Cooking Induced Corrosion of Metals

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Experimental Details:

Three metal vessels were used for this study. For each metal vessel, experiments were done simultaneously in three separate vessels (of equal size and weight) to check reproducibility and calculate standard deviation. The vessels were cleaned and the experiments were repeated thrice for each metal and each variety of rice. The resulting 9 data points for each metal vessel and each rice variety were averaged. All the experiments were performed in deionized water. In a typical reaction, 2 g of rice was taken in silver vessels and cooked in presence of 20 mL of DI water at 80 ^{o}C on hot plate. This specific temperature was chosen as reasonable silver release was observed in DI water at this temperature and there was no reason to use a condenser to keep the volume nearly constant. We have performed the experiments with tap water also but seemingly DI water worked better with good reproducibility and greater control on the data. A glass lid was used in each case to avoid evaporation of water. Equal amount of the supernatant was collected in equal time interval. In this optimized condition (from various control experiments) rice can be cooked in 2 hours of time. We performed cooking for a longer time to see maximum limit of silver uptake by the rice at experimental conditions. For real time application, the same experiment was performed at higher temperature to check the uptake of silver, where the rice was cooked within 20 min.

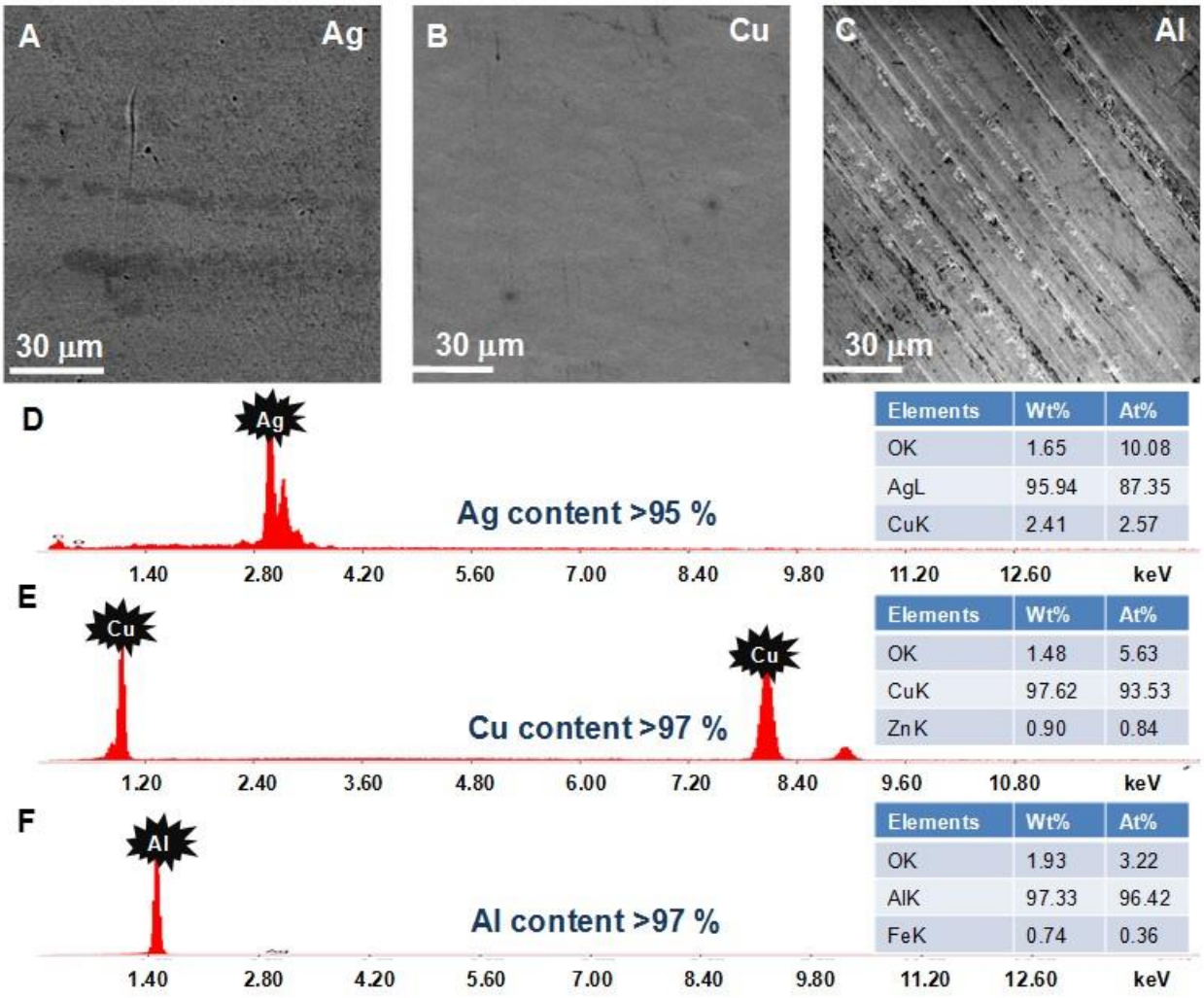

Figure S1: SEM image of A) silver, B) copper and C) aluminium vessels before use. D, E, F) SEM/EDS data of the above. The values are in wt% with some oxygen present in it. As for silver vessel (>95%), the impurities were copper (< 3 %) and oxygen (<2%). For copper vessel (>97%) the impurities were zinc (<1%) and oxygen (<2%) and for aluminum (>97%) it was iron (<1%) and oxygen (<2%).

