

The Effects of *Auricularia auricula-judae* on Blood Lipids Profile and Bone Density of Middle Aged Abdominal Obese Women

Jung-Soon Han, Jae-Kun Kim* and †Ae-Jung Kim**

Seoul National University of Education Lifelong Education Center, Dokhaksa College in Lifelong Center, 137-742, Korea

*Dept. of Food, Nutrition and Cookery, Keimyung College, Daegu 704-703, Korea

**The Graduate School of Alternative Medicine, Kyonggi University, Seoul 120-702, Korea

목이버섯 섭취가 복부비만 여성의 골밀도 및 혈청지질농도에 미치는 영향

한정순 · 김재근* · †김애정**

서울교육대학교 평생교육원 독학사칼리지 가정학과, *계명문화대학 식품영양조리학과, **경기대학교 대체의학대학원

국문요약

본 연구는 안전하면서 효율적으로 비만을 개선시키는데 도움이 될 수 있는 식품소재로 목이버섯을 선정하여 복부 비만이 있는 중년 여성의 골밀도 및 혈청지질농도에 미치는 영향에 대하여 알아보고자 하였다. 30~50대의 복부비만 여성 30명에게 4주 동안 대조군은 목이버섯을 섭취시키지 않았고, 실험군은 목이버섯을 식사와 함께 섭취하도록 하였다. 실험 전 후 골밀도(T-score, Z-score), 총 콜레스테롤, HDL-콜레스테롤, LDL-콜레스테롤, 중성지방을 측정하였다. 연구결과, 목이버섯 섭취군과 대조군 간에 T-score와 Z-score는 유의한 차이를 보이지 않았지만, 목이버섯 섭취군의 혈청 총 콜레스테롤, LDL-콜레스테롤 및 중성지방 수준이 대조군에 비해 유의하게 감소되었다.

Key words: *Auricularia auricula-judae*, bone density, abdominal obese, blood lipid profile

INTRODUCTION

The epidemic of obesity has grown over the decade and is now a worldwide public health problem. In Korea, as the obesity prevalence among adults greater than BMI (body mass index) 25 was 30.7%, 1/3 adults are considered obese (Ministry of Health, Welfare and Family, Korea Centers for Disease Control and Prevention, 2010). The abdominal obesity prevalence increases with increased age for both males and females, presenting that 25.6% of male subjects older than 19 showed abdominal obesity and 24.9% for female subjects, 28.2% of males older than 30 had abdominal obesity and 28.7% for females, and 31.3% of males older than 65 showed abdominal obesity and 45.0% for females (Ministry of Health, Welfare and Family, Korea Centers

for Disease Control and Prevention, 2009). Therefore, the rates of abdominal obesity have been found to be much higher in females than males. Obesity is a medical condition that excess body fat has accumulated in the body and, especially, abdominal obesity is the most dangerous risk factor causing a various metabolic diseases such as diabetes, hypertension, hyperlipemia, coronary heart disease, cardiac vascular disease and etc. (Grundt et al. 2004). As the different aspects of abdominal obesity were observed between males and females, drinking and smoking were major causes of abdominal obesity for males and abdominal obesity for females was affected by the life cycle including childbirth, menopause, aging and etc. (Wang et al. 2005). Therefore, abdominal obesity for females are related to environmental factors and natural process such as aging and threats the health.

† Corresponding author: Ae-Jung Kim, The Graduate School of Alternative Medicine, Kyonggi University, Seoul 120-702, Korea. Tel: +82-2-390-5044, E-mail: aj5249@naver.com

The importance of abdominal obesity is increasing with regard to disease prevention and health promotion.

For obesity and health management, mushrooms become one of the hottest functional foods. Mushrooms are high in nutrients such as carbohydrate, protein, minerals, vitamins, and dietary fiber, and it is reported that mushrooms prevent chronic metabolic diseases, reducing cholesterol levels and have anticancer effects. (Morenga et al. 2010). And recent research suggests that calcium rich mushrooms help combat bone density loss after weight loss. *Auricularia auricula-judae* is high in Ca and vitamin D in comparison with other mushrooms (Han YB 2009, National Rural Science Institute, 2008). Vitamin D that plays an important role in absorption of calcium and calcium supply minimizes bone loss (Michelle et al. 2010). It is considered that vitamin D promotes to absorb Ca in the intestine, re-absorb Ca in the kidney and suppress the secretion of parathyroid hormone (Han JS 2010). In the studies in other countries (Mauricio et al. 1992), sufficient Ca and vitamin D supplies increase bone density and it is known that vitamin D is a critical factor for bone density. And *Auricularia auricula-judae* protects bone density levels caused by malnutrition and unbalanced nutrition during the diet of abdominal obese women.

