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Review on antimicrobial treatments for textile

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ABSTRACT

Antimicrobials are used on textile substrate to control bacteria, fungi, mold, mildew and algae and the problem of deterioration, staining odors and health concerns that they cause. The term antimicrobial refers to broad range of technologies that can provide varying degree of protection for textile products against microorganisms. In this review paper covers the optimum discussion about the antimicrobial finish on textile substrate.

WHAT ARE MICROBES OR MICROORGANISMS?

Microbes are the tiniest creatures not seen by the naked eye. They include a variety of microorganisms like Bacteria, Fungi, Algae and viruses. Bacteria are uni-cellular organisms, which grow very rapidly under warmth and moisture. Further, sub divisions in the bacteria family are Gram positive(Staphylococcus aureus), Gram negative (E-Coli), spore bearing or non-spore bearing type. Some specific types of bacteria are pathogenic and cause cross infection. Fungi, molds or mildew are complex organisms with slow growth rate. They stain the fabric and deteriorate the performance properties of the fabrics. Fungi are active at a pH level of 6.5. Algae are typical microorganisms, which are either fungal or bacterial. Algae require continuous sources of water and sunlight to grow and develop darker stains on the fabrics. Algae are active in the PH range of 7.0-8.0. Dust mites are eight legged creatures and occupy the household textiles such as blankets bed linen, pillows, mattresses and carpets. The dust mites feed on human skin cells and liberated waste products can cause allergic reactions and respiratory
disorders.[1-4]

Sources of microbes

- In the air we breath
- In the soil
- In our skin and bodies
- Everywhere [3]

Ideal Conditions for microbial Growth

- Food
- Warm temperature
- Moisture (Humidity, Spills)
- Receptive surface (skin, fabric)

What are antimicrobials?

Antimicrobials control, destroy or suppress the growth of microorganisms and their negative effects of odors, staining and deterioration.[2]

Antimicrobial finishes

Antimicrobials do not all work the same. The vast majority of antimicrobials work by leaching or moving from the surface on which they are applied. This is the mechanism used by leaching antimicrobials to poison a microorganism. Such chemicals have been used for decades in agricultural applications with mixed results. Besides affecting durability and useful life, leaching technologies have the potential to cause a variety of other problems when used in garments. These include their negative effects because, they can contact the skin and potentially effect the normal skin bacteria, cross the skin barrier, and/or have the potential to cause rashes and other skin irritations.[5]

A more serious problem with leaching technologies has to do with their allowing for the adaptation of microorganisms. An antimicrobial with a completely different mode of action than the leaching technologies is a molecularly bonded unconventional technology. The bound unconventional antimicrobial technology, an organo functional silane, has a mode of action that relies on the technology remaining affixed to the substrate – killing microorganisms as they contact the surface to which it is applied. Effective levels of this technology do not leach or diminish over time. When applied, the technology actually polymerizes with the substrate making the surface antimicrobial.

This type of antimicrobial technology is used in textiles that are likely to have human contact or where durability is of value.[5-6]

Necessity of Antimicrobial Finishes

Antimicrobial treatment for textile materials is necessary to fulfill the following objectives:
• To control microorganisms
• To reduce odour from perspiration, stains and other soil on textile material
• To reduce the risk of cross infection being carried by feet from ward to ward in hospital
• To control spread of disease and danger of infection following injury
• To control the deterioration of textiles particularly fabrics made from natural fibre caused by mildew [3]

Requirements for Antimicrobial Finish

Textile materials in particular, the garments are more susceptible to wear and tear. It is important to take into account the impact of stress strain, thermal and mechanical effects on the finished substrates. The following requirements need to be satisfied to obtain maximum benefits out of the finish:

• Durability to washing, dry cleaning and hot pressing
• Selective activity to undesirable microorganisms
• Should not produce harmful effects to the manufacturer, user and the environment
• Should comply with the statutory requirements of regulating agencies
• Compatibility with the chemical processes
• Easy method of application
• No deterioration of fabric quality
• Resistant to body fluids.[7,8]