	Ag	Al	Cu	Mn	Zn	Ni
MQ water	0.0	0.0	1.8	0.0	8.8	0.0
DI water	0.1	0.0	1.8	0.0	3.8	0.0
Tap water	0.1	0.0	1.3	15.9	446.9	0.0

Table S2: Blank concentration of metal ions in MilliQ, de-ionized and tap water. All the results are in ppb.

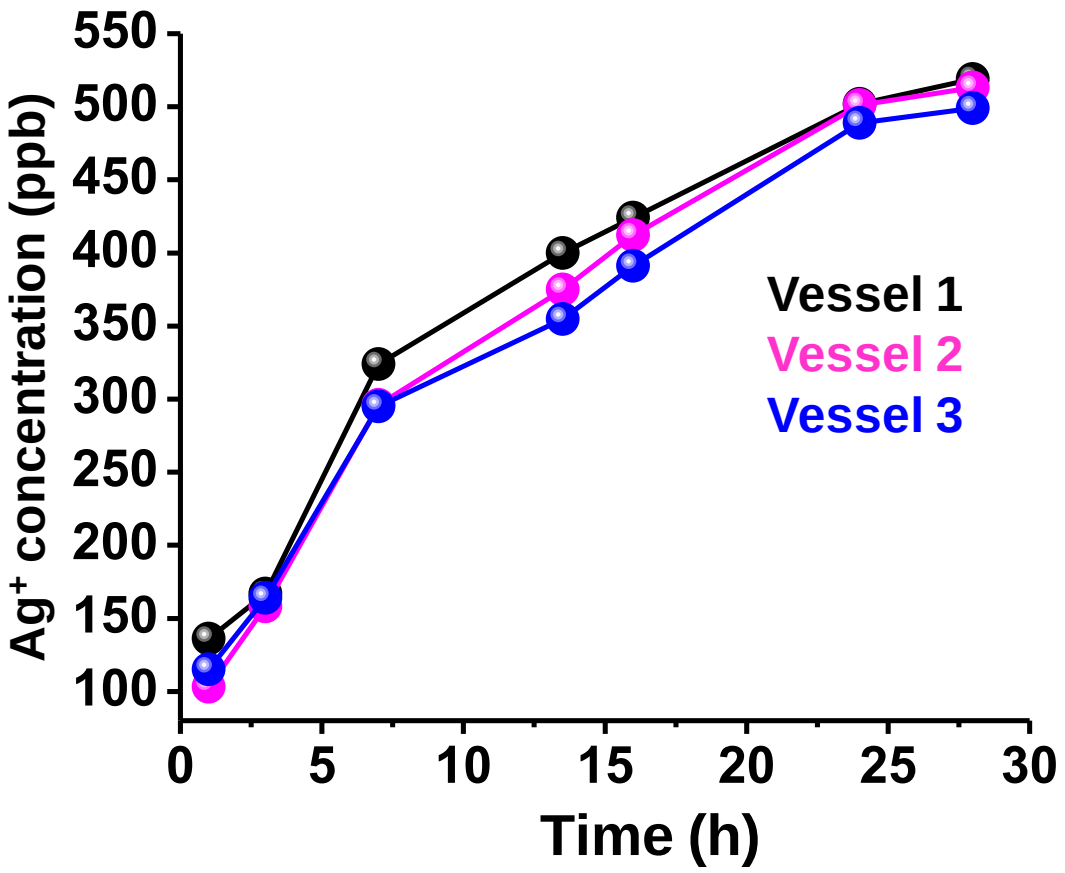

Figure S3: Comparison among time dependent silver release in deionized water at 80^{o}C showing almost similar type of behavior for all three vessels used in this study.

