, teamwork, emphasis on quality, commitment and productivity of the Nigerian workers have painted a rather negative picture of an apathetic, uncommitted men and women, who are unresponsive to motivational techniques. The Nigerian workers have been described as indolent, apathetic and unresponsive to motivation and generally, not willing to put forth maximum productive efforts (Salau, Faiola, & Akinbode, 2014). Whichever way we look at it, the Nigerian workers are what we have, hence we must encourage them to make meaningful contribution to the development of the nation by becoming more productive.

### *The Nexus between Ethics and Professionalism*

Odozi (2007) defined ethics as the rules or principles of appropriate behaviour or conduct for morality and encompasses doing what is good and right, even when that will bring us some pain. Adelabu (2008) explained that ethics is the study of moral principles, beliefs, attitudes and how people should conduct or behave in social

interactions. Therefore, personal, business and professional ethics have consciously and/or unconsciously evolved over time in order to regulate, control and improve service delivery professionally. Professional ethics involve the standards of competence and practice or code of conduct expected of the professionals or trade group or association, both written and unwritten.

However, when ethics and professionalism are combined as professional ethics, it involves a nexus of written and unwritten norms and best practices such as honesty, integrity, competence, loyalty, transparency, accountability et cetera. (Odozi, 2007). Ethical and professional standard must be set by the individual employee, groups, organization and professional bodies so as to prevent human excesses in terms of greed, lust for power, fraud and other malpractices usually exhibited by workers in the organizations such as libraries.

## IX. CONCLUSION

There is a connection between workplace ethics, productivity and professionalism. A healthy or positive interrelationship of the three concepts by workers on an organization will have a positive impact on the organizations' aims and objectives. But as can be seen in the literature, when workers in the library organizations exhibits unethical attitudes at work, it will result to un professionalism and will affect productivity in those library organizations in a negative way.

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# Antagonistic Activity of Bacteria Isolated from Conifers of Tbilisi and its Surroundings against Phytopathogenic Fungi

*L. Amiranashvili, I. Danelia, T. Modebadze, N. Gagelidze, N. Zakariashvili, S. Kvitsiani, G. Andiashvili & G. Badridze*  
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## ABSTRACT

Urban tree mortality is a serious worldwide problem. The stressful ecological situation created by the globalization and climate change turned city trees even more vulnerable to impact of pests and pathogens. Many plant diseases can be managed using antagonistic microorganisms and biological control allows the host plant to survive. Isolation and studying of the antagonistic activity of endophytic bacteria against those pathogenic fungi, which are likely to cause massive diseases and dying of coniferous plantations in Tbilisi and its surroundings was the aim of the presented work. Some strains of the genus *Bacillus* with high antagonistic activity against several phytopathogenic mycelial fungi (*A. alternata*, *A. infectoria*, *E. nigrum*, *C. spicifera*, *C. inaequalis*, *D. gregaria*, *D. iberica*, *D. sapinea*) have been revealed using the bicultural techniques. Further study of these strains may be promising as biocontrol agents, both for disease prevention and control, especially in natural ecosystems, where the use of chemicals is strictly limited.

*Keywords:* phytopathogenic mycelial fungi, *Bacillus*, antifungal activity of bacteria.

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*Urban tree mortality is a serious worldwide problem. The stressful ecological situation created by the globalization and climate change turned city trees even more vulnerable to impact of pests and pathogens. Many plant diseases can be managed using antagonistic microorganisms and biological control allows the host plant to survive. Isolation and studying of the antagonistic activity of endophytic bacteria against those pathogenic fungi, which are likely to cause massive diseases and dying of coniferous plantations in Tbilisi and its surroundings was the aim of the presented work. Some strains of the genus Bacillus with high antagonistic activity against several phytopathogenic mycelial fungi (*A. alternata*, *A. infectoria*, *E. nigrum*, *C. spicifera*, *C. inaequalis*, *D. gregaria*, *D. iberica*, *D. sapinea*) have been revealed using the bicultural techniques. Further study of these strains may be promising as biocontrol agents, both for disease prevention and control, especially in natural ecosystems, where the use of chemicals is strictly limited.*

**Keywords:** phytopathogenic mycelial fungi, *Bacillus*, antifungal activity of bacteria.

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## I. INTRODUCTION

The death of urban trees and forests in general, is a serious environmental problem worldwide. Trees already been affected by pests and

pathogens became especially sensitive and vulnerable to stresses in the era of globalization and climate change (Jentsch et al. 2007, Tubby & Webber 2010, Smith 2011, IPCC 2012).

Recently, biological control (biocontrol) is in the center of scientists' and practitioners attention; it has become a constituent of an integrated approach to combating pests and diseases. The main purpose of biocontrol is to reduce the population of a pathogen or pests, which would allow the survival of the host plant and, consequently, the entire population (Bale et al. 2008). Such an approach is often advantageous because in many cases biocontrol agents are found in the plant itself. They are endophytic microorganisms inhabiting plant tissues and are integral components of its microbiome (Jia et al. 2016). They can be represented by viruses as well as bacteria and fungi (Lenteren et al. 2018). Endophytes play an important role in plant development and resistance to adverse environmental conditions (Reid & Greene 2012).

Many plant diseases can be managed using antagonistic microorganisms (Shafi et al. 2017, Cook et al. 2002). Some of them possess the ability to fight one particular phytopathogen (under certain conditions), while others can manage a wide range of plant pathogens. The mechanisms of growth inhibition of the phytopathogenic fungi may be different: production of biologically active substances (Yáñez-Mendizábal et al. 2011, Wang et al. 2015), increase of systemic resistance of plants (Lahlali et al. 2013), or competition with pathogens for nutrients and ecological niche (Kumar et al. 2011).

The majority of bacterial antagonists belong to the genus *Bacillus* (Soria et al. 2012, Wang et al. 2015, Zhang et al. 2015, Chen et al. 2016, Jha et al. 2016, Shafi et al. 2017). *B. subtilis* is one of the most popular biological agents for plant disease management (Wang et al. 2015, Tozlu et al. 2018, Yáñez-Mendizábal et al., 2011, Chen et al. 2013, Li et al. 2013). *B. subtilis* QST 713 is widely used in biocontrol programs worldwide (Abbasi & Weselowski 2014).

