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Antibacterial property of synthetic upper leather treated by garlic and ginger peels extracts

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The garlic and ginger peels have been thrown as a waste. Nowadays researchers have been trying to investigate the antimicrobial properties of garlic and ginger peels extracts. Nevertheless, the effects of these materials on synthetic leather have not been experimented. The study aims at antimicrobial treatment of synthetic leather by the peels extracts and examining it against the staphylococcus epidermis bacterium. The peels have been collected in Bahir Dar city, Ethiopia, dried in the oven for one hour at 104°C, weighed and grounded in a grinder with a mesh size of 50-300 mesh. For both materials, 40 g of peel powder has been dissolved in 400 mL of ethanol solvent and stirred by a magnetic stirrer and then extracted by ultrasonic extraction method. Leather samples have been treated by extracted peels (5%, 15% and 20%) together with citric acid as a binder and soap as wetting agent. The antimicrobial properties of the treated samples have been assessed by a disc diffusion test method. The garlic peel extract at all concentrations levels has a wider inhibition zone indicating that garlic peel extract is more efficient at inhibiting *Staphylococcus epidermis* growth than ginger peel. Therefore; it could be used as antimicrobial treatment of synthetic leather.

Keywords: Antibacterial property, Disc diffusion, Garlic peel, Ginger peel, Staphylococcus epidermis bacterium, Synthetic upper leather

Leather is a strong, flexible and durable material obtained by chemical treatment called tanning of animal skins and hides which can prevent it from its decay. Synthetically it is made by coating of polyvinylchloride or polyurethane on a textile /polyester fabric. Natural leathers are more popular in the market than synthetic due to its better properties such as beautiful appearance, softness, and a porous structure that give them high water absorption and vapour permeability[1,10]. However, natural leather has lesser abundant in market compared to that of synthetic because of their restricted source, high price, as well as protect animals[1,2]. Synthetic leather is made to resemble natural leather and can be made from a fabric as a base substrate to be coated with polyvinylchloride and polyurethane, mainly this leather can be used as a shoe upper materials1[3,22]. Some another comparative advantages of the synthetic leathers over natural leathers includes less cost, animal friendly, produced virtually every colour, easily clean, and so on[13]. Though, synthetic leather is water proof and more affordable than natural leather, it has lesser air permeability property of the synthetic leather allows heat to be created, when a shoe is dressed and the sweat gland in the body secret sweat, which contains lipid and protein. The bacteria will grow to breakdown the protein into small components and smell occur[10]. Upper parts /peels of garlic and ginger of household kitchen left after the garlic and ginger are used as food have been thrown as a waste and researchers have been collecting it and studied for their antibacterial effects. However, they have not, tested the effects of these materials on synthetic leather, but this study has experimented on it. The current study focuses on antimicrobial finish of the synthetic leather to avoid this type of bacteria problem on it by using the extracts of garlic and ginger peels. Previously, numerous studies have been conducted on antibacterial potential of garlic and ginger extracts that showed significant effect on defending against bacteria[11,12].

Based on the researchers finding (Table 1), in dry basis, ginger peel has composition of 58% carbohydrate, 9.42% crude protein, 9.21% crude fat 7.02% fiber, 7.41% ash and 0.31% moisture. On the other hand garlic peel has 93% carbohydrate, and small amounts of protein and fat[12] in a dry base. Garlic has been utilized to fight infectious illness for millennia in

Table 1 — Phytochemical compounds content in garlic

Content of Garlic	References
Cysteine, Cysteine sulfoxides, Glutathione, Glucosinolates and Bioactive compounds (Alliin, Ajoenes, Allyl sulfides and 1,2vinyldithiin) Protein, Crude	8, 24
Protein, Crude fiber, Volatile oil, Carbohydrate, Vitamin C, Selenium, Zinc, Alliin and glutamyl-(S)-allyl-L-cysteine	9, 24
Amino acids, Manganese, Potassium, Calcium, Phosphorus, Magnesium, Sselenium. Sodium, Iron, Zinc, Copper, some Vitamin, Allyl disulfide, Allyl trisulfide, Alliin and Ajoene	23, 25

