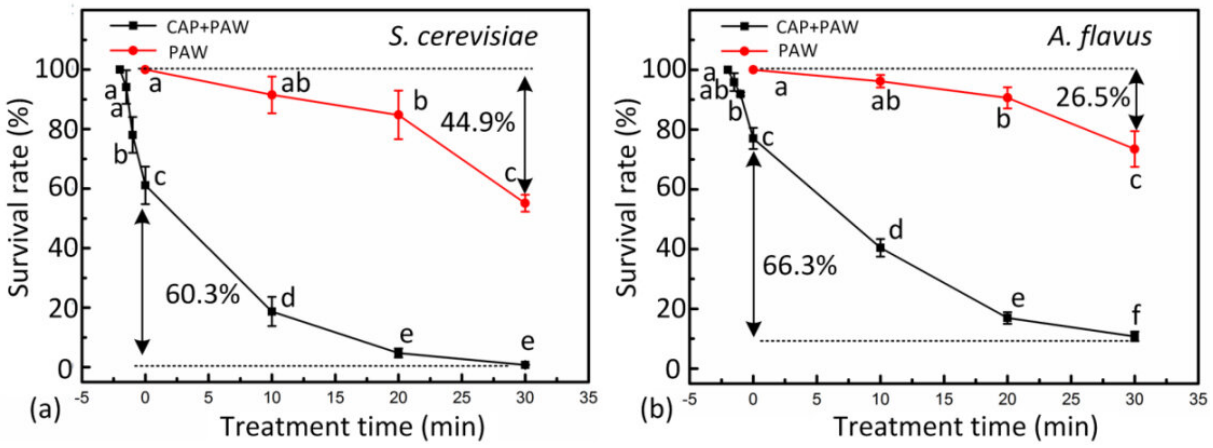
Combination effects under low temperature plasma have synergistic fungicide effects

November 3 2022, by Zhang Nannan



The combined treatment of CAP and PAW increased the killing efficiency of Saccharomyces cerevisiae and Aspergillus flavus. Credit: Xu Hangbo

Prof. Huang Qing's group from the Hefei Institutes of Physical Science (HFIPS) of the Chinese Academy of Sciences has recently proved that the combination of cold atmospheric plasma (CAP) and plasma-activated water (PAW) has synergistic fungicide effects. Related research results were published in the *Chemical Engineering Journal.*

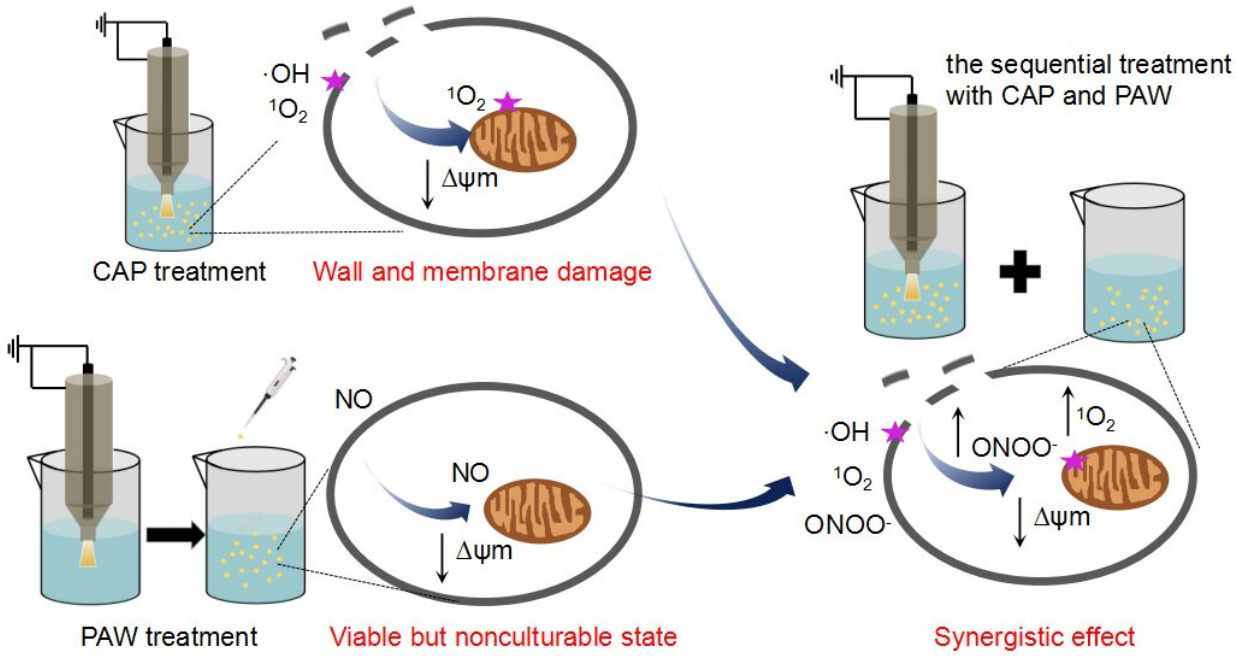
In recent years, the researchers have made a series of studies on the mechanism and application of non-thermal plasma microbial disinfection and sterilization.

In this study, they proposed the sequential use of CAP and PAW to inactivate two kinds of typical fungus (Saccharomyces cerevisiae and Aspergillus flavus) and investigated the fungicidal mechanism of CAP, PAW, and the combination of CAP and PAW.

According to the researchers, this combination exhibited a synergistic effect and could be effective in improving the fungicidal efficiency. To elucidate this synergistic mechanism, they further investigated the reactive oxygen and nitrogen species (RONS) (·OH, $^1O_2$, H_2O_2, $ONOO^-$, NO_2^-, NO_3^-) produced by CAP or PAW, and specifically examined the changes of various RONS (·OH, $^1O_2$, H_2O_2, NO, $ONOO^-$) in the cellular under the two treatment methods.

When CAP was applied alone, ·OH and $^1O_2$ could cause the inactivation of fungi by destroying the wall and membrane structure.

Although treatment with PAW alone cannot directly lead to wall and membrane damage, instead, it can leave the fungus in a viable but non-culturable state (VBNC).



Different inactivation mechanisms of fungi under three treatments (CAP, PAW and CAP+PAW). Credit: Xu Hangbo

"The synergistic effect under combined treatment of CAP and PAW is what we want," said Prof. Huang Qing.

Under the first stage of CAP treatment, the wall and membrane structure of fungi was damaged. In the subsequent PAW treatment, more $^1O_2$ and $ONOO^-$ entered the cells and caused irreversible damage to mitochondria and energy metabolism system, thus leading to fungal inactivation.

This study provides an alternative method of using CAP in combination with PAW to improve the killing efficiency of fungal microorganisms.

More information: Hangbo Xu et al, Enhance the inactivation of fungi by the sequential use of cold atmospheric plasma and plasma-activated water: Synergistic effect and mechanism study, *Chemical Engineering Journal* (2022). DOI: 10.1016/j.cej.2022.139596

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