Isolation and studying of the antagonistic activity of endophytic bacteria against those pathogenic fungi, which are likely to cause massive diseases and dying of coniferous plantations in Tbilisi and its surroundings was the aim of the presented work.

## II. MATERIAL AND METHODS

### 2.1 Isolation and identification of antagonistic bacteria

For the isolation of bacteria, antagonistic to mycelial fungi, those isolates that exhibited fungicidal activity on the primary inoculations of plant leaves and needles were transferred to nutrient agar. Sampling of the material from sick and externally healthy trees of Tbilisi and its surroundings and preparation of inoculations for phytopathological study was described previously (Danelia et al. 2021). Bacterial isolates were incubated at 30 °C for 2 days. The Streak-plate and the Spread-plate techniques were used to obtain the pure cultures (Harley et al. 2005).

The primary identification of bacterial isolates was performed according to their morphological characters (colony morphology, cell shape, size, gram staining, ability to form spores).

Bacteria with high fungicidal activity were identified by sequencing of corresponding sites of 16S rDNA at the University of Guelph (Canada) (Danelia et al. 2021).

### 2.2 Fungicidal activity test

The fungicidal activity of bacterial isolates was studied on microscopic fungi, isolated from different plants growing in Tbilisi and its

surroundings, which were considered as dominants in terms of prevalence and frequency among tested plants (Danelia et al. 2021). Namely: *Alternaria alternata* (Fr.) Keissl., *Epicoccum nigrum* Link., *Curvularia spicifera* (Bainier) Boedijn, *Curvularia inaequalis* (Shear) Boedijn., *Dothiorella gregaria* Sacc., *Dothiorella iberica* A.J.L. Phillips, J. Luque & A. Alves., *Diplodia sapinea* (Desm.) Kickx. Another species of the genus *Alternaria* – *A. infectoria* E.G. Simmons, also known for its high pathogenic properties (Agrios 2005), was studied as well, which had frequency less than 5% and was characterized by sporadic distribution.

The dual culture technique with a fungal block in the center of Petri dish was used to test the fungicidal activity of bacterial isolates (Soria1 et al. 2012). 5 mm agar blocks of 5 day-old fungal test-cultures, grown on a beer wort agar nutrient medium at 25 °C were placed in the center of 90 mm diameter Petri dish with beer wort agar. 2.5 cm-s were measured from the center crosswise in four directions at each dish, and one loopful of 24-hour culture suspensions of four different bacteria were inoculated. Each fungal culture was inoculated in the same manner without bacterial cultures, as control. The Petri dishes were incubated at 25 °C for 5 days. Test was performed twice on each fungus and bacterium. After 5 days, the diameters of fungal cultures grown on both, control and test variants were measured. Inhibition of a fungus growth was calculated by the following formula:

$$x = \frac{a-b}{a} \times 100\%$$

$x$  is the percentage of a fungus growth inhibition;  $a$  - diameter of a fungus in control variant;  $b$  - diameter of a fungus inhibited by a bacterium. The mean values of two experimental results were used to analyze the fungicidal activity (Table 1).

## III. RESULTS AND DISCUSSION

Among the microbiota, isolated from plant samples, along with microscopic fungi, bacterial cultures with low frequency were found as well; most of them revealed clear antagonism to

phytopathogenic fungi. The primary inoculants of some of this specimen are shown in Figure 1.

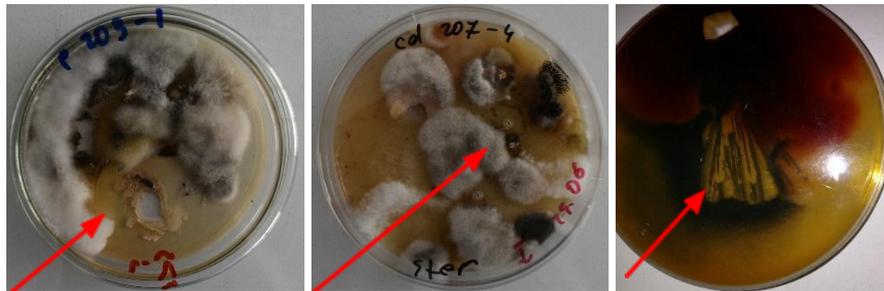


Fig. 1: Primary inoculants of needles in which the fungicidal activity of bacteria was detected (indicated by an arrow)

Totally 40 pure cultures of endophytic bacteria were isolated; 38 out of them were identified as *Bacillus* according to their morphological characteristics (colony morphology, cell shape, size, Gram staining, and spore producing ability) (full list of bacteria is shown in Table 1). Two other isolates (conditional names - PL 201 and

TS) had very weak antagonistic activity against studied fungi or did not reveal it at all (the data are not given).

The results of fungicidal activity of some bacterial isolates by dual culture technique are demonstrated in Table 1 and Fig. 2.