many cultures across the world and may be taken as capsules or powders and utilized in our diets[4]. Traditionally, garlic and ginger has been used for periods all-inclusive by various cultures to fight contagious disease and as a food spice and traditionally people were used the ginger and garlic peels for treating injuries[23,25]. It has antibacterial properties against Gram-positive and Gram-negative bacteria[14,20]. Moreover, harmful bacteria can be efficiently abolished by raw garlic[14] and also some researchers have studied, investigation of antioxidant and antimicrobial properties of garlic peel extract (Allium sativum) and its use as natural food additive in cooked beef and conclude that garlic peel extract exhibited antibacterial activity similar to garlic bulb, which may be explained that the bioactive compounds present in the garlic bulb are likely to be available in the peel[19]. Elizabeth et al., in 2013 investigated on Production of oleoresin from ginger (Zingiber officinale) peels and evaluation of its antimicrobial and antioxidative properties and according to their findings Ginger peels have both antioxidative and antimicrobial properties, therefore there should not be leave ginger peel as a waste [23].

Generally, many studies including those mentioned in Table 1 had been carried out to study the antimicrobial activity of varieties of plant extracts against different types of bacteria with different degree of success[5,19,20,21]. Many documented papers shows garlic contains aromatic sulphur in the form of compound allicin, which has antibacterial properties against *Escherichia coli*, *Salmonella*, *Staphylococcus aureus*, *Streptococcus pneumoniae*, *Klebsiella pneumoniae*, *Proteus pneumoniae*, *Clostridium pneumoniae*, *Mycobacterium pneumoniae*, and *Helicobacter pylori* [6,22,2,25]. However, application of these antimicrobial riche materials on synthetic leather finishing which can retard or could avoid the odor occur in our feet is not researched yet. Therefore, the aim of this research work concerned on extract preparation from garlic peel and ginger peel and investigating the effect of extract on synthetic leather. Extraction was done using ultrasonic extraction method and then the antimicrobial effects of the extracted peels were investigated in the current study.

Experimental section

Materials and methods

Materials

The garlic and ginger peels were collected from kitchens of household and hotels from different places in Bahir dar city, Ethiopia, beneficiated and then allowed to be dried for 10 days in a shade. Then a powder was made using attrition mill. Samples were then packaged, labeled, sealed and stored for further analysis[15,16,23]. The abilities of garlic and ginger peel extracts to inhibit the *Staphylococcus epidermis* growth were assessed after treatment by disc diffusion method following standard procedure [23]

Extraction methods

Extraction was done in the laboratory following reported methods.[9, 23, 25]. In this study, for ginger peel, 40 g of the peel and 400 mL of ethanol solvent was used to get enough extracts to apply on the leather samples, then stirred it for 24 h on a magnetic stirrer, Extraction was done using ultrasonic extraction method. For garlic peel, 40 g dried powder was prepared for extraction at a material liquor ratio of (MLR 1:8) 320 mL of ethanol as a solvent. The extraction was carried out for 2 h at 45°C with frequent vibrating. After extraction, the perspective sample was filter through Whatman filter paper. After filtration the filtrate was placed in a container and stored at room temperature for 18 h. The whole procedure is shown in Fig. 1.

The yield of the extraction was calculated by the following equation.

Yield (%) $= \frac{w1-w2}{w2} \times 100$, where, w_1 and w_2 are the weight of the powder before and after the extraction (sludge), respectively.

For garlic extract it was yield $= \frac{40-28.5}{28.5} \times 100 = 40\%$ and that of ginger was yield $\frac{40-31}{31} \times 100 = 29\%$

Media preparation bacteria refreshing and growth method

The sterilization, refreshing, agar nutrient and bacteria growth are discussed by referring with Fig. 2.