For this study, *Auricularia auricula-judae* was selected as a food that is safe for health and reduces obesity effectively. And also the effects of *Auricularia auricula-judae* on the blood lipid profiles and bone density for women with abdominal obesity were examined.

MATERIAL AND METHODS

1. Subjects

30 female volunteers aged between 30's and 50's who had greater than 30% of body fat and 0.85 of abdominal fat were divided into an experimental group (*Auricularia auricula-judae* intake group 20 females) and a control group (C group, 10 females). The experiment was conducted for 4 weeks. A group of participants took on soaking and blanching of 12 g of *Auricularia auricula-judae* a day for 4 weeks and the control group did not take *Auricularia auricula-judae*.

2. Experimental design

The amount of *Auricularia auricula-judae* (12 g) was determined based on the daily dietary fiber consumption (greater than 5 g of dietary fiber per day) regulated by Korea Food & Drug

Administration (Kim et al. 2008) and *Auricularia auricula-judae* that were produced in North Korea and sold by Mirak Food were served with meals in the morning, afternoon and evening after soaking *Auricularia auricula-judae* in water and blanching it in boiling water for 10 seconds.

3 Bone density measurement

The bone densities measured by QUS (quantitative ultrasonography) and AOS-100 (ALOKA Co, Japan) while the participants were sitting comfortably, putting their left heels on a foot stand (Barbieri TF 1998).

4. Serum lipid analysis

The participants fasted for more than 10 hours in the previous day of the examination, they had their blood taken on the empty stomach, and serum total cholesterol levels, HDL-cholesterol, LDL-cholesterol, and triglyceride (TG) were analyzed by a serum automatic analyzer (Hitachi 7170, Hitachi Ltd, Japan) after centrifuging their serum (John D 1992).

5. Survey of eating habits

Thirteen questions about eating habits were asked with yes and no answers. The total points were converted ; calculating two points for "yes" answer and one point for "no" answer for each question. Lower points indicate more positive eating habits.

6. Data analysis

SPSS PASW Statistics 18.0, a general statistic package was used to analyze the collected data, in order to verify the experimental effects in *Auricularia auricula-judae* between the experimental group and the control group, a pairwise t-test for observing the changes after the experiment was conducted, and ANCOVA with the previous results of the experiment as a covariate was conducted to examine the effects of *Auricularia auricula-judae* according to the groups.

RESULT AND DISCUSSION

1. Characteristics of the subjects

The average age of A group was 47.6, the height was 156.3 cm, and the weight was 64.7 kg and their dietary behavior was 18.6 and the BMI was 26.4. The average age of C group: control group was 46.3, the height was 154.7 cm and the weight was

Table 1. Characteristics of the subjects

Variables	C group	A group
Age (years)	46.3±8.3 ¹⁾	47.6±4.6
Height (cm)	154.7±6.5	156.3±3.5
Weight (kg)	58.8±5.5	64.7±8.2
Dietary behavior	16.3±3.0	18.6±2.9
BMI (kg/m ²)	24.5±1.7	26.4±2.7

¹⁾ Mean±S.D. C group: control group.

A group: *Auricularia auricula-judae* consumption group.

Table 2. Life style of the subjects

Variables	C group		A group	
	Frequency	Percent(%)	Frequency	Percent(%)
Drinking	4	40.0	1	5.0
Non-drinking	6	60.0	19	95.0
Smoking	-	-	-	-
Non-smoking	10	100.0	20	100.0
Married	7	70.0	19	95.0
Unmarried	3	30.0	1	5.0
Postmenopausal	4	40.0	6	30.0
Premenopausal	6	60.0	14	70.0

C group: control group.

A group: *Auricularia auricula-judae* consumption group.

58.8 kg and their dietary behavior was 16.3 and the BMI was 25.5. 60% of C group never drank alcohol and all females were non-smokers. 70% of the participants were married and 30% were menopausal. 95% of A group: *Auricularia auricula-judae* consumption group did not drink alcohol, all females were non-smokers, 95% of the participants were married and 30% were menopausal.