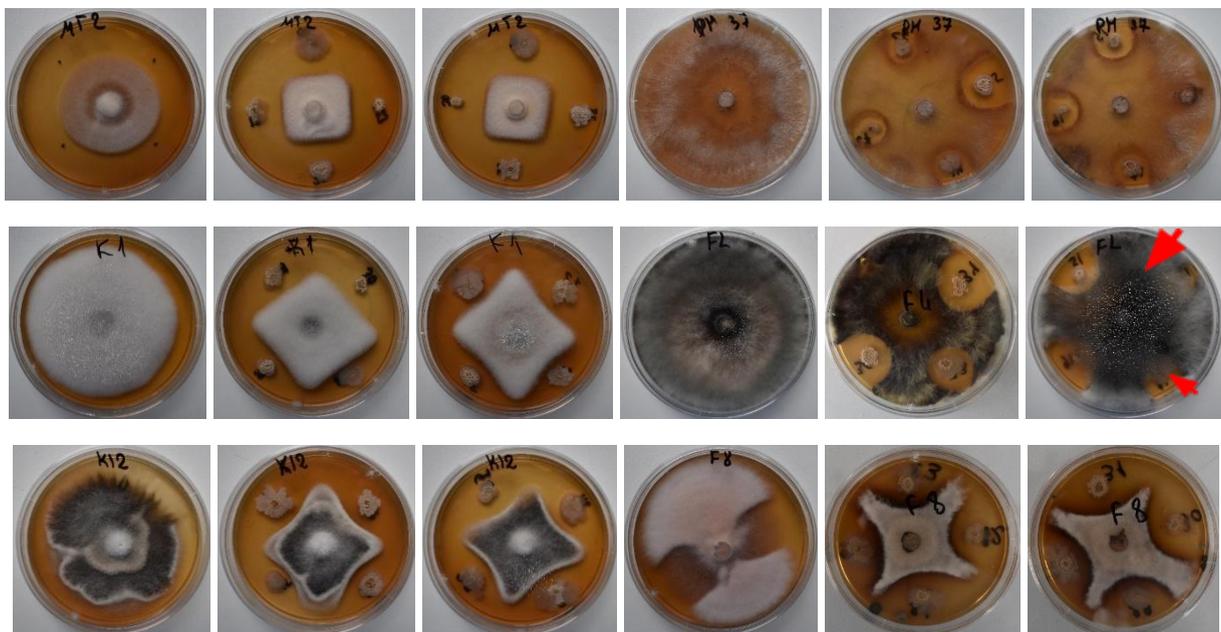


Fig. 2: Antagonistic relation of some bacterial isolates towards different micromycetes

From Table 1 it is clear that 38 isolates of bacteria inhibited the growth of all studied fungi at various degrees; this is acceptable to the antagonistic activity against different strains of the same fungal species as well.

The highest antagonistic susceptibility towards all three strains of *Epicoccum nigrum* (F5, P4-1-1, F8) was found for bacterial isolates with the conditional names T347 and CD461; although the growth of *E. nigrum* F5 was more inhibited by the bacterial strain T 347 (41.2%), *E. nigrum* P4-1-1

was sensitive to strain CD 293 (50%), which demonstrated high effectiveness against *E. nigrum* F8 as well (54.5%). Five other strains (CD 207, TI 286, CAN 334, CP 452, and CD 461) have revealed a similar rate of growth inhibition (54.5%).

Since the genus *Alternaria* is a powerful plant pathogen, which causes a great harm to agricultural products (Lagopodi & Thanasouloupoulos 1998, Agrios 2005), and was detected in 91.5% of the tested plants (Danelia et al. 2021), the antagonistic activity of bacteria against its four isolates - *A. alternata* K1, *A. alternata* K12, *A. alternata* P314-5-1, *A. infectoria* P362-1-1, was investigated as well.

Bacteria with the conditional names T347 and CD461 showed the highest activity in terms of growth inhibition of all four strains of *Alternaria*. T347 was especially effective against *A. alternata* K12 and *A. infectoria* P362-1-1 (53.1% and 62%, respectively); while CD461 revealed the better results against *A. alternata* K1 and *A. alternata* P314-5-1 (51.7% and 55%, respectively); similar inhibitory effect (62%) on *A. infectoria* P362-1-1 demonstrated the bacterial isolate AC 427, whereas B 462 – was effective against *A. alternata* P314-5-1 (55%).

