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Effect of legumes on bone mineral density and bone biomarkers in the osteoporotic rat model

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골다공증 흰쥐 모델에서 두류의 섭취가 골밀도와 골지표에 미치는 영향

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Objectives: The anti-osteoporotic effects of soybeans have been suggested, but the effect of other legumes frequently consumed in Asia needs to be studied. This study was examined the effect of taking soybean, mung bean, cowpea, or adzuki bean on bone mineral density (BMD) and bone biomarkers in ovariectomized (OVX) rats.

Materials and Methods: Ten weeks old female Sprague-Dawley rats were either sham-operated (Sham, n=9) or surgically ovariectomized. After recovery from the surgery, the rats were fed a AIN-93M diet (OVX, n=9) or AIN-93M containing soybean (OVX-S, n=9), mung bean (OVX-M, n=9), cowpea (OVX-C, n=9), or adzuki beans (OVX-A, n=9) for 12 weeks. BMDs of the right femur, tibia and lumbar spine were measured at the end of the dietary experiment using dual-energy X-ray absorptiometry (DEXA). The concentrations of serum or urinary calcium, phosphate, alkaline phosphatase (ALP), osteocalcin, and deoxypridinoline (DPD) were measured. The total amounts of tumor necrosis factor alpha (TNF-α), interleukin-6 (IL-6), interleukin-1β (IL-1β), osteoprotegerin (OPG), and receptor activator of nuclear factor κB ligand (RANKL) protein from tibia and femur of the rats were assessed by western blot analysis.

Results: The OVX and all bean groups had a significantly higher final body weight, and subcutaneous fat weight, had a significantly lower uterus weight than in the Sham group, but not significantly different among the OVX and all bean groups Serum calcium was significantly lower in the OVX and all bean groups compared to the Sham group. Serum phosphorus in the OVX-M group was significantly lower than in the Sham group. Serum ALP in the OVX group was significantly higher than Sham, OVX-S, and OVX-M groups. Serum osteocalcin was significantly higher in the OVX-S, OVX-M, and OVX-A groups than in the Sham and OVX groups. Urinary calcium was no significant differences between the Sham group and OVX group, but the OVX group was significantly higher than OVX-A group. Urinary DPD excretion was significantly higher in the OVX group compared to the Sham group and not significantly different among the OVX and all bean groups. The BMD of the femur in

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the OVX group was significantly lower than in the Sham, OVX-S, and OVX-M groups. The Sham and all bean groups had a significantly lower the expressions of TNF-α and IL-6, had a significantly higher the expressions of OPG/RANKL ratio than in the OVX group. However, the expression of IL-1β did not significantly differ among the OVX and all bean groups. The results from this study suggest that soybean and mung bean may have a preventive effect on bone loss in the osteoporotic rat model.

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Table 1. Bone remodeling biomarkers in serum and bone mineral density of the lumbar spine, right femur and tibia [1]

	Sham	OVX	OVX-S	OVX-M	OVX-C	OVX-A
Ca(mg/dl)	14.81 ± 0.27^{a,2}	13.21 ± 0.30^{b}	13.53 ± 0.44^{b}	13.08 ± 0.16^{b}	13.64 ± 0.19^{b}	13.07 ± 0.13^{b}
P(mg/dl)	16.25 ± 0.83^{ab}	15.34 ± 0.71^{abc}	17.37 ± 1.17^{a}	13.28 ± 0.62^{c}	14.45 ± 0.84^{bc}	15.16 ± 0.80^{abc}
ALP(U/l)	16.50 ± 2.84^{a}	25.48 ± 2.10^{b}	15.72 ± 0.98^{a}	17.22 ± 1.67^{a}	21.04 ± 2.39^{ab}	21.13 ± 1.73^{ab}
OC(ng/ml)	159.88 ± 20.88^{a}	165.78 ± 17.01^{a}	223.63 ± 13.77^{bc}	257.26 ± 10.93^{cd}	200.02 ± 21.15^{ab}	288.60 ± 18.39^{d}
BMD(mg/cm^2)						
Spine	280.11 ± 6.23^{a,2}	240.67 ± 4.78^{b}	254.67 ± 4.36^{b}	248.89 ± 4.57^{b}	249.78 ± 3.95^{b}	249.33 ± 4.05^{b}
Femur	331.22 ± 11.98^{a}	294.22 ± 4.55^{b}	328.78 ± 4.56^{a}	321.78 ± 7.32^{a}	316.33 ± 9.03^{ab}	311.22 ± 9.03^{ab}
Tibia	226.00 ± 7.01	212.67 ± 5.71	214.56 ± 4.62	210.89 ± 5.41	221.22 ± 4.33	213.00 ± 7.34