Antimicrobial Finishing Methodologies

The antimicrobial agents can be applied to the textile substrates by exhaust, pad-dry-cure, coating, spray and foam techniques. The substances can also be applied by directly adding into the fibre spinning dope. It is claimed that the commercial agents can be applied online during the dyeing and finishing operations. Various methods for improving the durability of the finish include:

• Insolubilisation of the active substances in/on the fibre

• Treating the fibre with resin, condensates or cross linking agents

• Micro encapsulation of the antimicrobial agents with the fibre matrix

• Coating the fibre surface

• Chemical modification of the fibre by covalent bond formation

• Use of graft polymers, homo polymers and/or co polymerization on to the fibre.[7]

MECHANISM OF ANTIMICROBIAL ACTIVITY

Negative effect on the vitality of the microorganisms is generally referred to as antimicrobial. The degree of activity is differentiated by the term ëcidalí that indicates significant destruction of microbes and the term ecstatic represents inhibition of microbial growth without much destruction.

The activity, which affects the bacteria, is known as antibacterial and that of fungi is antimycotic. The antimicrobial substances function in different ways. In the conventional leaching type of finish, the species diffuse and poison the microbes to kill. This type of finish shows poor durability and may cause health problems. The non-leaching type or bio-static finish shows good durability and may not provoke any health problems. A large number of textiles with antimicrobial finish function by diffusion type. The rate of diffusion has a direct effect on the effectiveness of the finish. For example, in the ion exchange process, the release of the active substances is at a slower rate compared to direct diffusion ad hence, has a weaker effect. Similarly, in the case of antimicrobial modifications where the active substances are not released from the fibre surface and so less effective. They are active only when they come in contact with microorganisms.

Considering the medical, toxicological and ecological principles has developed these so called new technologies. The antimicrobial textiles can be classified into two categories, namely, passive and active based on their activity against microorganisms. Passive materials do not contain any active substances but their surface structure (Lotus effect) produces negative effect on the living conditions of microorganisms (Anti-adhesive effect). Materials containing active antimicrobial substances act upon either in or on the cell.[9]

Antimicrobial Function & Adaptation

Antimicrobials primarily function in two different ways. The conventional leaching types of antimicrobials leave the textile and chemically enter or react with the microorganism acting as a poison. The unconventional bound antimicrobial stays affixed to the textile and, on a molecular scale, physically stabs (the membrane) and electrocutes (the biochemical in the membrane) the microorganism on contact to kill it. Like an arrow shot from a bow or bullet shot from a gun, leaching antimicrobials are often effective, but they are used up in the process of working or wasted in random misses. Some companies incorporate leaching technologies into fibers and slow the release rate to extend the useful life of the antimicrobial or even add them to chemical binders and claim they are now "bound". Whether leaching antimicrobials are extruded into the fiber, placed in a binder or simply added as a finish to fabrics or finished goods, they all function the same. In all cases leaching antimicrobial technologies provide a killing field or "zone of inhibition". This zone exists in real-world uses if it is assumed that the right conditions exist for leaching of a lethal dose at the time that it is needed.[10]
The zone of inhibition is the area around the treated substrate into which the antimicrobial chemistry leaches or moves to, killing or inhibiting microorganisms. This killing or inhibiting action of a leaching antimicrobial is witnessed when an AATCC 147 test or other zone on inhibition test is run. These tests measure the zone of inhibition created by a leaching antimicrobial and clearly defines the area where the antimicrobial has come off the substrate and killed the microorganisms in the agar. Such a phenomenon can be seen in Figure1. This Figure shows the difference between the leaching and the non-leaching antimicrobial treatments on textiles both as first treated and then after five household launderings.[11]

TESTING

a) Zone of Inhibition Testing

Microbes are living organisms and like any living organism will take extreme measures to survive. Microorganisms can be genetically mutated or enzymatically induced into tougher "super-strains" if they are exposed to sub lethal doses (exposed to - but not killed) of antimicrobial agents. This ability of microorganisms to adapt to potential toxicants has been recognized in the medical community for years. Sub lethal levels of antibiotics are generated in the patients who discontinue taking antibiotics once their symptoms subside instead of continuing through to the end of the period prescribed by the physician. The exposure of the microbe to a sub lethal dose of an antimicrobial can cause mutation of their genetic materials allowing for resistance that is then replicated through the reproductive process creating generations of microorganisms that are no longer affected by the chemistry.