Fig. 1 — (a) Ginger peel (b) Garlic peel, (c-e) *e*xtraction process of the antimicrobial material, milling, solvent weighting and dissolving and filtration respectively from right to left, (f) final antimicrobial ginger peel extract and (g) garlic peel extract

Media preparation

Types of general media that were used for growing the bacteria are nutrient agar and nutrient broth. Nutrient broth was used for refreshing the bacteria. It was also prepared depending on number of Petri dish and media fill. It was dissolved in distilled water and put on stove for uniform dilution for few seconds. After the dilution completed, all media were put in Petri dish, test tube and other material in autoclave for sterilization for 15 min with 120°C, 20 bar pressure. After sterilization completed, and then equipment was put in chamber to reduce contamination

Bacteria refreshing producer and bacteria growth

7 g of nutrient broth was mixed with 200 mL of distilled water. It was put on heater for proper dissolution of the solution and then for purification of the nutrient broth it was sterilized using autoclave.

Fig. 2 — (a) Sterilization, (b) bacteria refreshing, (c) agar nutrient and (d) bacterial growth agar diffusion

The nutrient broth was spilled on test tube. For refreshing the bacteria, it was purred on nutrient broth solution in the test tube and placed inside the incubator for 24 h to refresh the bacteria and then the bacteria inoculation was on hold on Petri dish uniformly by using swab, placed synthetic leather samples in agar, and stored in inoculator for 24 h.

Leather samples preparation, treatment and assessment of antibacterial properties of the leather samples

Seven synthetic leathers with diameter of 20 mm and thickness of 1.4 mm were used. Three samples of each were treated by peel extracts and the other three for each peels extracts were remained untreated for control groups. These leather samples were sprayed by the extracts. Then dried at 8℃ for 3 min and cured at 160℃ for 3 min which were done following the American Association of Textile Chemists and Colorists (AATCC) of AATCC, ISO20645[23]. The test was conducted by disc diffusion method. After the bacteria was developed the diameter of inhibition were measured.

Leather samples antimicrobial treatment

Three different concentration of antimicrobial finishing agent was prepared. During this preparation ML ratio of 1:40 with time duration of 30 min at 90℃ with citric acid 4 g and wetting agent 2 g and 5%, 15% & 20% amount of the extracted antimicrobial agent for S1, S2, and S3, respectively, were used, the amount of extracted peels concentration used was taken referring the literatures[23]. Then the samples were treated with these solutions. It was mixed with leather for 30 min at 90℃ for each sample and padded on padding mangle individually in the presence of citric acid used to cross linking (binder) to get a wet pick up of 80% on weight of the leather sample. The leather sample was then dried at 90℃ for 3 min.

Results and Discussion

The results in Fig. 3 are showing the effect of the extracts on the gram positive bacteria. The antimicrobial activity of treated leather samples is shown in the Fig. 4. The current study revealed that the garlic and ginger peels extracts have interesting antimicrobial effect on *Staphylococcus epidermis* bacteria. However, the effectiveness of the two peels extracts are different as illustrated in Figs 3 and 4. This is due to its natural ingredients as it has been discussed by other researchers as well[9,18,23,2]. The antimicrobial property assessments of the treated leather samples were done using disk diffusion test or agar diffusion test method. It is a quick way to assess the antimicrobial activity of a material or solution in relation to a target microorganism[23]. As shown in Fig. 4, there is a big difference inhibition capability between the ginger and garlic peel extracts, as zone of inhibition for garlic peel extract has greater inhibition

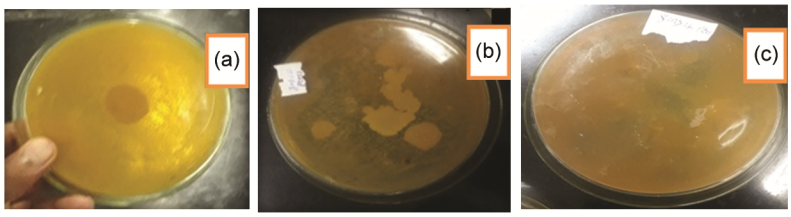

Fig. 3 — (a) Controlled sample, (b) treated sample by garlic extract and (c) by ginger extract material by disc diffusion method (15% extracted materials are used for both)

