

## **Effect of Korean Fermented Soybean Food Diets on Gastrointestinal Function and Immune Activities in Experimental Animals**

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### **Summary**

We investigated the effects of Korean traditional fermented soybean foods (chungkookjang, viscous substance and doenjang) on immunohistochemical reaction in gastrointestinal (GI) tract and immune response in experimental animals. The immunohistochemical densities of immunocompetent cells (CD4 and CD8), enteroendocrine cells (gastrin and serotonin), universal nitric oxide synthase (uNOS), PKC- $\alpha$  and c-kit in GI tract were observed by immunohistochemical staining. Immune responses were observed by changes of subpopulations in splenocytes and thymocytes in vivo, and production ability of IFN- $\gamma$  and IL-4 in mouse serum in vivo and MTT assay in vitro.

After chungkookjang diet fed, we found that CD4 immunoreactive cells were mildly stained in perivascular and intravascular areas of gastric submucosa, and strongly stained in the lamina propria of mucosa and submucosa within both duodenum and jejunum in chungkookjang diet fed group. The feeding of dietary chungkookjang mucilage(viscous substance) caused to increase the immunohistochemical densities of CD4 and CD8 lymphocytes in mucosa and submucosa of gastroduodenal region. Immunohistochemical densities of CD8 lymphocytes were strong in colonic mucosa of chungkookjang diet fed group, while strong in colonic submucosa of experimental groups. Immunoreactive densities of gastrin and serotonin were strongly stained in pyloric part of stomach and duodenal villi in experimental groups.

The number of gastrin and serotonin immunoreactive cells was more significantly increased in experimental groups than control group. The uNOS immunoreactive neurons and nerve fibers were strongly stained in vascular walls of submucosa and myenteric plexus in experimental groups.

After doenjang diet fed, we found that CD4 and CD8 immunoreactive cells were strongly stained in lamina propria of villi and bottom of the crypts in jejunum, and muosa, submucosa and intravascular area of adventitia in colon of 5% doenjang diet fed group. The universal nitric oxide synthase (uNOS) immunoreactive neurons and nerve fibers were mildly stained in submucosa and myenteric plexus and adventitia in jejunum and strongly stained in myenteric plexus in colon of all doenjang diets fed groups. The colonic immunoreactive density of protein kinase C- $\alpha$  was strongly stained in mucosal epithelium and muscle layer of 2.5 and 5 % doenjang diets fed groups, while that of c-kit (stem cell factor) was strongly

stained in mucosal epithelium in of all doenjang diets fed groups and strongly stained in muscle layers of 5% doenjang diet fed group.

The immune activities of thymic Th lymphocytes were significantly increased in 15% chungkookjang diet fed group. After viscous substance (1%, 3%, 6%) diets fed for 3 weeks, The immune activities of splenic B/T lymphocytes and Th/Tc lymphocytes were increased in 6% viscous substance diet fed group. The immune activity of thymic Th lymphocytes was increased in 3% and 6% viscous substance diet fed group. The viscous substance powder (1 - 100  $\mu$  g/ml) treatment was significantly suppressed proliferation of cultured Molt4 leukemia cells in 1-10 $\mu$ g/ml and cultured S180 sarcoma cells in dose dependent manner in vitro. The immune activity of thymic Th lymphocytes was increased in all concentrations of viscous substance administration group(p.o.). The production of IL-4 in blood serum was significantly increased in all concentrations of viscous substance powder after administration of p.o. for 3 weeks. The immune activities of thymic Th and Tc lymphocytes were increased in 2.5% doenjang diet fed group. The production of IFN- $\gamma$  in blood serum was significantly increased in all doenjang diet fed groups. The doenjang powder (1 - 100  $\mu$  g/ml) treatment suppressed proliferation of cultured Molt4 leukemia cells in 10 $\mu$ g/ml in vitro, especially 10  $\mu$  g/ml treatment was significantly decreased.

These morphological and immunological results indicated that intake of Korean fermented soybean foods(chungkookjang, doenjang) could be increase mucosal immune activity, gastrointestinal motility, blood circulation in GI tract and immune activity of body. These results provide experimental evidence of Korean fermented foods on health benefits.