This phenomenon is of serious concern to the medical community and food processing industries and should be a serious consideration for the textile industry as it chooses the antimicrobials to which it will be exposing the public and their

workers. As with any chemistry that migrates from the surface - a leaching antimicrobial is strongest in the reservoir, or at the source, and weakest the farther it travels from the reservoir.
The outermost edge of the zone of inhibition is where the sub lethal dose can be found. This is where resistant microbes are found that have been produced by leaching antimicrobials. This is demonstrated in the following images where a microbe was taken from the outer edge of the zone of inhibition of a common leaching .Antimicrobial from treated carpet fiber (Figure 2) and used to inoculate a new test plate. This second test plate (Figure 3) shows the adapted microorganisms growing within the zone of inhibition. The adapted organism is taken from the second plate and used to inoculate a third plate (Figure 4). The microorganism used to inoculate this plate is fully adapted to the leaching antimicrobial and has overgrown the fabric. The ghost zone indicates the organism being slowed but not controlled by the leaching toxicant. All this occurred within just two generations of the test organism under these test conditions.

A significantly different and much more unique antimicrobial technology used in the textile industry does not leach but instead remains permanently affixed to the surface it is applied to. Applied in a single stage of the wet finish process, the attachment of this technology to surfaces involves two means. First and most important is a very rapid process, which coats the substrate (fabric, fiber, etc.) with the cationic species (physisorption) one molecule deep.

This is an ion exchange process by which the cation of the silane quaternary ammonium compound replaces protons from water or chemicals on the surface. The second mechanism is unique to materials such as silane quaternary ammonium compounds. In this case, the silanol allows for covalent bonding to receptive surfaces to occur (chemisorption). This bonding to the substrate is then made even more durable by the silanol functionality, which enables them to homopolymerize. After they have coated the surface in this manner, they become virtually irremovable, even on surfaces with which they cannot react covalently. .[2]

Once polymerized, the treatment does not migrate or create a zone of inhibition so it does not set up conditions that allow for adapted organisms. Because the technology stays on the substrate it does not cross the skin barrier and does not effect normal skin bacteria, cause rashes or skin irritations. This organo functional silane technology has been used for over two decades to treat surfaces from leather and foams to virtually all types of fabrics and is not consumed by the microorganism. It does not poison the microorganism. When a microbe contacts the organ functional silane treated surface of the fabric, the cell is physically ruptured by a sword like action and then electrocuted by a positively charged nitrogen molecule (Figure 6). This antimicrobial technology has been verified by its use in consumer and medical goods including socks, surgical drapes and carpets in the USA, Asia, and other areas in the world. This technology has been used for nearly twenty-five years without any human health or environmental problems in manufacturing facilities or in actual end use situations.[3]

Antimicrobial Treatment Verification

Another important property of a useful antimicrobial is that its presence should be verifiable. In effect, it is the only way to know that an antimicrobial is really on the product. There is no easy way to tell whether leaching antimicrobials are present on a product. The only known verification technique for a leaching chemistry is to use exacting laboratory tests, which take days or weeks to perform. With the bound antimicrobial technology though, a simple staining test can be performed in a matter of minutes at the mill or in a store to verify proper treatment of a fabric or other surface. This is a very important part of a quality assurance program that gives the manufacturer, the retailer, and the consumer confidence that a feature, normally invisible to the senses, can be seen and is actually on the product providing the protection for which they have paid.[4]