**Table 1:** Inhibition of microscopic fungi growth by bacterial isolates (%)

Conditional name of a bacterial isolate	<i>Epicoccum nigrum</i>			<i>Curvularia</i>		<i>Diplodia</i>		<i>Dothyorella</i>		<i>Alternaria</i>			
	F5	F8	P4-1-1	<i>inaequialis</i> FE	<i>spicifera</i> 456-2-1	sp. FL	<i>sapinea</i> P361-1-1	<i>gregaria</i> MT2	<i>iberica</i> CP4 50-5-2-2	<i>alternata</i> K1	<i>alternata</i> K12	<i>infectoria</i> P362-1-1	<i>alternata</i> P314-5-1
P 203	33.0	41.5	21	40.7	32	36.0	<b>60</b>	27.8	19	44.1	42.0	53	48
AB 206	30.4	48.0	35	44.4	32	54.6	58	25.0	14	48.0	44.9	50	48
CD 207	35.8	<b>54.5</b>	39	40.7	41	<b>58.1</b>	58	38.9	5	50.3	48.4	47	51
CP 216	2.7	43.6	32	ND	41	0	53 <sup>1</sup>	27.7	ND	0	0	53	34
PH 269	29.0	49.1	39	44.4	64	45.3	56	33.3	23	48.0	46.1	50	45
PH 269	31.6	49.1	39	44.4	64	47.7	56	31.5	14	23.6	46.1	56	45
TJ 270	33.0	51.7	43	40.7	0	48.8	58	24.1	5	41.5	40.6	40	38
TI 286	30.2	<b>54.5</b>	39	40.7	64	45.3	51 <sup>1</sup>	35.2	14	47.3	40.6	35	48
CD 293	33.0	<b>54.5</b>	<b>50</b>	44.4	73	46.5	58	37.0	23	48.9	44.7	50	48
PC 296	31.8	46.7	43	44.4	73	47.7	58 <sup>1</sup>	31.5	23	40.3	41.8	53	45
CPT	33.0	44.1	39	<b>51.8</b>	68	50.0	53 <sup>1</sup>	37.9	5	45.5	23.4	56	41
CTA 315	34.4	50.6	25	44.4	77	46.5	56	37.5	5	48.9	41.2	53	48
CP 325	38.5	51.7	43	44.4	68	47.6	56	41.4	19	45.0	36.0	56	48
CAN 334	34.4	<b>54.5</b>	46	48.1	68	53.5	58	35.6	23	45.7	47.3	59	48
<b>T 347</b>	<b>41.2</b>	<b>53.2</b>	46	48.1	77	56.9	58	45.6	14	50.3	<b>53.1</b>	<b>62</b>	48
AC 427	26.2	44.1	29	44.4	<b>77.5</b>	43.0	53 <sup>1</sup>	36.2	14	44.3	45.8	<b>62</b>	45
JUN 442	31.6	49.3	39	33.3	64	44.2	53 <sup>1</sup>	32.5	14	29.9	38.3	53	48
CP450-5Y	2.7	46.1	ND	ND	ND	37.8	ND	13.0	ND	0	51.1	ND	ND
CP 450-5	31.6	46.6	39	44.4	68	57.3	53	38.1	ND	45.5	48.1	50	51
CP 452	31.6	<b>54.5</b>	43	48.1	73	<b>58.1</b>	56	39.3	ND	45.7	48.4	56	45
P 456	39.8	51.9	39	48.1	68	48.8	58	41.2	ND	45.5	44.7	56	45
CD 457	28.8	47.9	ND	44.4	ND	51.1	ND	39.6	ND	42.9	46.7	ND	ND
P 460	35.7	50.6	29	40.7	64	52.3	56 <sup>1</sup>	43.0	45	48.3	48.7	56	48
<b>CD 461</b>	39.9	<b>54.5</b>	<b>50</b>	48.1	73	53.5	58	<b>48.2</b>	42	<b>51.7</b>	48.7	56	<b>55</b>
B 462	28.8	50.4	39	48.1	73	50.0	<b>60</b>	42.4	<b>63</b>	44.3	44.7	53	<b>55</b>
CD 463	33.1	51.8	39	44.4	73	50.0	<b>60</b>	44.4	0	46.9	47.3	53	48
PC 464	39.8	53.2	29	48.1	73.5	47.6	<b>60</b>	38.5	50	46.6	47.0	43	48
P 475	34.4	46.6	ND	40.7	68	48.8	56	41.4	58	41.5	42.1	50	51
CD 477	34.4	50.6	43	40.7	64	51.1	58	41.2	42	45.0	43.5	50	48
P 503	39.8	50.4	43	40.7	68	47.7	58 <sup>1</sup>	41.4	50	41.7	47.5	53	45
CP 513	33.0	44.1	25	44.4	68	45.3	<b>60</b>	37.5	50	42.9	47.3	53	45
PC 515	37.2	45.4	32	40.7	68	48.8	<b>60</b>	39.3	42	42.9	46.3	53	51
PC 515-3	34.4	51.8	35	44.4	64	52.3	58	42.1	42	44.1	47.9	50	51
CP 521	26.2	50.6	35	44.4	73	44.1	60 <sup>1</sup>	39.8	54	40.3	46.1	53	48
CD 534	34.4	53.0	43	44.4	36	52.3	<b>62</b>	43.5	ND	46.6	48.4	50	ND
CD 539	28.9	45.5	39	33.3	36	41.8	56 <sup>1</sup>	33.3	50	40.3	40.0	59	ND
TB	26.1	53.1	35	33.3	70	45.3	56	39.9	42	44.1	47.0	47	45
P 526	<b>41.6</b>	47.0	29	40.7	43	48.8	60	37.0	50	38.8	48.5	47	45

Note: ND - No data available; <sup>1</sup> - Incomplete inhibition of air mycelium development; <sup>2</sup> - The air mycelium of the fungus "covered" the bacteria (see Fig. 2; (indicated by an arrow); The best results of fungicidal activity of bacterial isolates towards a particular fungi are given in red

The fungicidal activity of tested bacteria was studied against two species of the genus *Curvularia*: *C. inaequalis* FE and *C. spicifera* 456-2-1. The strain with conditional name CPT revealed the highest activity against *C. inaequalis* FE (51.8%), while strains CTA 315, T 347, and AC 427 were active against *C. spicifera* 456-2-1 (77% -77.5%). It should be noted that additionally four other bacterial isolates: CP 452, CD 461, B 462, and PC 464 demonstrated close to the best fungicidal activity against both strains of *Curvularia*: their inhibitory effect was 48.1% against *C. inaequalis* FE, and 73-73.5% - against *C. spicifera* 456-2-1.

The antagonistic activity of experimental bacteria was studied against *Diplodia* and *Dothyorella* strains as well (in particular: *Diplodia* sp. FL, *Diplodia sapinea* P361-1-1, *Dothyorella gregaria* MT2, *Dothyorella iberica* CP450-5-2-2). These genera, like the aforementioned *Epicocum*, *Alternaria*, and *Curvularia*, are dangerous plant pathogens (Phillips et al. 2005, Ivanová et al. 2016, Bußkamp et al. 2020) and were distinguished with high frequency of occurrence among the studied plants of Tbilisi and its surroundings (Danelia et al. 2021).

The highest fungicidal activity against *Diplodia* sp. FL was observed in bacterial strains - CD 207, CP 452 (58.1%), while against *Diplodia sapinea* P361-1-1 strain CD 534 was effective (62%);

bacterial strain CD 461 showed positive results towards *Dothyorella gregaria* MT2 (48.2%); against *Dothyorella iberica* CP450-5-2-2 the strain B 462 (63%) was effective.

Almost the maximal antagonistic activity against *Diplodia* and *Dothyorella* strains was revealed among several tested bacterial isolates: in case of *Diplodia* sp. FL and *Diplodia sapinea* P361-1-1 were active strains AB 206, CD 207, and T 347, against *Dothyorella gregaria* MT2 and *Dothyorella iberica* CP450-5-2-2 – strain P 475 (41.4% and 58%, respectively).

Summarizing the experimental results, it is clear that several bacterial strains revealed high antagonistic activity against different species of various genera of microscopic fungi. Especially two strains have demonstrated the maximal or near-maximal antagonistic activity against almost all studied fungal cultures: isolates CD 461 (out of 13 tested fungal strains was active against 11 ones, with maximal activity against 5 ones) and T 347 (was active against 11 fungal strains, with maximal fungicidal activity against 4 ones).

Nine bacterial strains with the best fungicidal activity were identified by sequencing of corresponding sites of 16S rDNA at the University of Guelph (Canada); their 95% similarity to some species of the genus *Bacillus* was revealed (Table 2).

