



TAMRAS: STUDY REPORT

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TamRas: Low-cost, Point-of-Use Solution for Microbially Safe Drinking Water

Over 1.7 billion people drink water that is contaminated with human feces which leads to more than 1 million diarrheal deaths every year, mostly among children under the age of five (U5) [1]. Diarrhea is the second leading cause of mortality among U5 children, next only to pulmonary diseases [2]. 94% of water borne diarrheal diseases are preventable by providing access to clean drinking water and improved sanitation and hygiene [3]. According to a global study in over 20,000 children in seven developing countries, diarrheagenic *E.coli* was identified as one of the top three pathogens along with rotavirus and *Cryptosporidium* associated with moderate to severe diarrhea[4]. WHO reports that improving drinking water quality through household water treatment can lead to a 35-39% reduction in diarrhea [5].

Simple, sustainable interventions to purify water at community as well as household level can tremendously reduce the water borne diseases and deaths. Globally several researchers have demonstrated that solar disinfection [6], chlorination [7], boiling [8], filtration [9,10] etc. reduce the counts of water borne diarrheagenic pathogens at the point of use (PoU), which in turn reduce diarrheal morbidity among children. However, most of these have some limitations or drawbacks due to which the target populations do not use them in a sustainable manner (11,12,13, 14). Most PoU filters have unaffordable upfront costs and recurrent costs in terms of maintenance and replacement of filter cartridges etc., making them unsustainable [15,16]. Thus, providing safe water at the PoU to vulnerable and marginalized communities in a sustainable manner continues to be a major challenge to governments in developing countries. There is a clear need for a PoU drinking water treatment technology that is appropriate, affordable, accessible, self-sustainable as well as effective in reducing microbial contamination in drinking water. This can save millions of lives globally.

TamRas:

Storing drinking water in copper pots was a traditional practice in India and finds mention in ancient texts of Ayurveda [17]. Earlier studies published from our laboratory have indicated that storing contaminated drinking water in copper pot for 16 h at room temperature kills major diarrhea causing pathogens including *Vibrio cholerae*, *Salmonella* Typhi, *E. coli*, *Shigella flexneri* [18,19] and rotavirus [20]. Since copper pots are not

affordable to a poor household, a simple, and affordable (~USD 15) copper device was developed which was as effective as the pots in decontaminating diarrheagenic pathogens when tested under laboratory conditions [18]. The levels of copper leached into water after 16h storage was <200 ppb; well within WHO permissible limits of 2000 ppb [21]. A well-controlled, multi-centric study conducted by the Indian Council for Medical Research (ICMR) scientists convincingly refuted the association of copper in Indian childhood cirrhosis [22]. The safety of our copper device treated drinking water was further established through a sub-chronic toxicity study in Sprague Dawley rat model and found to be safe [23].

A prospective cohort study undertaken in households of seven peri-urban villages around Bengaluru, India, during 2014, to test the effectiveness of the device in reducing fecal pathogens in drinking water in households, showed that there was a significant reduction in the coliforms (86 %; 95% CI 82.6-87.4; $p < 0.0001$) and *E. coli* (92 %; 95% CI 89.0-95.0; $p < 0.0001$) counts in 100 mL of water samples, after copper device intervention. The percentage of WHO compliant households with zero *E. coli*/100 mL water increased significantly ($p < 0.001$) from 33.3 to 49.02 % after intervention (unpublished data, TDU).

Third party testing: TamRas was tested as per WHO/ NSF protocols by Bhavan's Research Centre, Mumbai for antimicrobial activity against strains (of *Vibrio cholerae*, *Salmonella* Typhi, *E. coli*, *Shigella flexneri*) that are recommended by WHO/ National Science Foundation. When 5 log per mL was inoculated in normal tap water stored in TamRas for 10h, no counts were recovered on culture plates, indicating that the device was highly active against bacterial pathogens in tap water. The device caused <1 log reduction when the same load was in WHO simulated water (high TDS, high turbidity). This indicates that the effect of TamRas is dependent on input water quality.

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