Antimicrobial substances and their effect

Many antimicrobial agents used in the textile industry are known from the food stuff and cosmetics sector. These substances are incorporated with textile substrates comparatively at lower concentrations. It must be ensured that these substances are not only permanently effective but also that they are compatible with skin and the environment. A wide palette of antimicrobial compounds is now in use but differ in their mode of action. The following list demonstrates the polyvalent effect of the various antimicrobial substances:

Materials with active finishes contain specific active antimicrobial substances, which act upon microorganisms either on the cell, during the metabolism or within the core substance (genome). However, due to the very specific nature of their effect, it is important to make a clear distinction between antibiotics and other active substances, which have abroad range of uses.
Oxidizing agents such as aldehydes, halogens and proxy compounds attack the cell membrane, get into the cytoplasm and affect the enzymes of the microorganisms. Coagulants, primarily alcohols irreversibly denature the protein structures. Radical formers like halogens, isothiazones and peroxo compounds are highly reactive due to the presence of free electrons.

These compounds virtually react with all organic structures in particular oxidizing thiols in amino acids. Even at the lowest level of concentrations, these substances pose particular risk to nucleic acids by triggering mutations and demonization.
One of the most durable type of antimicrobial products is based on a diphenyl ether (bis-phenyl) derivative known as either 2, 4, 4'-trichloro-2' hydroxy dipenyl ether or 5-chloro-2-(2, 4-dichloro phenoxyl) phenol. Triclosan products have been used for more than 25 years in hospitals and personal care products such as antimicrobial soap, toothpaste and deodorants. Triclosan inhibits growth of microorganisms by using an electro chemical mode of action to penetrate and disrupt their cell walls. When the cell walls are penetrated, leakage of metabolites occurs and other cell functions are disabled, thereby preventing the organism from functioning or reproducing. The Triclosan when incorporated within a polymer migrates to the surface, where it is bound. Because, it is not water-soluble, it does not leach out, and it continuously inhibits the growth of bacteria in contact with the surface using barrier or blocking action.

Quaternary ammonium compounds, biguanides, amines and glucoprotamine show poly cationic, porous and absorbent properties. Fibres finished with these substances bind microorganisms to their cell membrane and disrupt the lipo poly saccharide structure resulting in the breakdown of the cell. Complexing metallic compounds based on metals like cadmium, silver, copper and mercury cause inhibition of the active enzyme centers (inhibition of metabolism). Amongst these, the silver compounds are very popular and already been used in the preparation of antimicrobial drinking water. Chitosan is an effective natural antimicrobial agent derived from Chitin, a major component in crustacean shells. Coatings of Chitosan on conventional fibres appear to be the more realistic prospect since; they do not provoke an immunological response. Fibres made from Chitosan are also available in the market place.

Natural herbal products can be used for antimicrobial finishes since, there is a tremendous source of medicinal plants with antimicrobial composition to be the effective candidates in bringing out herbal textiles.[5]

Benefits of Antimicrobial Textiles

A wide range textile product is now available for the benefit of the consumer. Initially, the primary objective of the finish was to protect textiles from being affected by microbes particularly fungi. Uniforms, tents, defense textiles and technical textiles, such as, geotextiles have therefore all been finished using antimicrobial agents. Later, the home textiles, such as, curtains coverings, and bath mats came with antimicrobial finish. The application of the finish is now extended to textiles used for outdoor, healthcare sector, sports and leisure. Novel technologies in antimicrobial finishing are successfully employed in non-woven sector especially in medical textiles. Textile fibres with built-in antimicrobial properties will also serve the purpose alone or in blends with other fibres. Bioactive fibre is a modified form of the finish, which includes chemotherapeutics in their structure, i.e., synthetic drugs of bactericidal and fungicidal qualities.