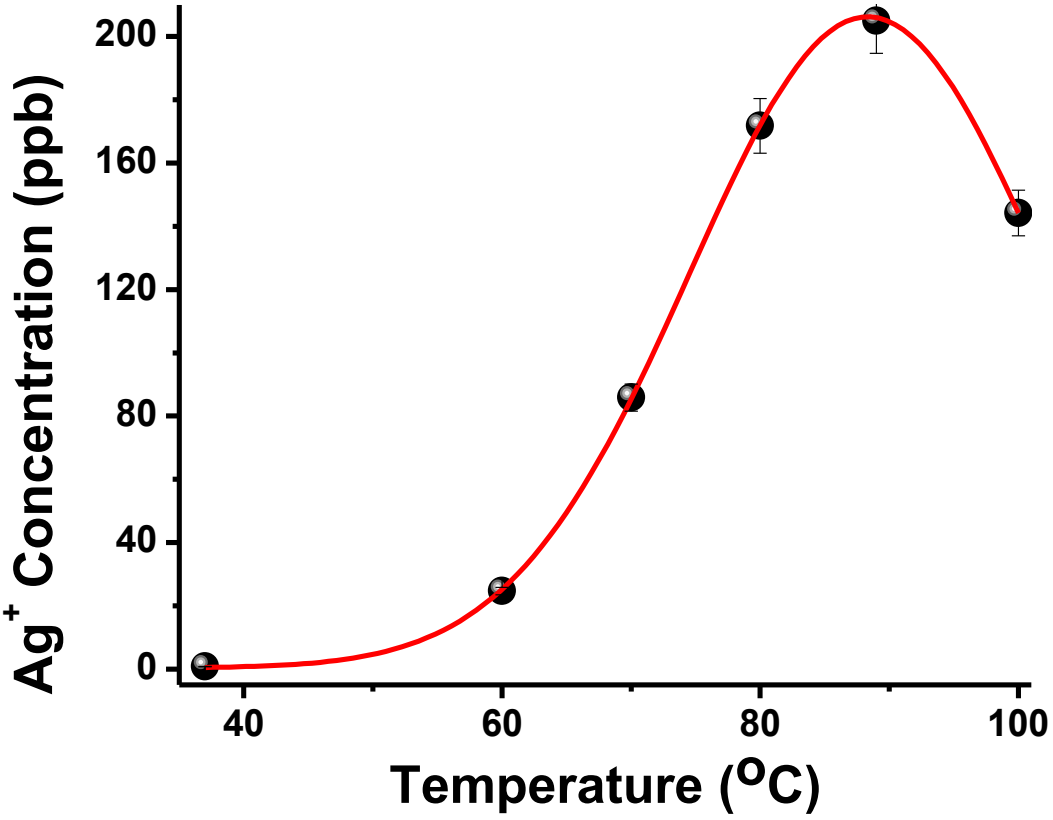

Figure S4: Temperature dependent silver release after 3 h in deionized water showing highest silver release at 90°C. Release at 80°C is comparable with 90°C data. To avoid excessive evaporation of water, we have conducted our all experiments at 80°C. At 100°C water starts boiling and at this temperature liquid and gaseous state exist together. Bubbles formed during heating reduces the available surface area of the silver vessel due to cavitation, which might be the reason for the reduction in silver release. Error bar shows the variation of 9 data points.

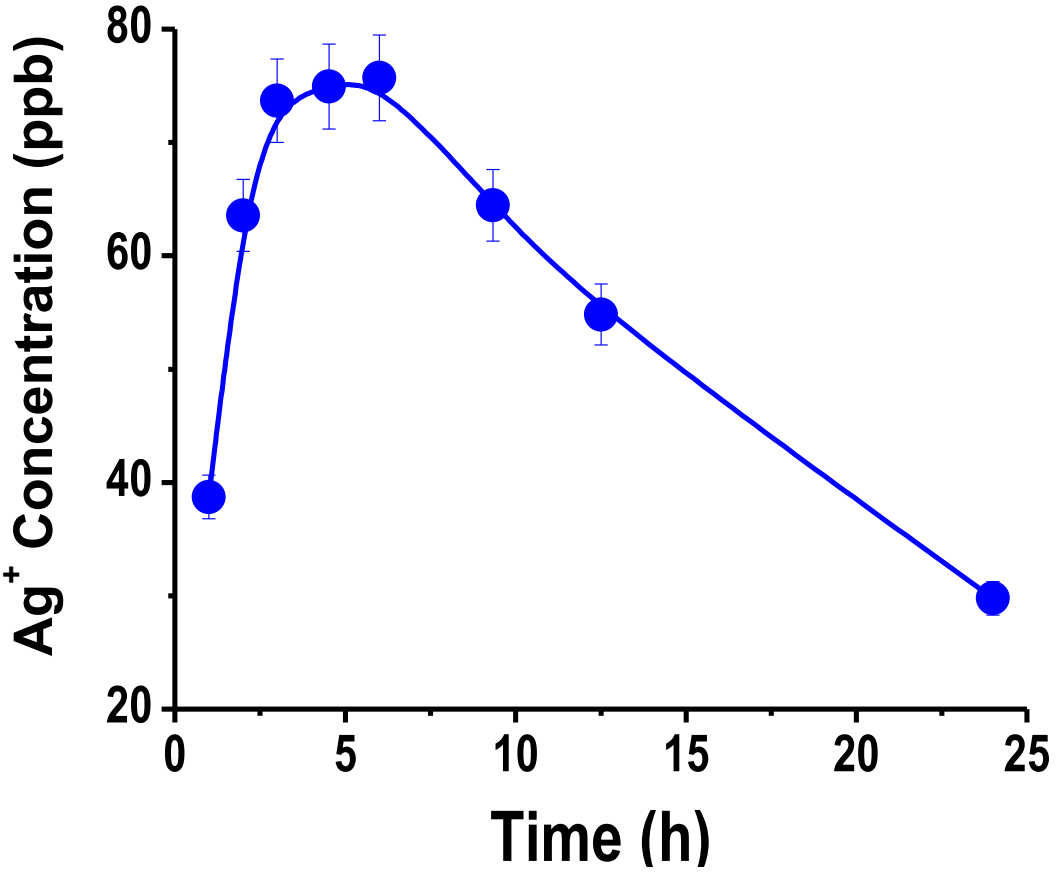

Figure S5: Time dependent silver release in tap water showing gradual increase in silver concentration in water up to 7 hours. After that silver concentration showed constant decrease with time. Error bar shows the variation of 9 data points.