**Table 2:** Results of the identification of bacterial cultures

Conditional name of isolate	Species	Coefficient of similarity detected by sequence	Similarity Coefficient was Identified with the following species
P 203	<i>Bacillus</i> sp.	>99.6%	<i>Bacillus subtilis</i> , <i>Bacillus mojavensis</i> , <i>Bacillus halotolerans</i> , <i>Bacillus tequilensis</i> , and <i>Bacillus vallismortis</i>
CD 207	<i>Bacillus</i> sp.	>99.5%	<i>Bacillus velezensis</i> , <i>Bacillus amyloliquefaciens</i> , <i>Bacillus subtilis</i> , <i>Bacillus vallismortis</i> , and <i>Bacillus siamensis</i>
TI 286	<i>Bacillus</i> sp.	>99.5%	<i>Bacillus velezensis</i> , <i>Bacillus amyloliquefaciens</i> , <i>Bacillus subtilis</i> , <i>Bacillus vallismortis</i> , and <i>Bacillus siamensis</i>
CTA 315	<i>Bacillus</i> sp.	>99.6%	<i>Bacillus subtilis</i> , <i>Bacillus mojavensis</i> , <i>Bacillus halotolerans</i> , <i>Bacillus tequilensis</i> , and <i>Bacillus vallismortis</i>
CAN 334	<i>Bacillus</i> sp.	>99.5%	<i>Bacillus velezensis</i> , <i>Bacillus amyloliquefaciens</i> , <i>Bacillus subtilis</i> , <i>Bacillus vallismortis</i> , and <i>Bacillus siamensis</i>
P 460	<i>Bacillus</i> sp.	>99.5%	<i>Bacillus velezensis</i> , <i>Bacillus amyloliquefaciens</i> , <i>Bacillus subtilis</i> , <i>Bacillus vallismortis</i> , and <i>Bacillus siamensis</i>
CD 452	<i>Bacillus</i> sp.	>99.6%	<i>Bacillus amyloliquefaciens</i> , <i>Bacillus vallismortis</i> , <i>Bacillus nematocida</i> , <i>Bacillus velezensis</i> , and <i>Bacillus subtilis</i>
T 347	<i>Bacillus</i> sp.	>99.7%	<i>Bacillus subtilis</i> , <i>Bacillus tequilensis</i> , <i>Bacillus mojavensis</i> , <i>Bacillus halotolerans</i> , and <i>Bacillus vallismortis</i>

#### IV. CONCLUSION

Some strains of the genus *Bacillus* characterized by the high antagonistic activity against different genera of phytopathogenic mycelial fungi have been revealed; so the selected bacterial cultures may be promising biocontrol agents towards tested pathogens.

Tree death mostly is caused by several pathogenic fungi simultaneously, therefore, further study of the fungicidal potential of revealed individual bacterial strains against various phytopathogenic fungi would be of great importance for their bioprotective use in natural ecosystems, where chemical control is strictly limited; It must be taken into consideration that all tested phytopathogenic fungi belong to the same class; moreover, pairs *Diplodia-Dotiorella* and *Curvularia-Alternaria* - to the same family (*Botryosphaeriaceae* and *Pleosporaceae*, respectively).

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# Prevention and Control of Covid-19 using Lime and Lemon Hand Sanitizer

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## ABSTRACT

This research is designed to develop Lemon and Lime hand sanitizer which will be used in the control and prevention of Covid-19. Lemon and lime hand sanitizer were prepared. A quarter baskets of lime and lemon were gotten each from Lokoja market; they were taken to the laboratory. The lime and lemon were adequately washed and blended into syrup which was used for the preparation of the individual concentration of the hand sanitizer. 100 ml of isopropyl alcohol was added to 100 ml of Lemon juice to create the lemon (LE 100) sanitizer. 100 ml of isopropyl alcohol was also added to 100 ml of Lime juice to create the lime (LI 100) sanitizer, and 100 ml of isopropyl alcohol was mixed with 50ml of lemon and 50 ml of lime juice to form the (LE/LI 50/50) hand sanitizer. The antibacterial sensitivity test was carried out using the disc method, which was soaked in the hand sanitizer. It was observed that the reaction of the sensitivity of the bacteria to the hand sanitizer varied. For LE 100, Micrococcus spp. was more sensitive than other Gram-positive bacteria with a 29 mm zone of inhibition. Streptococcus spp. was more sensitive to LI 100 with a 31 mm zone of inhibition and Bacillus spp., was more sensitive to LE/LI 50/50 with a 25 mm zone of inhibition. .

*Keywords:* lime, lemon, covid-19, hand sanitizer, anti bacterial sensitivity.

*Classification:* DDC Code: 813.54 LCC Code: KF27

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## ABSTRACT

*This research is designed to develop Lemon and Lime hand sanitizer which will be used in the control and prevention of Covid-19. Lemon and lime hand sanitizer were prepared. A quarter baskets of lime and lemon were gotten each from Lokoja market; they were taken to the laboratory. The lime and lemon were adequately washed and blended into syrup which was used for the preparation of the individual concentration of the hand sanitizer. 100 ml of isopropyl alcohol was added to 100 ml of Lemon juice to create the lemon (LE 100) sanitizer. 100 ml of isopropyl alcohol was also added to 100 ml of Lime juice to create the lime (LI 100) sanitizer, and 100 ml of isopropyl alcohol was mixed with 50ml of lemon and 50 ml of lime juice to form the (LE/LI 50/50) hand sanitizer. The antibacterial sensitivity test was carried out using the disc method, which was soaked in the hand sanitizer. It was observed that the reaction of the sensitivity of the bacteria to the hand sanitizer varied. For LE 100, *Micrococcus spp.* was more sensitive than other Gram-positive bacteria with a 29 mm zone of inhibition. *Streptococcus spp.* was more sensitive to LI 100 with a 31 mm zone of inhibition and *Bacillus spp.*, was more sensitive to LE/LI 50/50 with a 25 mm zone of inhibition. For Gram negative bacteria, response to LE 100, *Escherichia coli* was more sensitive than other Gram-negative bacteria with a 22 mm zone of inhibition. *Pseudomonas aeruginosa*. was more sensitive to LI 100 with a 18 mm zone of inhibition, and *Escherichia coli* were more sensitive to LE/LI 50/50 with a 20 mm zone of inhibition. Lemon and lime extracts have an essential role as antimicrobial agents against microorganisms. They are natural, cheap, safe, and due to increasing antibiotic resistance among bacteria. Lime and Lemon*