These fibres are not only used in medicine and health prophylaxis applications but also for manufacturing textile products of daily use and technical textiles. The field of application of the bioactive fibres includes sanitary materials, dressing materials, surgical threads, materials for filtration of gases and liquids, air conditioning and ventilation, constructional materials, special materials for food industry, pharmaceutical industry, footwear industry, clothing industry, automotive industry etc.[6]

Development

To benefit from the consumer demand for antimicrobial/antibacterial products and for the antibacterial and antifungal performance needs of the textile world, manufacturers have a choice. In choosing, they should utilize a treatment that provides for an odor reduction/antibacterial claim and an antimicrobial finish for their textile products consistent with their claims and the needs of their target consumers. This selection should be done by considering:

- Adopting an antimicrobial technology with a proven history of use. This will help shorten the timelines in bringing products with an antibacterial/antifungal/odor-reducing, antimicrobial feature to market.
- Adopting a non-leaching antimicrobial that doesn't pose the risk of crossing the skin barrier. If it creates a "zone of inhibition" it leaches or moves and has the potential to cause problems.
- Adopting a non-leaching antimicrobial that doesn’t pose the risk of creating adaptative resistant microorganisms.
- Adopting an antimicrobial technology that can have its proper application tested for at the mill or at the retailers. A verifiable quality assurance program should be a key component of any application process.
- Adopting an antimicrobial technology that has technical and marketing support.

Numerous retail buyers have stated that the antimicrobial/antibacterial "feature" is quickly moving to a standard requirement for the products that they buy. Manufacturers that don't currently treat fabrics with a durable antimicrobial finish should consider shielding their products from eroding value by incorporating microbial control. As manufacturers look to enhance the value of their products they should recognize antimicrobial finishes as a feature with a future and the future is now.[7]

Antimicrobial & Antioxidant Activity of Orange Pulp and Peel

The oranges were purchased from the local market of Bela. The orange peel and pulp were subjected to successive extraction with solvents in increasing order of their polarity viz. Acetone, hexane, methanol and distilled water. Orange peel and pulp powder was extracted separately by aqueous extraction. The phenolic content of these samples were studied according to the method described by Folin Ciocalteu. In vitro antioxidant activity of orange peel and pulp were assessed using three different methods (Reducing power, Gallic acid method and DPPH scavenging activity). The in-vitro antioxidant activities on these two samples were evaluated. The antioxidant activity by Gallic acid in the orange peel higher in the distilled water (210mg/g) and low in the hexane (79mg/g) and in orange pulp higher in the acetone (522mg/g) and lower in the hexane (210mg/g) and by the DPPH method the higher in distilled water and hexane of orange peel and pulp.[8]

Antimicrobial Activity of Clove and Ginger Powder Extracts on Streptococcus Mutans

To evaluate the antimicrobial activity of clove and ginger powder extracts on Streptococcus Mutans. An in-vitro study was conducted to assess effectiveness of 5%, 10%, and 50% clove and ginger powder extracts on Streptococcus mutans. The ditch plate method was used to test the antimicrobial activity. Ditches were prepared on blood agar plates with the help of punch having 6-mm diameter. The plates were left for 1 hr at room temperature and then incubated at 37°C for 48 hours and examined for zone of inhibition. There was no zone of inhibition observed with 5% clove and ginger powder extracts. There was significant difference in mean diameter of zone of inhibition of 10% and 50% clove and ginger extract. Results showed that both clove and ginger powder extracts had antimicrobial activity against streptococcus.[9]

The Spices Of Life: Testing The Antimicrobial Effects Of Garlic (Allium Sativum), Cinnamon (Cinnamomum Zeylanicum), And Clove (Syzygium Aromaticum) Against Streptococcus Mutans

It is obvious that spices have been used to enhance the flavor of food for centuries, but what other uses do they possess? This question was posed in the hopes of discovering antimicrobial properties in various household spices. Garlic (Allium sativum), cinnamon (Cinnamomum zeylanicum), and clove (Syzygium aromaticum) were chosen to examine their effects on the bacteria Streptococcus mutans. To obtain an extract from the spices, an aqueous extraction method combined with filtration was used. The extracted compounds were applied to the bacteria through the paper disk diffusion method. The same disk diffusion method was then used to examine commercial mouthwashes and synergistic effects of the spices on the S. mutans. After incubation, the amount of bacteria revealed no inhibition from the spices. There was, however, inhibition when the bacteria were exposed to the mouthwashes. Overall, the results were inconclusive, but it is likely that the method of extraction used for the spices prevented inhibition from being observed.[10]

