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THE FIRST REPORT ON THE MICROSCOPIC EXAMINATION OF THE BRIGGS RAUSCHER REACTION AND ITS MODIFICATION WITH TARTRAZINE

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ABSTRACT

This work aims to microscopically examine the solid residues obtained after evaporation of the Briggs-Rauscher (BR) reaction mixture, as well as the effect of tartrazine addition. Individual BR components, the complete BR mixture, pure tartrazine, and the BR system containing tartrazine were evaporated and analyzed by optical microscopy and SEM. Distinct morphological differences were observed, particularly after tartrazine addition.

INTRODUCTION

Tartrazine is an organic dye widely used as a colorant in the food, pharmaceutical, and related industries [1,2]. The BR reaction is a well-known oscillating chemical system [3]. However, microscopic characterization of solid residues obtained after evaporation of the BR reaction mixture has received little attention. Therefore, optical microscopy and SEM were applied to compare the morphology of BR residues in the absence and presence of tartrazine.

EXPERIMENTAL

For morphological characterization, the individual components of the BR reaction, the complete BR reaction mixture, pure tartrazine, and the BR reaction containing tartrazine were prepared in separate Petri dishes. The BR mixture consisted of 0.7 mL malonic acid (0.282 mol dm^{-3}), 0.5 mL $MnSO_4$

(0.0376 mol dm^{-3}), 0.5 mL $HClO_4$ (0.15 mol dm^{-3}), 0.5 mL KIO_3 (0.376 mol dm^{-3}), and 0.3 mL H_2O_2 (9.8 mol dm^{-3}). The tartrazine-containing system was prepared by adding 0.001 g of tartrazine to the complete BR mixture, while pure tartrazine was prepared by dissolving 0.001 g in 1 mL of distilled water. All samples were allowed to evaporate under ambient conditions (approximately 25 °C, atmospheric pressure) for 48 h, yielding solid residues suitable for microscopic analysis.

Optical microscopy was performed using a Geefantech transmission microscope at magnifications of 160×, 400×, and 1600×. Representative micrographs were selected after examining multiple regions of each sample to ensure that the observed features reflected the characteristic morphology.

Scanning electron microscopy (SEM) was carried out using a JEOL JSM-6460LV microscope (JEOL Ltd., Tokyo, Japan). Prior to imaging, the samples were mounted on aluminum stubs using conductive adhesive tape and sputter-coated with gold (BAL-TEC SCD 005, Balzers, Liechtenstein) to minimize charging effects. Particle sizes were determined using SemAfore 5.21 software.

RESULTS AND DISCUSSION

The evaporated samples were subjected to microscopic analysis, under magnifications ranging from 160 to 400 and up to 1600×. To the best of our knowledge, optical microscopic characterization of the evaporated BR system is reported here for the first time.

Figure 1 a) shows optical microscopy characterization of evaporated samples for each BR system component, of the complete BR system, of tartrazine itself, and of BR with tartrazine. Potassium iodate shows hexagonal particles, malonic acid exhibits a chain-like morphology, while the H_2O_2 sample shows a spider-web-like appearance. BR reaction, when evaporated, shows agglomerated particles containing partly defined hexagonal granules and a chain morphology with snowflake features (Figure 1 a). Under the optical microscope, tartrazine itself possesses granules full of small needles, while the mixture of tartrazine and BR reaction shows hexagonal granules that become more agglomerated compared to the BR ones.

To have better insight into the morphology of the same samples, they underwent SEM analysis (Figure 1b).

The fractured plate morphology with well-defined plate edges ranging from 4 to 12 μm was observed for KIO_3, while a gravelly morphology was observed for $HClO_4$, ranging from 0.7 to 4 μm. Large, broken particles were observed for malonic acid, while irregular particles of 2–7 μm were present in the $MnSO_4$ sample. BR has a gravelly morphology with particles ranging from 0.9 to 6 μm, showing a similar morphology to the mixture morphologies of $HClO_4$ and $MnSO_4$.

