

SYNERGISTIC EFFECT OF COMBINATION HERBAL EXTRACT TREATMENT ON THE ANTIBACTERIAL AND MOISTURE MANAGEMENT PROPERTIES OF KNITTED FABRICS FOR HEALTHCARE APPLICATIONS

ABSTRACT

The present investigation aims for exploring the synergistic antibacterial and moisture management properties of combination herbal extracts treated single jersey knitted fabrics and identification of the best treated fabrics for the management of perianal abscess and fistula-in-ano as a draining wound contact layer in the disposable multi-layered absorbent fabric batting for the perianal region.

In the preliminary screening for selection of herbs, Wild turmeric (*Curcuma aromatica* Salisb.) and Holy basil (*Ocimum tenuiflorum* Linn) or *ocimum Sanctum* were selected based on their well-known medicinal properties obtained from the various literatures. The active components in these herbs were extracted using aqueous media and methanolic extract. Among the two extraction methods, the solvent extraction process yield percentage was found to be higher for both the herbs. In the phytochemical screening of aqueous and methanol extract of Wild Turmeric (WT) and holy basil (HB), five combination herbal extracts were prepared in the proportion of 100%:0%; 75%:25%; 50%:50%; 25%:75% and 0%:100%. The phytochemical screening analysis reveals that among the herbal extracts the combination herbal extract prepared with methanol as

solvent in 50%:50% & 75%:25% proportion possessed with the significant presence of many phyto chemicals when compared with other combinations of herbal extracts.

The Minimum Inhibitory Concentration (MIC) study using the broth dilution method was carried out for the aqueous and methanolic extracts of wild turmeric (*Curcuma aromatica* Salisb.) and holy basil (*Ocimum tenuiflorum* Linn.) against *Staphylococcus aureus* and *Escherichia coli*, which are identified as the major isolates in the pus cultures of perianal abscess and fistula - in- ano in many research works. The minimum inhibitory concentration results revealed that the combination herbal extracts prepared using methanol as a solvent are having lowest MIC values when compared to the aqueous combination herbal extracts. Among the methanol extract samples, 50%WT: 50%HB combination herbal extracts proportion yielded minimum MIC values against *S. aureus* and *E. coli* bacteria when compared to other combination herbal extract proportions. The results show that balanced synergic action of bio-active components in both the herbs is found in this formulation.

The synergy between wild turmeric and holy basil was calculated based on their MIC values using the Fractional Inhibitory Concentration (FIC) index method for both aqueous and methanol combination herbal extracts. The FIC index values obtained for methanol extract of 50%WT: 50%HB combination herbal extract proportion for *Staphylococcus aureus* and *Escherichia coli* are 0.750 and 0.624 respectively. Since the FIC index values are < 1 for both bacterial strains, which indicates that the constituent herbs in this combination herbal extract proportion, are found to be synergic in action against the bacterial strains.

Gas Chromatography-Mass Spectrometry (GC-MS) analysis was carried out to confirm the presence of active components in the methanolic extracts of Wild turmeric (*Curcuma aromatica* Salisb.), Holy basil (*Ocimum tenuiflorum* Linn.) and the 50:50 proportion of Wild turmeric (*Curcuma aromatica* Salisb.) and Holy basil (*Ocimum tenuiflorum* Linn.) extracts. In the GC-MS analysis, many active components were

detected. The GC-MS analysis results of the methanol extracts of *Curcuma aromatica* Salisb. and of holy basil (*Ocimum tenuiflorum* Linn.) were identified with 30 compounds each. The GC-MS results of methanol extract of. The GC-MS results of the methanol extract of 50% WT: 50% HB combination herbal extract proportion was identified with 30 compounds. In this proportion, apart from the active components of wild turmeric and holy basil, five new compounds have been identified. The new compound formation may be due to the mixture of wild turmeric and holy basil extracts.

The antioxidant results of the 50% WT: 50% HB combination herbal extracts show that the extract is near match with the standard (Ascorbic acid) at higher concentrations. The cytotoxicity study of the 50% WT: 50% HB combination herbal extracts revealed that the extract is identified with an acceptable cytotoxicity grade with cell viability percentage of 89.1.

By having methanolic extracts of Wild Turmeric (WT) and holy basil (HB), a preliminary finishing trial was conducted by using Pad-Dry-Cure method with D-optimal factorial design. Based on the moisture management potential, cotton, lyocell and micro denier polyester fabrics have been chosen for the treatment with combination herbal extracts. The pre-treated single jersey knitted fabrics of cotton, lyocell and micro denier polyester fabrics were given finishing treatment with the wild turmeric (*Curcuma aromatica* Salisb.) and holy basil (*Ocimum tenuiflorum* Linn.) combination herbal extract proportions of 100%:0%, 75%:25%, 50%:50%; 25%:75% and 0%:100%. The aim of the preliminary studies is to find out the influence of combination herbal extract proportion, textile material and their interaction effect on the antibacterial and moisture management properties of the treated fabrics.

The treated fabrics were tested for their anti-bacterial activity against *Staphylococcus aureus* and *Escherichia coli* and the moisture management properties. The ANOVA results revealed that the overall moisture management and anti-bacterial properties of the tested single jersey knitted fabrics are influenced by the material type,

combination herbal extract proportion and the interaction between material type and the combination herbal extracts proportion.

Among the combination herbal extract proportions, 50% WT: 50% HB combination herbal extract proportion was observed with good antibacterial and overall moisture management capability. In terms of material, with regard to antibacterial property, lyocell and micro denier polyester material showed good results in 12 hour and 24 hour contact time against *S. aureus*. Against *E. coli*, cotton and micro denier polyester showed good results in 12 hour and 24 hour contact time respectively. Among the materials, with regard to overall moisture management capability, all the materials are observed in the moisture management grade – III (0.40-0.59). Hence it was decided to conduct further trials to optimize the finishing process parameters using these three materials with 50% WT: 50% HB combination herbal extract proportion.

With pre-treated cotton, lyocell and micro denier polyester single jersey knitted fabrics, using the 50% WT: 50% HB combination herbal extract proportion, a finishing trial was conducted using the pad-dry-cure method. Box-Behnken response surface experiment design was used for the study. The ANOVA results revealed that the type of material used and the finishing process parameters influenced the moisture management properties. The combination herbal extract concentration percentage significantly influenced many moisture management properties in all the three materials. Further the study revealed that the interaction of finishing process parameters was seen in many moisture management properties.

The 50% WT: 50% HB combination herbal extract treated cotton; lyocell and micro denier polyester single jersey knitted fabrics were tested for their antibacterial properties against *S. aureus* and *E. coli* against 12 hour contact time, which is required for the chosen application. The study results show that the antibacterial properties are significantly influenced by the type of material used and the finishing process parameters especially combination herbal extract concentration percentage. The study further

revealed that bacterial adherence pattern of the tested textile materials is different from each other.

By using the optimized finishing process parameters, the combination herbal extract treated single jersey knitted fabrics were used as a wound contact layer and a disposable multilayered absorbent fabric batting assembly model was developed for the management of persistent drainage and infection in perianal abscess and fistula-in-ano. The developed product model was validated for moisture management, air-permeability, cytotoxicity, free swell absorptive capacity and fluid affinity characteristics. The present work outcomes are expected to improve the quality of life of people who are suffering from the annoying problem of perianal abscess and fistula-in-ano.