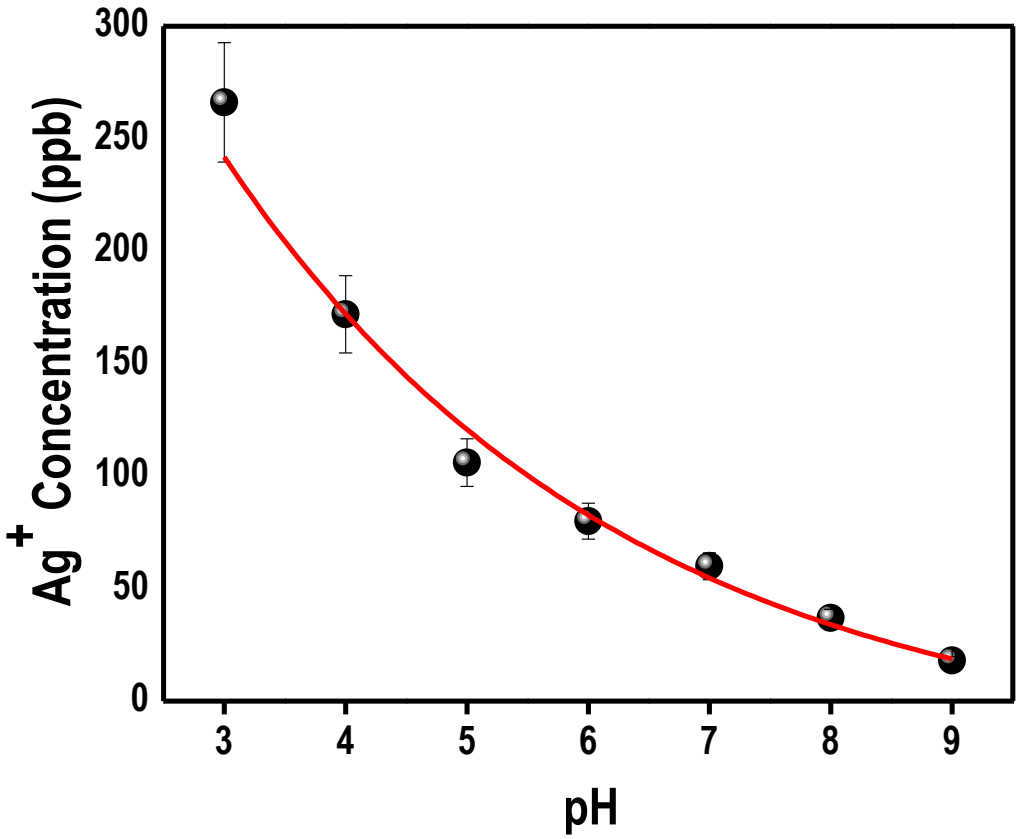

Figure S6: pH dependent study showing enhanced silver concentration of silver in acidic condition in DI water when heated for 1 h at 70^{o}C. Acidic pH was maintained using acetic acid and basic pH was maintained using sodium bicarbonate. To correlate our data to real cooking, we have done rest of our experiments at neutral pH. The error bar represents the variation of nine data points.