Antimicrobial Activity of Allium sativum (Garlic) Extract against Some Selected Pathogenic Bacteria

This study investigated the antimicrobial activity of garlic (Allium sativum) extract on six pathogenic microorganisms using the agar well diffusion method. These bacteria include; Pseudomonas aeruginosa, Staphylococcus aureus, Proteus mirabilis, Escherichia coli, Bacillus subtilis and Salmonella typhi. Four different extracts were obtained from the bulbs of garlic (water-soluble and ethanol-soluble extracts). There were zones of inhibitions around the wells which indicate that the organisms were sensitive to both water and ethanol extract of garlic. The result showed that the isolates behaved differently in their sensitivity to the different extracts added to their growth medium. Ethanol extracts of the garlic was absolutely effective against four pathogenic bacteria.

Escherichia coli and Bacillus subtilis were resistant to the extracts. Comparison of the inhibitory activity of the extracts with both gram-positive and gram-negative antibiotics revealed that gentamycin and chloramphenicol has the highest zone of inhibition against the susceptible bacterial strains used. Gram-negative antibiotic discs used recorded significantly higher activity antimicrobial activity against Pseudomonas aeruginosa and Salmonella typhi when compared to the ethanol and water extracts of the plant. The quantitative and qualitative phytochemical analysis indicates that the extract of Allium sativum (garlic) constitutes antimicrobial activity. This investigation indicates that though plant had antimicrobial and greater inhibitory effect thus confirming its use in folk medicine.[11]

The Antibacterial Effect of Ginger and Garlic Extracts on Some Pathogenic Bacteria Isolated from Patients with Otitis Media

Newly obtained rhizomes of Zingiber officinale (Ginger) and Cloves of Allium sativum (Garlic) were put together, leaved nearly at 250C to permit air-drying, milled to fine powder and then these powders would be extracted (each alone) using water and ethanol as solvents for the extraction. After that, the extracts were examined for its antibacterial (inhibitory) effect toward some clinical isolates (patient with otitis media) of Staphylococcus aureus, Staphylococcus epidermidis, Streptococcus pyogens (G+ve) and Pseudomonas aeruginosa, Klebsiella pneumonia, Proteus mirabilis (G-ve). In this study, the antibacterial (inhibitory) effect of the extracts of both ginger and garlic has been determined toward six clinical bacterial isolates (mentioned previously). Two kinds of extracts for ginger and two kinds of extracts for garlic have been obtained (involving watery extract and ethanolic extract) and then examined separately and in combination of these extract.

In the present study, some antibiotics (cloxacillin, cefepime, cefoxitin, clindamycin and tobramycin) were used to compare their effect with the effect of the extracts obtained. Disc diffusion method (Kirby-Bauer method) was used to determine the antibacterial activity of extracts. The test isolates showed variable susceptibility to the garlic and ginger extract (aqueous and ethanolic) and to other antibiotics (cloxacillin, cefepime, cefoxitin, clindamycin and tobramycin). The outcomes of susceptibility experiment depicted that ethanolic extract of garlic and ginger (each alone and in combination) showed more inhibitory effect than aqueous extract and also the combination of ethanolic extract of both ginger and garlic resulted in inhibitory effect greater than each extract alone. Both ginger and garlic extract have antibacterial activity (especially the ethanolic extract) against some pathogenic G+ve and G-ve bacteria.[12]

Antimicrobial activities of the crude methanol extract of Acorus calamus Linn

A partially-purified fraction obtained from column chromatographic preparation of the crude methanol extract of Acorus calamus Linn. rhizomes was investigated for its antimicrobial activities on various microorganisms including bacteria, yeasts and filamentous fungi. It exhibited high activity against filamentous fungi: Trichophyton rubrum, Microsporum gypseum, and Penicillium marneffei with IC50 values of 0.2, 0.2 and 0.4 mg/ml, respectively. However, it showed moderate activity against yeasts: Candida albicans, Cryptococcus neoformans and Saccharomyces cerevisiae (MIC 0.1-1 mg/ml) and low activity against bacteria (MIC 5->10 mg/ml). Scanning electron microscopic observation revealed that hyphae and conidia treated with this fraction were shrunken and collapsed, which might be due to cell fluid leakage.[13]

