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Advances in Clinical Toxicology

Reproductive Toxicity of Soy and Soy-Based Products

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Abstract

Soybean is a nutrient commonly consumed by Asians, brought to Turkey from the Far East and cultivated. Many processed products containing soybean as the raw material are available as human and animal food. Soy and soy-based products occupy an important place in daily basic nutrition and food supplements. Since it contains many food elements important for human and animal health, soy has become the main source of nutrition in necessary situations. Due to its significant vitamin, mineral and protein content, its consumption in America has raised rapidly.The aims of this review are to explain reproductive toxicity of soy and soy-based products.

Keywords: Toxicology; Reproductive; Soybean; Isoflovan

Introduction

Soybean is known as a cheap source of high quality protein and amino acids. Soybean is traditionally consumed, found in northern and central China, east Russia, Korea, Taiwan and Japan. It contains large amounts of phytoestrogens such as soy isoflavones and consumed as soy flour, soy milk and soy oil and many other forms [1,2]. In recent years, millions of babies have been routinely fed soy-based food without any adverse effects [3]. Food containing development and growth-promoting oils, vitamins, minerals, aminoacids and the soy protein isolate are used in the first year following birth in 20-25% of babies born in the United States [4,5]. However, the American Academy of Paediatrics (AAP) [4] and the European Society for Pediatric Gastroenterology Hepatology and Nutrition (ESPGHAN) Committee do not advise feeding with soy-based food as a substitute for breast milk [6]. The most recent studies have revealed that, for a growing number of worldwide babies with lactose intolerance brought on by breast milk or milk of animal origin causing lactase deficiency, the main source of nutrition is soy milk.

Effects of Soy and Isoflavones in Females and Males

Infancy is a sensitive phase regarding impairment of the endocrine system. Prolonged exposure to phytoestrogens during this critical developmental stage may cause adverse effects on reproductive ability.

The total isoflavone amount in babies fed a daily average of 6-9 mg/kg soy causes much higher plasma isoflavone concentrations than in babies fed cow's milk [7-9]. Circulating phytoestrogen concentration in babies fed soy is 13,000-22,000 times more than endogenous oestrogen levels in pregnant women, and 50-100 times more than oestradiol levels [7,10,11]. However, there are very few clinical and epidemiological studies investigating the effects of long-term feeding with food containing either soy or isoflavones on reproduction and fertility. In a study by Zung, et al. [12] when compared to babies fed cow's

milk-based compounds, the frequency of breast buds being observed up to the age of 2 years was higher in babies fed soy-based compounds. Bernbaum, et al. [13] reported that, in comparison to babies fed cow's milk, babies fed soy-based compounds had more oestrogenised vaginal epithelium. These data show that soy-based compounds may prolong physiological oestrogenisation in newborns [14]. In an extensive study carried out on 19,972 women, D'Aloisio, et al. [15] demonstrated that the development risk of benign straight muscle tumours of the uterus (uterine leiomyomata or fibroids) was related to feeding with soy-based formulae in infancy. Ingestion of phytoestrogens may cause low sperm concentration, decreased sperm quality, reduced sperm motility and, as a result, decreased libido [16] and infertility [17,18]. Hess [18], Glover & Assinder [19] reported that defects in the reproductive ability of male mammals were related to disorders in spermatogenesis. It has been reported that, spermatogenesis disorders resulting in infertility are caused by reproductive toxicity [20]. In one study, Sharpe, et al. [21] compared the long-term male reproductive function up to 6-weeks of age in marmosets fed cow's milk and a soy-based formula. In marmosets given soy food, despite a lower testosterone level, sertoli and Leydig cell count increase and adult testicle weight, no negative results of fecundity rates in the adolescent period were observed.

Owing to the biologically active components called isoflavones, their disease preventing effects, particularly in cancer, have been demonstrated through epidemiological and clinical researches. As well as being effective in the prevention of osteoporosis, hypercholesterolaemia and many hormone-influenced cancer types, soy isoflavones also play an important role in preventing oxidative stress due to their antioxidant efficacy. Genistein found in isoflavones stands out with its high antioxidant property. As well as the genistein in soy displaying the highest oestrogenic effect among phytoestrogens, its oestrogenic/antioestrogenic feature stems from its easily binding character to α and β oestrogen receptors due to the fundamental structural similarity to endogenous oestrogens [22,23]. It may show pure agonist, pure antagonist or selective agonist/antagonist effect as a ligand between α and β receptors. It has also been discovered that genistein shows oestrogenic/antioestrogenic effect by suppressing the 17-β-oestradiol oxidoreductase enzyme responsible for the conversion of oestrone to oestradiol. Despite widespread use of genistein for the purpose of preventing various diseases and cancer, it has been stated that no information on its safe usage is available and it has adverse effects such as a decrease in the size of the testicles, epididymis and prostate. From the point of food safety, while neither antibiotics nor oestrogen type hormones promoting rapid weight gain in animals are allowed in the production of organic animal products, current data is contradictory for soy, which contains genistein with oestrogenic effect [24].

Conclusion

Since soy and soy-based products are consumed both as human and animal food, the active components in its composition have particular significance for environmental health. Today, soy and soy products are widely used due to their positive effects on health. However, the potential adverse effects from consuming high doses of phytoestrogens in its structure are a cause for concern. In particular, genistein in soy being among endocrine disrupting chemicals (EDC) and the effects of phytoestrogens on health are still in the investigation stage. Due to both its structural features and the contradictions in researches, clear and reliable results regarding food safety have not been achieved.

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