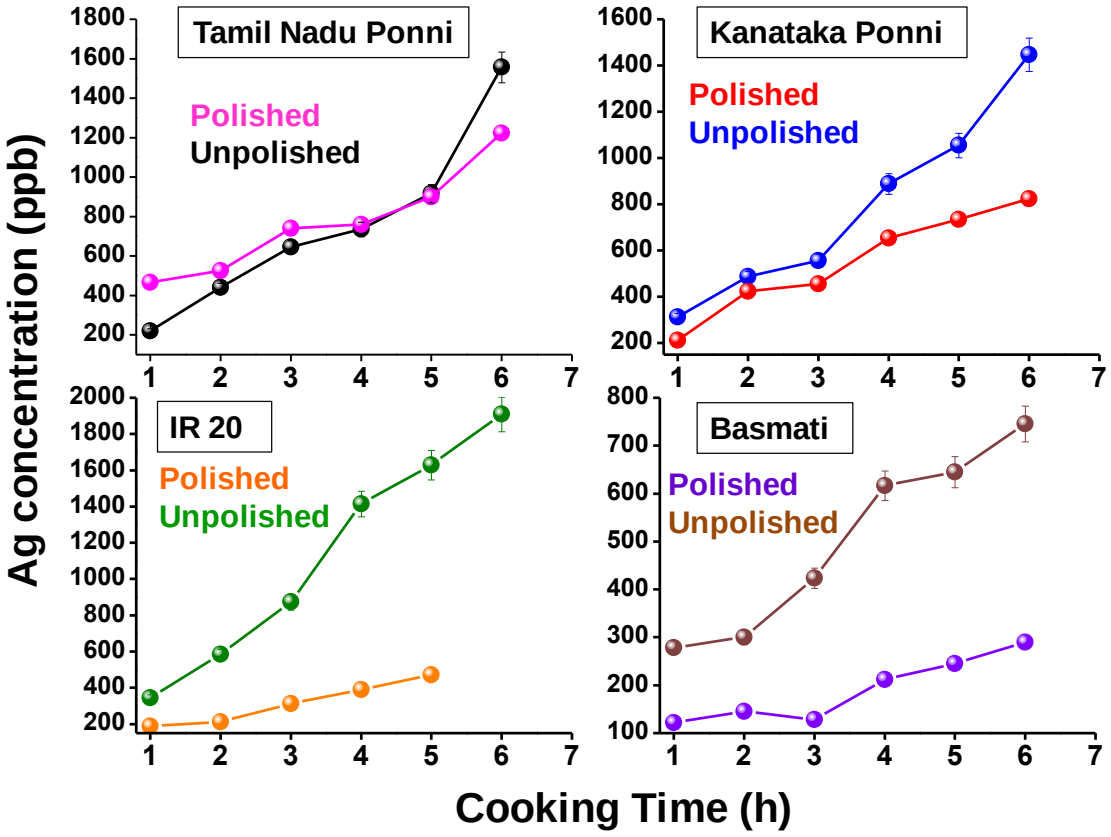

Figure S7: Comparison among several polished and unpolished rice varieties showing that the latter have better silver uptake capacity. Conditions of cooking were the same. Error bar shows the variation of 9 data points.

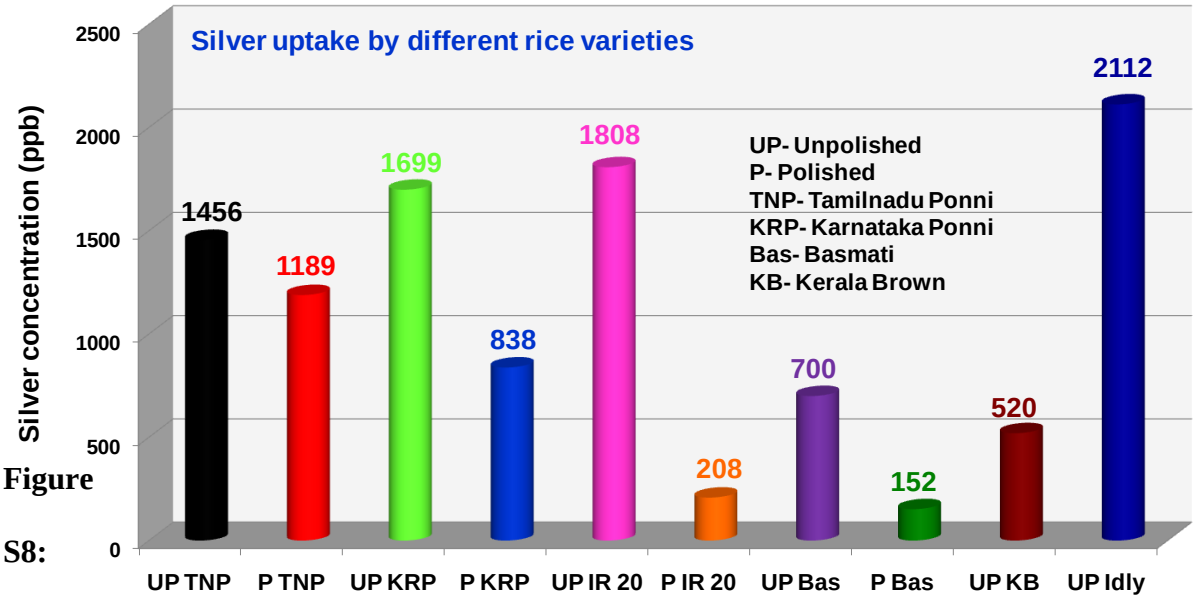

Figure S8: Comparison of silver uptake capacity of different rice varieties. All the other experimental conditions were kept the same. In all cases 2g of rice was cooked in 20 mL of DI water at 80^{o}C for 6 h and then digested and silver concentration was analyzed by ICP MS.