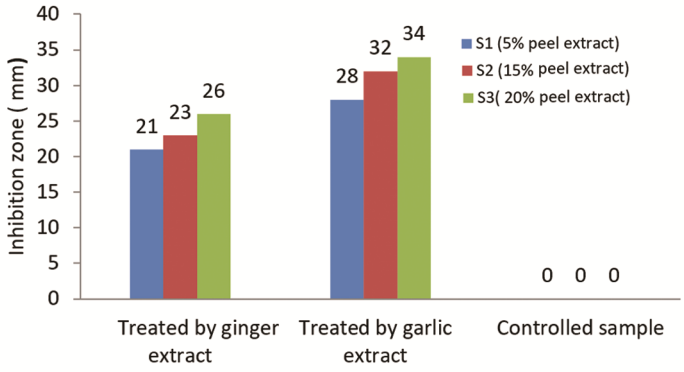

Fig. 4 — Inhibition zones of treated leather samples by garlic peel extract, ginger peel extract and controlled sample

power compared to that of ginger peel extract. The disc diffusion test for *Staphylococcus epidermis* bacteria, there was no clear zone around the untreated synthetic upper leather. However, there is slight zone of inhibition of bacteria around the synthetic upper leather treated by ginger peel extract with an average zone of inhibition 23.33 mm. On the other side, the size of zone of inhibition of bacteria to the garlic sample leather is about 31.33 mm in average which indicates a higher inhibition zone size compared to the untreated upper leather and leather treated with ginger peel extracts.

The size of the zone of inhibition is usually related to the level of antimicrobial activity, in other words an extract which has a larger zone of inhibition. Therefore, in this study the antimicrobial efficacy of garlic was more effective compared to that of ginger peel extracts. There is also a slight difference in zone of inhibition within using same extracts from one treated sample to the other. However, regarding the differences between the two extracts have different visible reasons, firstly due to different antimicrobial ingredients found in peel extracts in nature. In other words, because of garlic's antibacterial activity was caused by sulphur compounds, allicin, interacting with sulphur (thiol) groups of microbial enzymes (trypsin and other proteases), inhibited the microbial growth[17]. Previous researchers found that garlic peel contains 93.26% carbohydrate, 5.50% moisture, and 0.57% protein. Furthermore, the fat level of the peel is 0.05%, which is significantly lower than the 0.52% found in the garlic bulb. The need of detailing the level of moisture content of the peels and its ingredients is to provide a detail understanding regarding the materials for the readers.

The result reveals the ethanol extract of garlic peels worked against the bacteria (*Staphylococcus aureus*, *Escherichia coli* and *Proteus vulgaris*) and the strong aroma of ginger is the result of pungent ketones including gingerol[23]. As per mad Mohamed Abdallah, ginger is popular ingredient in modern diets, riches in antimicrobial rhizome; rhizome disbands an aromatic and commercial importance to the economy of its gardeners in different countries[9]. Generally, the current study revealed that there is a clear inhibition zone around the synthetic upper leather and there is zone of inhibition of bacteria. Moreover, the average inhibition zone of bacteria in ginger extracts becomes 23.33 mm which is comparatively lower than that of garlic which means, the antimicrobial properties of garlic is better than that of ginger. Therefore, to the current research findings as size of zone of inhibition increase its antimicrobial properties of the materials are higher. These differences in zones of inhibitions of the bacteria in the two extracts are due to because of the antimicrobial ingredients available in nature are different.

Conclusion

In the current study the antibacterial property of synthetic upper leather finished by garlic and ginger peel extracts was conducted through disc diffusion test method on *Staphylococcus epidermis* bacterium and found garlic peel has a higher yield of antimicrobial properties compared to that of ginger the antimicrobial yield of garlic peel was 40% and that of ginger was 29%. The concentration of the materials used affects the efficacy of the materials. The higher inhibition zone was found at 20% concentration for both garlic and ginger peels of extracted materials. It has been shown that the average inhibition zone for garlic peel extract on the treated synthetic upper leather is 31.33 mm and that of the ginger peel is 23.3 mm. This shows the garlic peel extract has a greater inhibition zone than the ginger peel extract, in other wards garlic peel extract has a greater antibacterial property than the ginger peel extract. The treated sample leathers also have a very good resistance to washing. 20% garlic peel extracts has shown best antimicrobial properties.

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