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Apple cider vinegar (ACV®) displays antimicrobial activity directly against *Escherichia coli*, *Staphylococcus aureus* and *Candida albican* proteins and *in vitro* monocytes exposed to microbes by inhibiting inflammatory cytokine secretion

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Introduction: Extraintestinal pathogenic Escherichia coli (E-coli) are the most frequent cause of blood borne, urinary tract and hospital acquired infections. Candida albicans and S. aureus infections can also pose a huge threat especially following transplantation and to immunocompromised patients. Globally, there is a growing need for novel anti-microbial agents to target microbes and multi drug resistance from bacterial, fungal associated infections.

Aim: The aim of this study was to investigate the potential anti-microbial effects of ACV®. We used microbial strains: E-coli strain 6571, C. albicans strain 90828 and S. aureus purchased from ATCC. We tested the effect of commercial ACV® directly on microbial cultures over a 24-hour period, measuring inhibition zones. We also looked at whether ACV® could have an anti-inflammatory effect in vitro. This was tested using human blood derived monocytes which were incubated with microbes and AVC®. Collected supernatants were analyzed for pro-inflammatory cytokine secretion by ELISA.

Results: ACV® could significantly inhibit E-coli growth demonstrated by the results of direct co-culture with each of the microbial inoculum and ACV® in varying concentrations. The zone of inhibition with the addition of ACV® to each of the microbes varied dose dependently ACV® concentration. For C. albicans and S. aureus, concentrated ACV® had the strongest effect, whereas on E-coli cultures, the most potent effect was visible at lower dilutions including 1/50 dilution of the neat solution ($p<0.05$). When monocytes were cultured with both microbes they secreted inflammatory cytokines (TNFα, IL-6) ACV® was effective in significantly inhibiting inflammatory cytokine secretion in human peripheral blood monocytes cultured with E-coli, S. aureus and C. albicans. We also showed that ACV® can damage the microorganism protein moieties after 24-hours.

Conclusion & significance: ACV® displayed potent anti-microbial and anti-inflammatory activity against E-coli and C. albicans. We propose that ACV® could be potentially therapeutic.

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