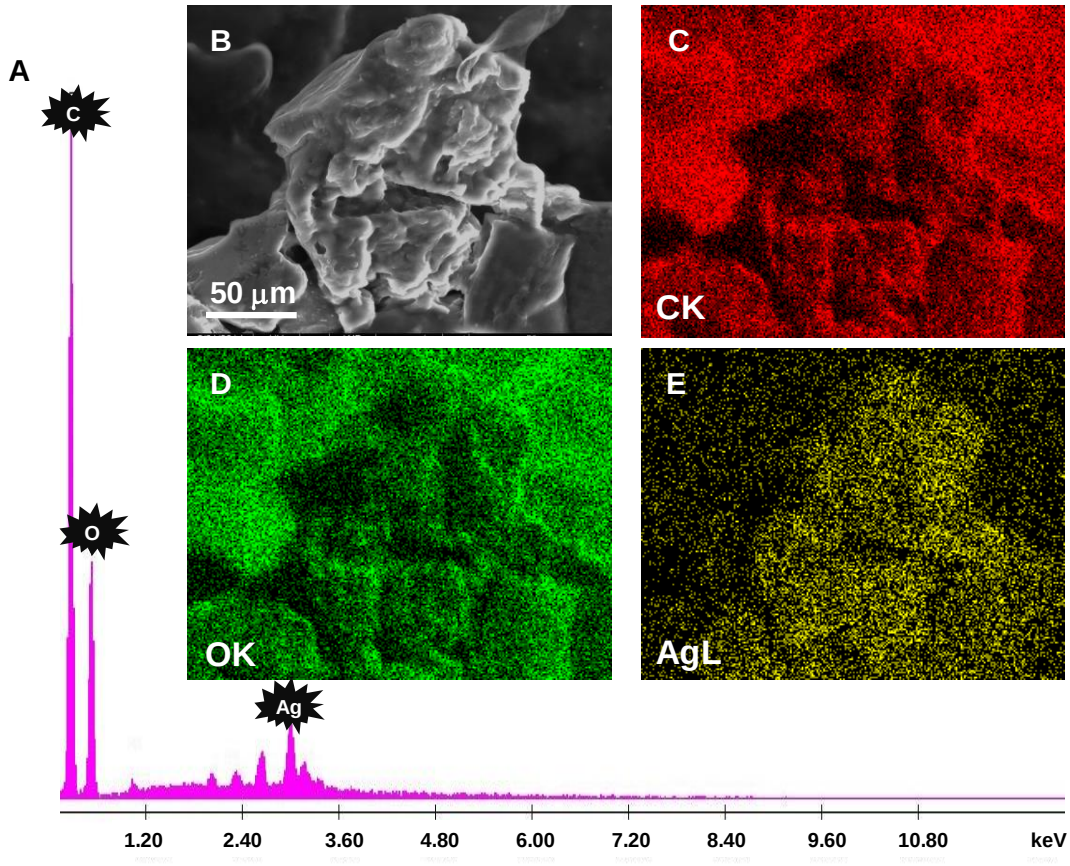

Figure S9: A) SEM/EDS of the silver adsorbed rice showing the uptake of silver. B) The SEM image shows the horizontal cut of the rice section for which elemental mapping was taken. C-E) elemental maps of carbon, oxygen and silver.

