

# Compounds from soy affect brain and reproductive development

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Two hormone-like compounds linked to the consumption of soy-based foods can cause irreversible changes in the structure of the brain, resulting in early-onset puberty and symptoms of advanced menopause in research animals, according to a new study by researchers at North Carolina State University. The study is a breakthrough in determining how these compounds can cause reproductive health problems, as well as in providing a key building block for how to treat these problems.

The study is the first to show that the actual physical organization of a region of the brain that is important for female reproduction can be significantly altered by exposure to phytoestrogens – or plant-produced chemicals that mimic hormones – during development. Specifically, the study finds that the compounds alter the sex-specific organization of the hypothalamus – a brain region that is essential to the regulation of puberty and ovulation. The study also shows that the phytoestrogens could cause long-term effects on the female reproductive system.

While the study examined the impact of these compounds on laboratory rats, neurotoxicologist Dr. Heather Patisaul – who co-authored the study – says the affected "circuitry" of the brain is similar in both rats and humans. Patisaul is an assistant professor in NC State's Department of Zoology. Her co-author is Heather Bateman, a doctoral student in the department.

Patisaul says this finding is extremely important because, while the changes in brain structure cannot be reversed, "if you understand what is

broken, you may be able to treat it." Patisaul says she is in the process of evaluating the effects of these compounds on the ovaries themselves.

Patisaul says that this study is also "a step towards ascertaining the effects of phytoestrogens on developing fetuses and newborns." Patisaul adds that these phytoestrogenic compounds cross the placental barrier in humans and that, while many people are concerned about the effects of man-made compounds on human health, it is important to note that some naturally occurring substances can have similar effects.

In the study, which will be published in an upcoming issue of *Neurotoxicology*, the researchers exposed newborn rats to physiologically relevant doses of the phytoestrogens genistein and equol, and then looked at reproductive health markers in the rats throughout their adulthood. The neonatal stage of development in rats is comparable to the latter stages of pregnancy for humans, Patisaul says. Genistein is a phytoestrogen that is found in various plants, including soybeans and soy-based foods. Equol is a hormone-like compound that is formed when bacteria found in the digestive system metabolize another phytoestrogen. However, only approximately a third of humans have the necessary bacteria to produce equol.

The study shows that both genistein and equol result in the early disruption of the rats' estrus cycle – which would be corollary to early onset of menopause in a human. The study also showed that genistein caused the early onset of puberty. The disruption of the estrus cycle could stem from problems with the brain or the ovaries, so the researchers decided to determine if the compounds had any effect on brain development or function.

Patisaul explains that the brains of both female rats and female humans have a region that regulates ovulation. "That part of the brain," Patisaul says, "is organized by hormones during development – which is the

neonatal stage for rats and during gestation for humans." Patisaul says the new study shows that the female brain is "critically sensitive" to genistein and equol during this crucial stage of development – and that this may indicate that the brain is also especially sensitive during this period to all phytoestrogens and possibly other man-made chemicals, such as bisphenol-A.

Source: North Carolina State University

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