*hand sanitizer is locally made; the materials are available in our environment. It has shown the ability to inhibit the growth of most Gram-positive and Gram-negative bacteria, and thus can be used in the control, prevention and management of Covid-19 pandemic.*

**Keywords:** lime, lemon, covid-19, hand sanitizer, anti bacterial sensitivity.

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## I. INTRODUCTION

The emergence of novel viral pathogens has always posed severe challenges to public health around the globe. One of these dangerous pathogens, Severe acute respiratory syndrome corona virus 2 or SARS-CoV-2, more commonly known for causing corona virus disease 2019 which has been declared a global pandemic by the World Health Organization in early 2020. Since its discovery in December 2019 in Wuhan, there have been millions of confirmed cases worldwide (He *et al.*, 2020; Han *et al.*, 2020). With cases increasing exponentially around the world, it has caused a significant burden on all aspects of society despite aggressive isolation approach to prevent the spread of the virus. Currently, therapeutic strategies to deal with COVID-19 are only supportive, making prevention aimed at reducing transmission the best method at this time (WHO, 2020). A recent study reveals that transmission of SARS-CoV-2 is possible in the form of aerosol and fomite, and the virus can remain viable and infectious in aerosols for hours on surfaces up to days, depending on the inoculum shed (Li *et al.*, 2019). Hence, it is crucial to interrupt the transmission chain of the virus through contact isolation and strict infection

control tools (Deftereos *et al.*, 2020). Following the face-mask approach, appropriate hand hygiene is of utmost importance as hands may be contaminated from direct contact with patients' respiratory droplets from coughs and sneezes or indirect contact via surfaces, which may then facilitate the transmission and spreading of the disease (Praveen and Chow dray, 2020 and Cruz *et al.*, 2020).

One of the many ways implemented to prevent the spread of this virus, as with previous contagious pathogens, is frequent and effective hand washing. In both healthcare and community settings, alcohol-based hand sanitizers have become a popular alternative to traditional hand washing with soap and water. Alcohol-based hand sanitizers have been utilized as an effective alternative to hand washing to prevent bacterial and viral infections, making it one of the essential protocols in decreasing the healthcare burden (Pittet *et al.*, 2009). To get the maximum benefit from hand sanitizers, the Centers for Disease Control and Prevention (CDC) recommends that people use a product that contains at least 60% alcohol, cover all surfaces of their hands with the product, and rub them together until dry. A range of hand sanitizers is available with various combinations of ingredients and modes of delivery. Given the popularity of hand sanitizers during this pandemic, it is essential to understand which hand sanitizers work best against this novel virus. (Boyce and Pittet, 2002). The World Health Organisation (WHO) recommends alcohol-based hand sanitizer (ABHS) in line with the proven advantages of their rapid action. However, the effectiveness against non-enveloped viruses is still debatable and questionable (Sattar, 2004; Mole, 2020). The World Health Organisation recommends alcohol-based hand sanitizer products with 62%–95% of alcohol as it is capable of denaturing the proteins of microbes and inactivating viruses (Kampf and Kramer, 2004; Kampf, 2012; Kassen and Jaafar, 2020, and Dixit *et al.*, 2014). There are a few challenges and concerns about this formulation in terms of fire hazards and skin toxicity due to high alcohol content (Eva *et al.*, 2014).

Hand sanitizers are generally active ingredients of alcohol and phenol, so they have a working mechanism by denaturing and coagulating germ cell proteins (Andre *et al.*, 2016). Alcohol at certain levels causes protein coagulation and lyses the cell membrane. Alcohol can also change the permeability of germ cell membranes, causing leakage of essential cell constituents and causing germs to die (Odebisi *et al.*, 2015). Lime peels contains alcohol compounds that can fight the effects of premature skin aging, kill viruses, and contains carvacrol compounds, which have benefits as disinfectants, anti-fungi, and antiseptic. Lime and lemon are rich in vitamin C and also help the body to absorb iron from food which supports the immune system. Limes and lemon being a citrus fruit consist of a higher concentration of citric acid, which is a potent natural antimicrobial with an antiviral activity that inhibits the viral mechanism of replication, thereby preventing the spread and proliferation of viruses. The acidic nature or composition of the above citrus fruits plays a vital role in the control of the spread of the unknown virus, most especially when used in the formulation of hand sanitizers because of the ability to inhibit the virulence of corona virus (Narang, 2018).

Natural antimicrobials, including fruits and plant extract, or organic acids, are currently tested to inhibit viruses and prevent their pathogenic impact on the host (Zhai *et al.*, 2020). Studies revealed that lemon fruit extract contains a high levels of phytochemicals such as flavonoids, phenols, alkaloids, and quinines, which are termed an antiviral molecules against Herpes simplex virus type 1, Hepatitis A virus and many other viral microbes (Hayat and Munnawar, 2017; Udochukwu *et al.*, 2014). Improving the efficiency of antimicrobial compounds requires a proper understanding of their mode of action. For example, gamma-corona virus pre-treated with elderberry extract damaged the viral molecular structure, causing elimination of Vero cell cytotoxicity. The mechanism of elderberry extract efficacy was attributed to altered virion envelopes and membrane vesicles (Zhai *et al.*, 2020). Tangerine, a polymethoxylated flavones found in citrus fruits peels such as limes and lemons

inhibits viral entry into cells by blocking viral fusion. Citrus extracts are active against avian influenza virus, Newcastle virus, and many other viruses in different environments (Hayat and Munnawar, 2017). The use of Lime and lemon hand sanitizers is a priority in eradicating Covid-19 due to the natural content of lime and lemon extract (Acharya *et al.*, 2020).

Natural fruits such as limes and lemons possess some chemical properties which play a vital role in altering the virulence of the virus, most especially when used as ingredients for the formulation of hand sanitizers. Chemical raw materials for hand sanitizer are increasingly scarce in the market and can cause fire hazards and skin toxicity due to high alcohol content. Therefore, there is a need to use natural ingredients that are environmentally friendly, safe, and without allergies.