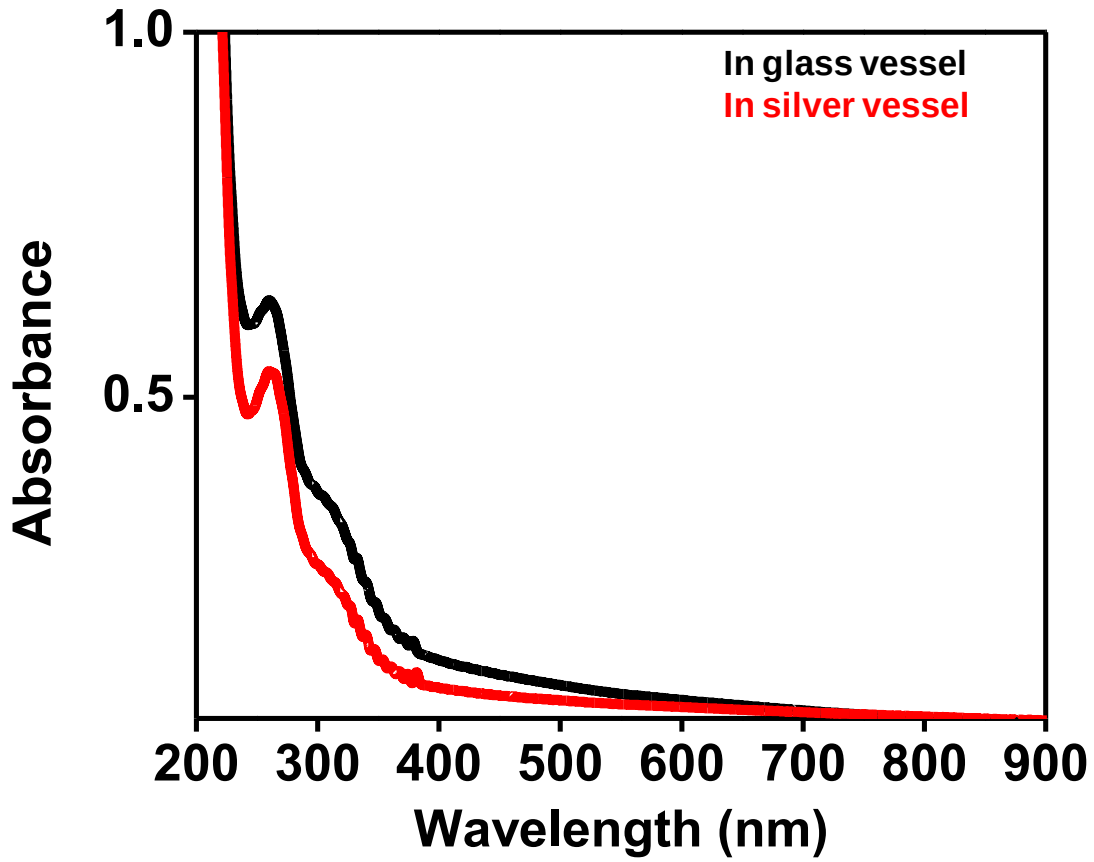

Figure S10: UV-Vis absorption spectra of supernatant solution from rice cooked in glass and silver vessel is showing similar kind of absorption feature. Absence of plasmonic feature confirms that silver nanoparticles are not formed upon interaction of starch and silver.

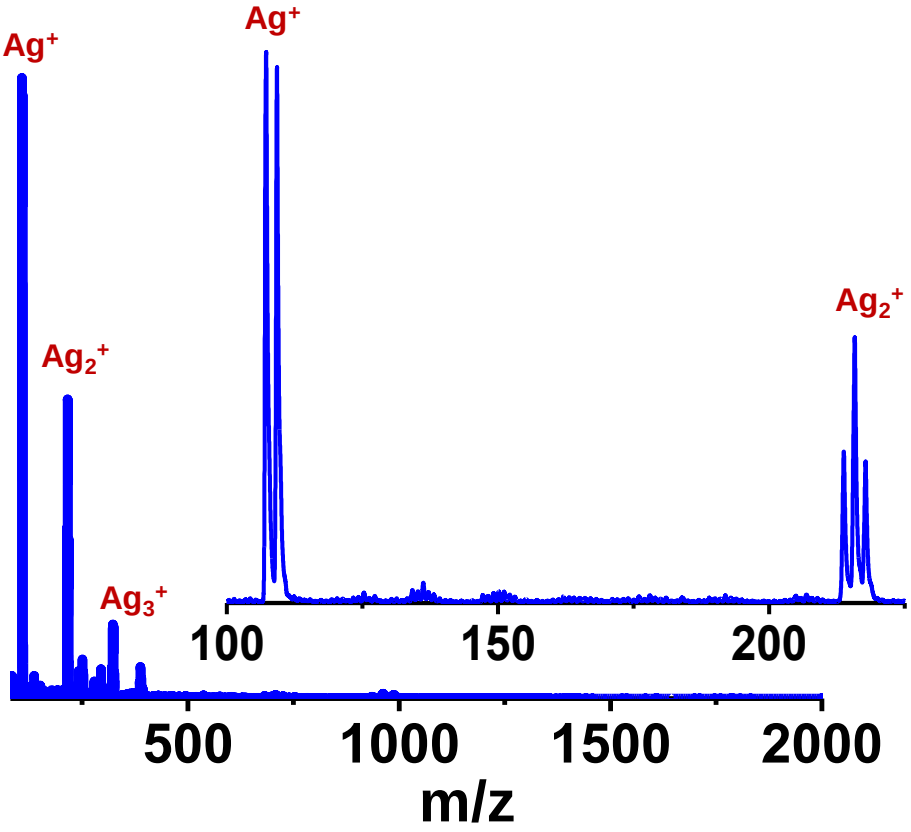

Figure S11: LDI MS of silver saturated rice (dry) in linear positive mode showing the formation of small silver clusters due to laser ablation on silver containing rice. This type of cluster formation is common with silver ion containing samples.

