

## **Independent and Combined Effects of Probiotics and Prebiotics as Supplements or Food-rich Diets on Propionic Acid-induced Rodent Model of Autism Spectrum Disorders**

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### **Abstract**

The link between nutrition and autism spectrum disorder (ASD) as a neurodevelopmental condition, which is clinically presented as significant delays or deviations in interaction and communication, has provided a fresh point of view and signals that nutrition may play a role in the etiology of ASD, as well as playing an effective role in treatment by improving symptoms. In this study, 36 male albino rat pups were used. They were randomly divided into five groups. The control group was fed only a standard diet and water for the 30 days of the experiment. The second group, which served as a propionic acid (PPA)-induced rodent model of ASD, received orally administered PPA (250 mg/kg body weight (BW)) for 3 days, followed by feeding with a standard diet until the end of the experiment. The three other groups were given PPA (250 mg/kg body weight (BW)) for 3 days and then fed a standard diet and orally administered yogurt (3 mL/kg BW/day), artichokes (400 mL/kg BW/day), and a combination of Lacticaseibacillus rhamnosus GG at 0.2 mL daily ( $1 \times 10^9$  CFU; as the probiotic of yogurt) and luteolin (50 mg/kg BW/day; as the major antioxidant an anti-inflammatory ingredient of artichokes) for 27 days. Biochemical markers, including gamma-aminobutyric acid (GABA), reduced glutathione (GSH), glutathione peroxidase (GPx1), tumor necrosis factor-alpha (TNF- $\alpha$ ), interleukin-6 (IL-6), and interleukin-10 (IL-10), were measured in brain homogenates in all groups. The data showed that while PPA demonstrated oxidative stress and neuroinflammation in the treated rats, yogurt, Lacticaseibacillus rhamnosus GG as a probiotic, and luteolin as a prebiotic ingredient in artichokes were effective in alleviating the biochemical features of ASD. In conclusion, nutritional supplementation seems to be a promising intervention strategy for ASD. A combined dietary approach using pro- and prebiotics resulted in significant amelioration of most of the measured variables, suggesting that multiple interventions might be more relevant for the improvement of biochemical autistic features, as well as psychological traits. Prospective controlled trials are needed before recommendations can be made regarding the ideal ASD diet.