## II. MATERIALS AND METHODS

### 2.1 Sample collection and hand sanitizer preparation

The materials were all brought to the microbiology laboratory at Salem University,

Lokoja. The lime and lemon were adequately washed and blended into syrup. The paste was then sieved using a big plastic sieve to remove the chaff; the same procedure was repeated for the lime. Hundred (100 ml) of lemon and lime were measured out separately using a glass measuring cylinder, a corresponding volume (100 ml) of 95 percent isopropyl alcohol was added to lemon and lime respectively. The lemon and alcohol, lime and alcohol, lemon, lime, and alcohol were formulated in varying concentrations. The solution was further filtered using a membrane filter to remove residues and provide sterility. After this was done, a very small quantity of alcohol was added to check for evaporation. The mixtures were transferred into sterile well-labeled spray bottles.

*Table 1:* Hand Sanitizer formulation and concentration

Hand Sanitizer	Juice concentration (ml)	Isopropyl alcohol concentration (ml)
Lemon Hand Sanitizer (LE)	100	100
Lime Hand Sanitizer (LI)	100	100
Lemon/Lime Hand Sanitizer	100 (LE 50 +LI 50)	100

### 2.2 Collection of bacterial isolates

Five Gram-negative and Gram-positive bacterial isolates were obtained from the Specialist hospital Lokoja, Kogi State. The Gram-positive isolates are *Staphylococcus* spp., *Streptococcus* spp., *Micrococcus* spp., *Streptobacillus* spp., and *Bacillus* spp. The Gram-negative isolates are *Pseudomonas aeruginosa*, *Samonella typhimurium*, *Escherichia coli*, *Samonella typhi*, and *Klebsiella* spp.

### 2.3 Determination of the Inhibitory and Bactericidal Potential of the Hand Sanitizer

To determine the inhibitory and bactericidal potential of the hand sanitizer, the hand sanitizer sensitivity disc was designed using a filter paper which was perforated to a size of 0.7cm in diameter. The filter paper disc was soaked in each of the individual sanitizers for 30 minutes. The Mueller-Hinton Agar was prepared according to the manufacturer's instruction and poured into 25

plates. Each bacterial isolate was streaked on five plates respectively. The discs were placed on the streaked plates for a particular bacterial isolate. This was done for all the isolates and incubated at

37°C for 24 hours. The clearance zone was determined by measuring the diameter of the cleared area around the disc with a meter rule (Udochukwu *et al.*, 2015).

### III. RESULTS

*Table 2:* Antimicrobial activity of Lemon and lime hand Sanitizers against Gram-positive bacteria

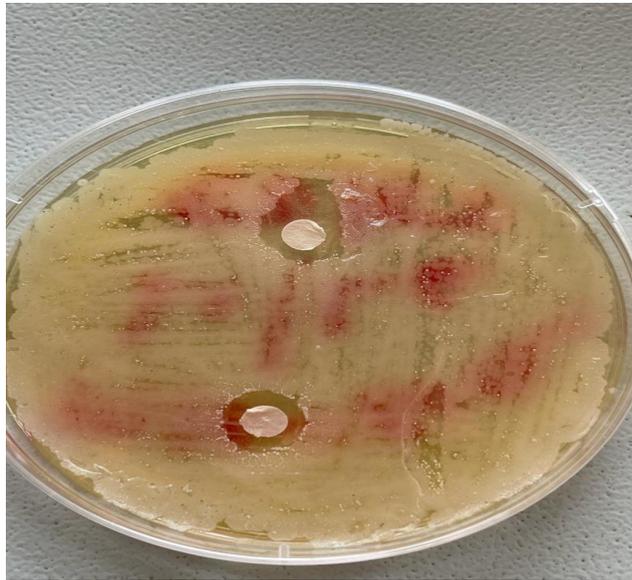
Isolates	LE 100	LI 100	LE 50/ LI 50
<i>Staphylococcus</i> spp.	S	S	M
<i>Streptococcus</i> spp.	R	S	MS
<i>Micrococcus</i> spp.	S	S	S
<i>Streptobacillus</i> spp.	R	MS	R
<i>Bacillus</i> spp.	S	S	S

*Key:* R=Resistance, S=Sensitive, MS=Moderately sensitive.

*Table 3:* Zone of inhibition of Lemon and Lime hand Sanitizers against Gram-positive bacteria

Isolates	LE 100 (mm)	LI 100 (mm)	LE 50/ LI 50 (mm)
<i>Staphylococcus</i> spp.	21.0	17.0	14.0
<i>Streptococcus</i> spp.	0.0	31.0	19.0
<i>Micrococcus</i> spp.	29.0	26.0	17.0
<i>Streptobacillus</i> spp.	0.0	17.0	0.0
<i>Bacillus</i> spp.	22.0	19.0	25.0

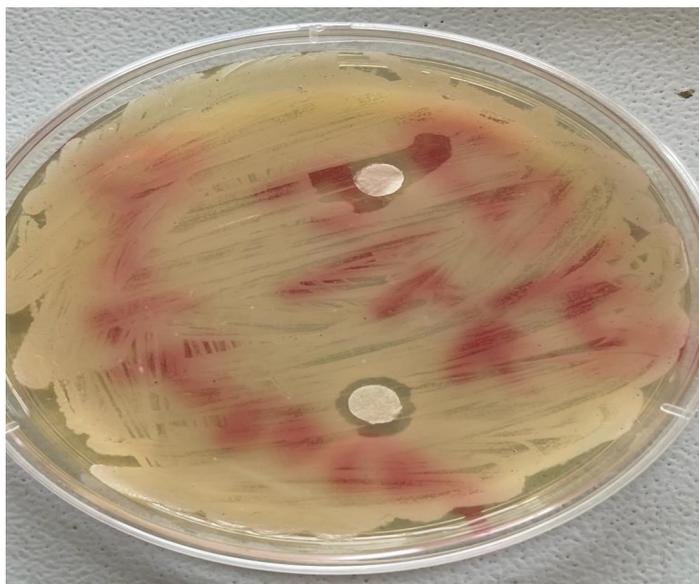
*Key:* MM = Millimeter (diameter of zone of inhibition).