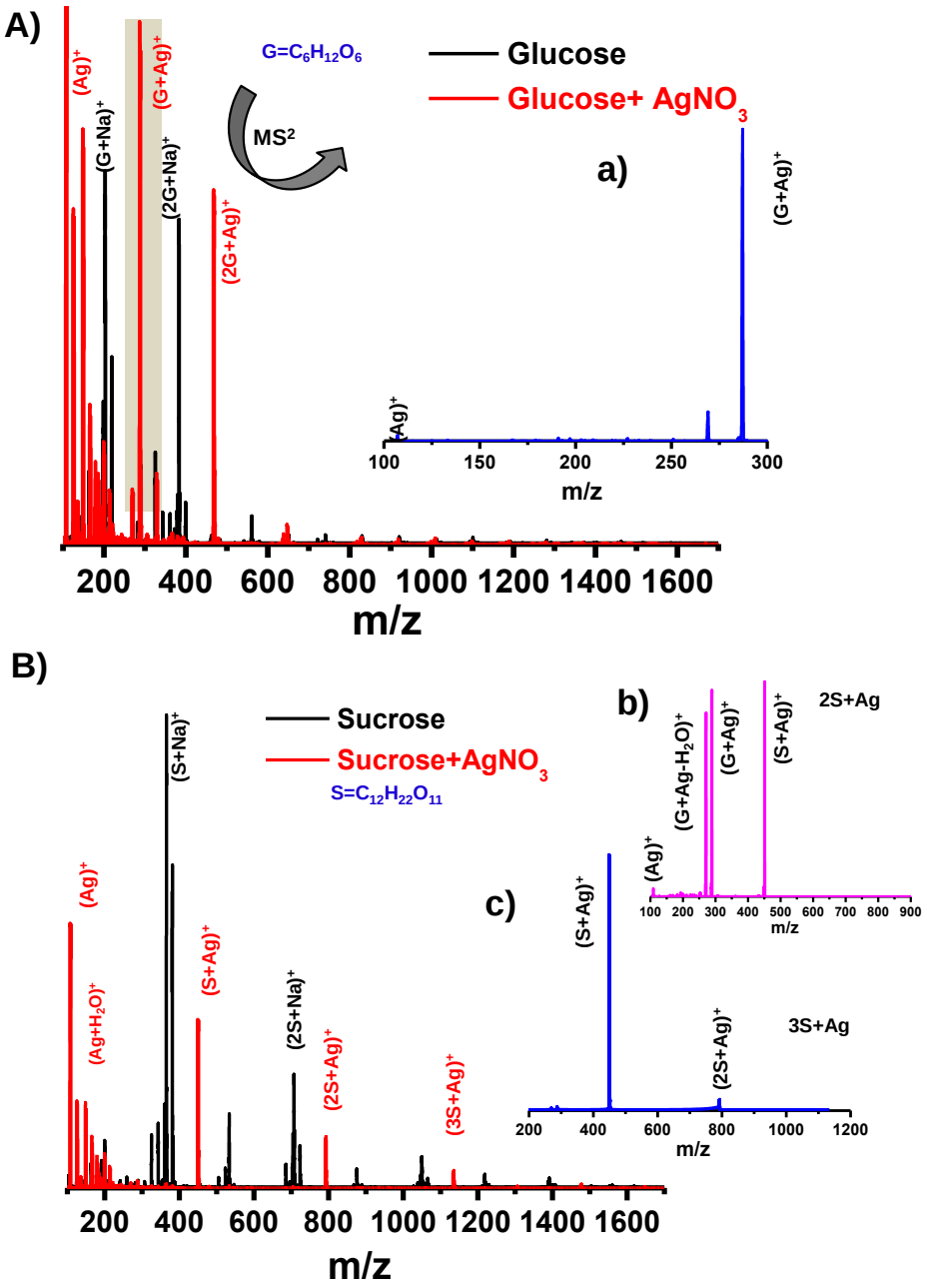

Figure S12: A) Comparative ESI MS of glucose and Ag-glucose complex in positive ion mode showing complexation of silver with glucose. ESI MS/MS of Ag-Glucose complex is shown in the inset a), where one glucose loss was observed to give free Ag^+ ion. B) Similar complexation behavior was observed for sucrose also. ESI MS/MS of dimer and trimer (shown in inset b) and c) are showing similar fragmentation patterns.

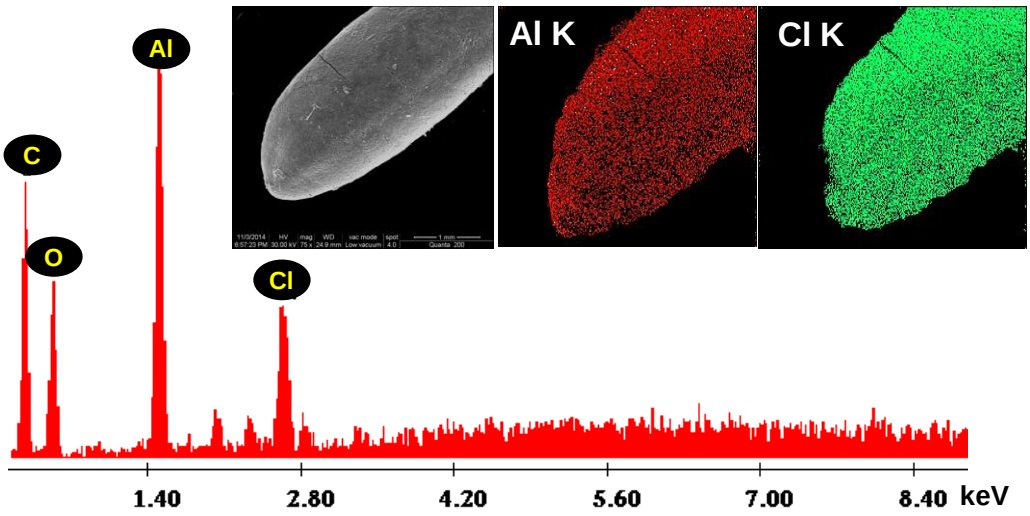

Figure S13: SEM/EDS of dried rice soaked in 1000 ppm aluminium containing solution and the corresponding elemental mapping showing uniform distribution of aluminium throughout the rice.