Investigation of antibacterial effects of garlic (Allium sativum), mint (Menthe spp.) and onion (Allium cepa) herbal extracts on Escherichia coli isolated from broiler chickens:-

This study was done to determine minimum inhibitory concentration (MIC) of the aqueous extracts of garlic (Allium sativum), mint (Menthe spp.) and onion (Allium cepa) in in vitro conditions against the Escherichia coli isolated from broiler chickens. E. coli was isolated from the infected tissues of the chickens which were suspected of Colibacillus infection. In this study, distilled water, phenol phenicol and floxacin antibiotics were used as control. E. coli was sensitive to antibiotics, but distilled water had no inhibitory effect on the activity of E. coli. In this experiment, each of the aqueous extracts was prepared by using distilled water in 6 concentrations: 0.5, 1, 2.5, 5, 10 and 20%, and was poured into the cavities in nutrient agar medium, and then the plates were kept in incubator at 37°C for 24 h. The resultsindicated that MIC of the garlic aqueous extract was 5%, but E. coli was resistant to the aqueous extracts of onion and mint.[14]

Antimicrobial Activities Of Turmeric And Ginger Root Used In The Treatment Of Infectious Fish Disease

Rhizoma curcumae (Turmeric) and Rhizoma zingiberis (ginger root) are medicinal plant of which combination are traditionally used in the treatment of infectious fish disease. . In this study turmeric and ginger extract with distil water and chloroform is used as solvent. These plants assayed for antimicrobial activity against two bacteria that is pseudomonas and E. coli. The plant extract shows various levels of antimicrobial activity on different microorganism. The most potent extract was formed from turmeric and ginger with chloroform.[15]

Herbal antimicrobial effect on textile substrate:- Combine Antimicrobial Effect of Ginger and Honey on Some Human Pathogens

This study is to determine the antibacterial effects of different honey samples on clinically isolated bacteria species. Ginger (Zingiber officinales) and honey are one of the nature gifts to mankind and have been used to prevent and control disease conditions. The crude extracts of the plant materials were used with pure honey collected from various parts of Kogi State. The Agar diffusion method was used to determine the antimicrobial activity of the plant extracts, honey and combination of both against Salmonella typhi, Shigella dysenteriae, Escherichia coli and Candida albican. The growth of all test organisms were inhibited though t varying degrees by the plant extract and honey and with greater effect when combined thus justifying their use in traditional medicines in treating enteric infection and other diseases across Africa.[16]

Antimicrobial Properties Of Peels Of Citrus Fruits

This study targeted the extraction and assay of antimicrobial metabolites from the peels. Peels were dried and antimicrobial metabolites were extracted from them by soxhlet extraction procedure. Extraction was done by solvents like cold water, hot water, methanol, ethanol, ethyl acetate and acetone. Extracts were subjected to antibacterial and antifungal susceptibility assay b agar well diffusion method. All the extracts of Lemon (Citrus lemon) were found to be effective against the used bacterial pathogens except hexane extracts. Methanol and acetone extract showed maximum zone of inhibition of 18 mm. Only methanol extract was effective against fungal pathogens showing a zone of inhibition of 18 mm. In case of orange (Citrus sinensis) hexane extract was found to be most effective against bacterial pathogens giving a zone of 13 mm. Only the cold water extract of orange was effective against fungal pathogens used in the study. Acetone extract of Mosambi (Citrus limetta) was most effective giving a zone of 20 mm against bacterial pathogens. Only cold water and ethyl acetate extracts of mosambi were effective against fungal pathogens giving a zone of inhibition of 17mm and 15 mm respectively.[17,18]

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