*Plate 1:* Inhibitory effect of LE 50/LI50 hand Sanitizer on *Micrococcus* spp.



*Plate 2:* Inhibitory effect of LI100 hand sanitizer on *Streptobacillus* spp.



*Plate 3:* Inhibitory effect of LE 50/LI50 hand Sanitizer on *Streptococcus* spp.

**Table 4:** Antimicrobial activity of Lemon and lime hand sanitizers against Gram-negative bacteria.

Isolates	LE 100	LI 100	LE 50/ LI 50
<i>Pseudomonas aeruginosa</i>	R	S	R
<i>Samonella typhimurium</i>	S	R	S
<i>Escherichia coli</i>	S	MS	S
<i>Samonella typhi</i>	S	S	S
<i>Klebsiella spp.</i>	R	R	R

**Key:** R=Resistance, S=Sensitive, MS=Moderately sensitive.

**Table 5:** Zone of inhibition of Lemon and Lime hand sanitizers against Gram-negative bacteria.

Isolates	LE 100 (mm)	LI 100 (mm)	LE 50/ LI 50 (mm)
<i>Pseudomonas aeruginosa</i>	0.0	18.0S	0.0
<i>Samonella typhimurium</i>	21.0	0.0	16.0
<i>Escherichia coli</i>	22.0	12.0	20.0
<i>Samonella typhi</i>	21.0	16.0	19.0
<i>Klebsiella spp.</i>	0.0	0.0	0.0

**Key:** MM = Millimeter (diameter of zone of inhibition).



**Plate 4:** Inhibitory effect of LI100 hand sanitizer on *Pseudomonas aeruginosa*.



Plate 5: Inhibitory effect of LI100 hand sanitizer on *Samonella typhi*.

#### IV. DISCUSSION

The lemon, lime, and lemon/lime 100% alcohol-based hand sanitizers were determined for their antimicrobial activity against clinical bacterial isolates, which comprised five Gram-positive bacteria such as *Staphylococcus* spp., *Streptococcus* spp., *Micrococcus* spp., *Streptobacillus* spp. and *Bacillus* spp. and five Gram-negative bacteria such as *Pseudomonas aeruginosa*, *Samonella typhimurium*, *Escherichia coli*, *Samonella typhi*, and *Klebsiella* spp., using disc diffusion agar method (Udochukwu *et al.*, 2015). The evaluation of antimicrobial activity was conducted in triplicate. The degree of inhibition of the hand sanitizers against the bacterial isolates is shown in Table 2 and 4.

The results indicated that the lemon, lime and lemon/lime hand sanitizers, showed antibacterial activities towards the Gram-positive and negative bacteria, but with variability relating to the bacterial genus and species. The reason for the different sensitivity of the Gram-negative bacteria compared to that of Gram-positive bacteria (Table 2 and 4) could be due to differences in their cell wall composition. Gram-positive bacteria contain an outer peptidoglycan layer, an effective permeability barrier, whereas Gram-negative bacteria have an outer phospholipid membrane (Samarakoon *et al.*, 2012). Hayes and Markovic (2002) investigated the antimicrobial properties

of lime and lemon. They found that both citrus fruits possess significant antimicrobial activity against *S. aureus*, *Escherichia coli*, *Samonella typhi*, *Streptobacillus* spp., *Bacillus* spp., and *Streptococcus* spp.

Nevertheless, *Klebsiella* spp., and *Pseudomonas aeruginosa* showed complete and slight resistance respectively (Table 4). This could be due to the physiological, biological, and genetic makeup of the organisms or the acidic pH of this citrus that will affect the charges of the amino acids that constitute the peptidoglycan, and it may affect the active sites of enzymes leading to defects in their activity (Aronoff, 2020; Abu-shanabetai, 2004). Infections caused by *P. aeruginosa*, especially those with multidrug resistance, are among the most difficult to treat with conventional antibiotics (CDC, 1999; CDC, 2019; CDC, 2020).

In this study, the growth of *Streptococcus* spp. and *P. aeruginosa* was slightly inhibited by the hand sanitizers. Such results are exciting, and with expectation, increasing the concentration of the extracts may produce more inhibition of this bacterium (Table 3 and 5). They may inhibit bacteria by a different mechanism and may have therapeutic value as an antibacterial agent against multi-drug resistant bacterial strains (Kavathekar *et al.*, 2004; Ravikumar *et al.*, 2005). The potency of the above-mentioned hand sanitizers against other mentioned isolates in (tables 2 and 4) might be a result of the essential oil present in the Citrus

extracts, which are limonene and  $\gamma$ -terpinene that can disrupt the bacterial membrane and inhibit the respiration and ion transport processes. Therefore, when the permeability of the membrane increases, essential oils pass through the cell wall and the cytoplasmic membrane may also thicken in the cytoplasm and damage the lipids and proteins layers. Flavonoid has an antibacterial, antimicrobial, antioxidant, and anti-inflammatory activities, with proven ability to inhibit specific enzymes, to stimulate some hormones and neurotransmitters, and scavenge free radicals. The bacterial isolates used in this study are mesophilic bacteria with an optimum temperature of 20°C to 45°C. On the other hand, Covid-19 being an envelope virus which does not thrive in a temperatures range of 20°C to 45°C. If these lemon and lime hand sanitizer is effective against these mesophilic bacteria, it can be a helpful tool in the control and prevention of Covid-19.

## V. CONCLUSION

Lemon and lime extracts have an essential role as antimicrobial agents against microorganisms. They are natural, cheap, safe, and due to increasing antibiotic resistance among bacteria. Lime and Lemon hand sanitizer are locally made, and the materials are available to our environment. It has shown the ability to inhibit the growth of most Gram-positive and Gram-negative bacteria, and thus can be used in the control, prevention and management of Covid-19. The use of locally made hand sanitizers should be encouraged because the ingredients needed for the formulation are safe, cheap, easily accessible, affordable, and without causing any adverse effect on the user.

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