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The Effect of Short-Term Exposure to Bisphenol-A and Its Analogue, Bisphenol-S on Growth, Survival and Sex Differentiation of Developing Zebrafish (*Danio rerio*)

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Abstract

Bisphenol A (BPA) is a commonly used industrial chemical that poses a significant threat to aquatic ecosystems due to environmental leaching. BPA is categorized as a xenoestrogen, which causes adverse impacts on the growth, development, and physiology of organisms. In response to increasing health concerns about BPA, Bisphenol S (BPS) was introduced as a safer alternative. However, the endocrine disruptive ability and environmental occurrence of BPS have raised concerns about its safety. Therefore, a comparative assessment on the biological effects of BPA and BPS is crucial in evaluating the relative safety of BPS. Hence this study was conducted to investigate the comparative effects of short-term exposure to BPA and BPS on the growth, survival, and sex differentiation of juvenile zebrafish (*Danio rerio*). Here, zebrafish of age 21 days post fertilization (dpf) were exposed to environmentally relevant higher concentrations of BPA (100 µg/L), BPS (100 µg/L) and treatment control (5% v/v ethanol) for 21 days, in triplicates. The length gain, weight gain, specific growth rate (SGR), survival rate and sex differentiation were determined at the end of the treatment. According to the results, the length gain, weight gain and SGR of fish under both BPA and BPS treatments were significantly higher than that of the treatment control. Of the bisphenols, BPA-treated fish showed a significantly higher weight gain and SGR than that of BPS treatment ($p < 0.05$), while no notable difference in length increment was observed between BPA and BPS treatments. Considerably lower fish survival rates were shown under both bisphenol treatments than in the treatment control ($p < 0.05$), while no significant difference in fish survival was observed between BPA and BPS ($p > 0.05$). The sex ratio (male: female) of the treatment control was 1:1.14 while, statistically insignificant, yet female-biased sex ratios of 1:2.07 and 1:2.33 were observed for BPA and BPS respectively ($p > 0.05$). In conclusion, both BPA and its analogue BPS have exerted negative effects on the growth and survival of juvenile zebrafish upon environmental exposure. Further both bisphenols and to a higher extent BPA showed increased weight gain, and SGR in zebrafish. Based on the observations, BPS cannot be recommended as a safe alternative to BPA, as both bisphenols significantly affect the growth, survival and to a lesser extent the sex differentiation of zebrafish in a comparable manner. Further cellular and physiological assessments are recommended in the zebrafish model to evaluate the relative safety of BPA substitutes.

Keywords: BPA, BPS, Growth, Survival rate, Sex ratio