[1]Values are expressed as mean ± SEM, n=9; ALP, alkaline phosphatase; OC, osteocalcin; DPD, deoxypyridinoline
[2]Values with different superscripts within a row are significantly different at $p<0.05$ by ANOVA with Duncan's multiple-range test.

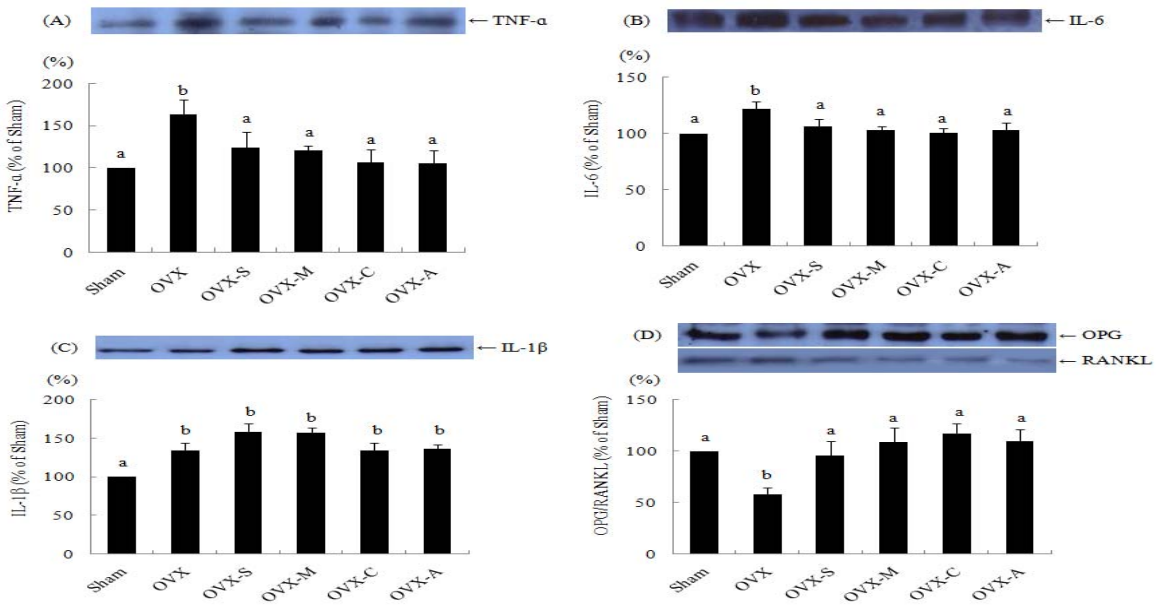

Fig. 1. Tumor necrosis factor-alpha (TNF-α; A), interleukin-6 (IL-6; B), interleukin-1β (IL-1β; C) and osteoprotegerin/receptor activator of nuclear factor κB ligand (OPG/RANKL; D) protein expression at femur and tibia of rats. Densitometric analysis of TNF-α, IL-6, IL-1β and OPG/RANKL ratio, as well as representative Western Blot images for TNF-α, IL-6, IL-1β, OPG and RANKL are shown. Data was expressed relative to the Sham group level, which was set at 100%. Values are expressed as mean ± SEM, n=7. Values with different superscripts are significantly different at $p<0.05$ by ANOVA with Duncan's multiple-range test.