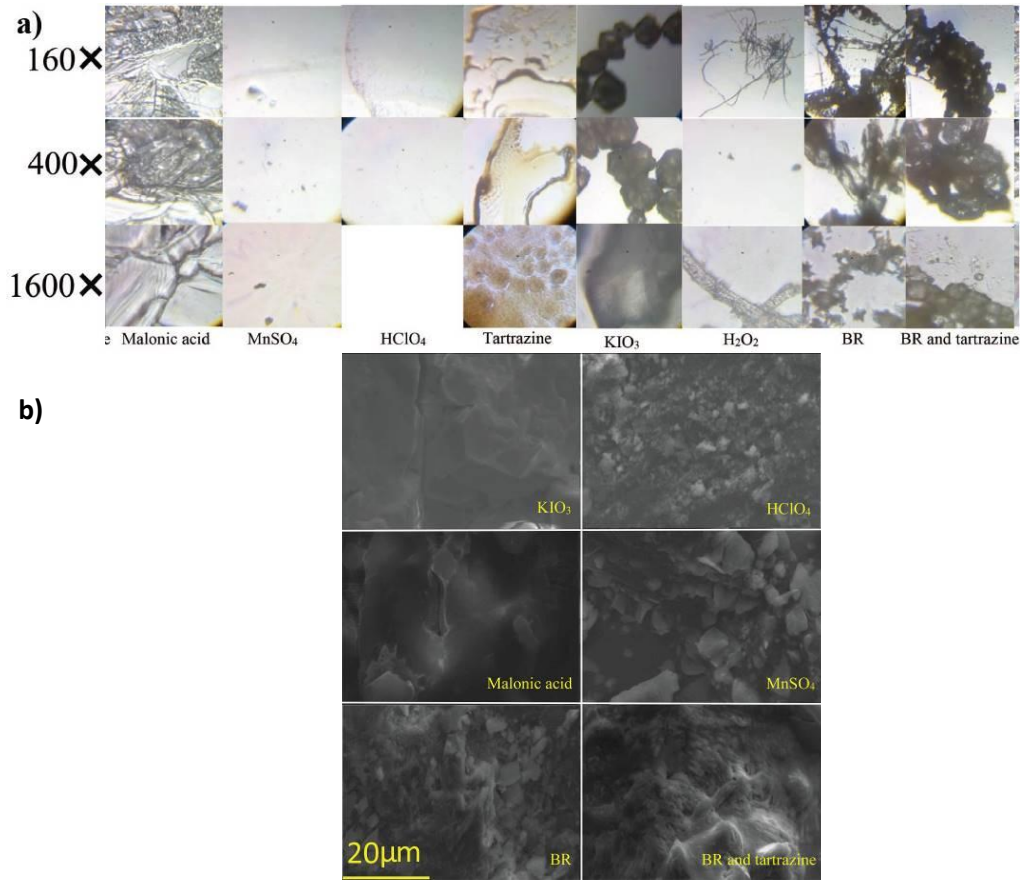


Figure 1. A) optical microscopy characterization of evaporated samples for each BR system component (as marked), of the complete BR system, of tartrazine itself and of BR with tartrazine under the magnifications of 160 to 400 and to 1600×; **B)** SEM characterization of the same samples, as marked in each figure.

After the addition of tartrazine to the BR system, the BR morphology has changed into a microporous form, possessing particles 0.3 to 1.3 micrometer-sized and 1.4–1.9 µm pores. This change in morphology indicates that the presence of tartrazine affects the formation and organization of the solid residue obtained from the BR system (Figure 1b).

CONCLUSION

This work presents microscopic characterization of solid residues obtained from the BR reaction system. Optical microscopy and SEM revealed clear morphological differences after tartrazine addition, including changes in particle size and structure. These results indicate that tartrazine affects the morphology and organization of the solid residue formed after evaporation of the BR reaction mixture.

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