

---

Symposium SA-1  
Saturday, July 29, 2006

## Dietary influences on anxiety and aggression

**Heather B. Patisaul, Ph.D.**  
**CIIT: Centers for Health Research**



High Isoflavone Soy Protein is Associated with Increased Aggression and Reduced Affiliation among Adult Male but not Female Cynomolgus Monkeys (*Macaca fascicularis*) initially Naïve to a Soy-Containing Diet.

Jay R. Kaplan<sup>1</sup>, Michael R. Adams<sup>1</sup>, Neal G. Simon<sup>2</sup>. Comparative Medicine, Wake Forest University School of Medicine, Winston-Salem, NC 27157-1040<sup>1</sup>; Department of Biological Sciences, Lehigh University, Bethlehem PA 18015<sup>2</sup>.

Isoflavones found in soybeans and soy-based dietary supplements bind to estrogen receptors and have dose and tissue-dependent effects on estrogen-mediated responses. Yet, the effects of isoflavone-rich diets on social behavior have not been evaluated systematically in nonhuman primates. We studied the effects of long-term (15 months) consumption of diets rich in soy isoflavones on spontaneous social behavior among adult male cynomolgus macaques (*Macaca fascicularis*) (n=44) living in nine stable social groups. There were three experimental conditions that differed only by the source of dietary protein: casein and lactalbumin (no isoflavones), soy protein isolate containing 0.94 mg isoflavones/g protein, and soy protein isolate containing 1.88 mg isoflavones/g protein. In the monkeys fed the higher amount of isoflavones, frequencies of severe aggressive (67% higher) and submissive behavior (203% higher) and mild submissive behavior (142% higher) were elevated relative to monkeys fed the control diet. In addition, the proportion of time spent by these monkeys in affiliative physical contact with other monkeys was reduced by 68%, time spent in proximity to other monkeys was reduced 50%, and time spent alone was increased 30%. There were no effects of treatment on serum testosterone or estradiol concentrations or the response of plasma testosterone to exogenous gonadotropin-releasing hormone. The frequency and pattern of social behavior also were examined in similarly housed, premenopausal females consuming for 24 months diets that derived all protein either from casein and lactalbumin or soy protein isolate containing 1.88 mg isoflavones/g protein. Unlike the males, the females exhibited no soy-related differences in either pattern or frequency of social behavior. Nor did soy affect any indices of menstrual cyclicity or ovarian hormone profile. The results indicate that long-term consumption of a diet rich in soy isoflavones can influence social behavior, but that such effects are not expressed equivalently in adult males and females.