Table 3. Change of blood lipid profile in C and A group

Variables	Group	Pre	Post	Change	t-value	p-value
Total cholesterol (mg/dl)	C	189.9± 27.1 ¹⁾	201.8±29.7	11.9±14.7	2.561** ²⁾	0.031
	A	210.5± 39.3	205.4±37.3	-5.1±16.8	-1.355	0.191
HDL-cholesterol (mg/dl)	C	62.9± 9.0	63.8±11.6	0.9± 5.67	0.511	0.621
	A	58.1± 11.7	56.6±10.8	-1.5± 4.8	-1.392	0.180
LDL-cholesterol (mg/dl)	C	114.8± 16.9	116.6±17.1	1.8± 7.0	0.813	0.437
	A	125.3± 24.0	119.3±21.7	-6.0±10.3	-2.606**	0.017
TG (Triglyceride) (mg/dl)	C	105.0± 52.4	104.8±35.1	-0.2±48.4	-0.013	0.990
	A	159.2±131.1	119.9±96.4	-39.3±50.5	-3.473***	0.003

¹⁾ Mean±S.D. ²⁾ * $p<0.05$, ** $p<0.01$, *** $p<0.001$. C group: control group. A group: *Auricularia auricula-judae* consumption group.

2. The changes of serum lipid profile

Based on the results that A group took *Auricularia auricula-judae* for 4 weeks, the LDL-cholesterol ($p<0.05$) and TG ($p<0.01$) were significantly reduced, but there were no differences in C group. It suggests that the dietary fiber in *Auricularia auricula-judae* (57.4 g Total dietary fiber) is the major contributing factor. Dietary fibers can be divided into two categories: soluble fiber and insoluble fiber. Especially, soluble dietary fiber increases excretion by hindering absorbing lipid in the intestine, hampering bile acid in small intestine by absorption, producing monoenoic fatty acid such as propionate, butyrate, acetate and etc by fermenting in the large intestine by microorganisms, and it is known that the monoenoic fatty acid hinders the synthesis of cholesterol when the monoenoic fatty acid enters into the liver (Heo et al. 2010). According to the study by Choi EJ (2004), after taking soluble dietary fiber, the cholesterol level in the blood for males was reduced by 2.5% and 5% for females, the triglyceride was also significantly reduced ($p<0.05$) in both males and females. Based on the study by Kim et al. (1992), it was reported that mushrooms were effective in reducing the total cholesterol levels, LDL-cholesterol, and neutral fat. These reports support the results that taking *Auricularia auricula-judae* for 4 weeks significantly reduced the total cholesterol levels and LDL-cholesterol in this study and it can be explained that soluble dietary fiber in *Auricularia auricula-judae* had effects.

3. The changes of bone density

T-Score in C group, control group was reduced under the 5% and no significant changes in T-Score were observed in A group [*Auricularia auricula-judae* intake group] before and after the experiments. There were no significant differences in the changes in Z-Score for both A group and C group according to taking

Auricularia auricula-judae. While genetic and environmental factors such as nutriment balances, physical exercise, gender differences, hormone and etc. are known as factors that affect bone density and especially, nutriment balance among environmental factors is recognized as an important factor (Ha JM 2004). *Auricularia auricula-judae* is high in Ca and P in comparison with other mushrooms, Ca and P in *Auricularia auricula-judae* are easily absorbed in the body with the ratio of Ca (233.0 mg) and P (270.0 mg) is 1:1~1.5 (Han YB 2009), and it is rich in vitamin D that plays an important role in keeping the acid fast of Ca and P (Lee et al. 1997). Ca effects the peak bone mass and sufficient Ca supply minimizes bone loss. Lack of Ca causes osteoporosis, breaking the balance of Ca in the body, reducing Ca in the blood, stimulating to secrete parathyroid hormone, using Ca in the bones in order to compensate Ca in the blood, and finally reducing Ca in the bone (Lee EJ 2005). The study by Rozen and others (Rozen et al. 2003) that supplying Ca had a positive effect on acquiring bone mass and the results of the study (Lee EJ 2009) that reinforcing vitamin D delayed bone loss support the correlation between Ca and bone density. In addition, it is considered that vitamin D promotes to absorb Ca in the intestine, re-absorb Ca in the kidney and suppress the secretion of parathyroid hormone (Han JS 2010). In the studies in other countries (Mauricio et al. 1992), sufficient Ca and vitamin supplies increase bone density and it is known that vitamin D

is a critical factor for bone density. However, while, in this study, sufficient consumption of *Auricularia auricula-judae* rich in Ca and vitamin D somewhat increased the bone density but failed to show a significant increase in the bone density, it is estimated that the precision of a quantitative ultrasound bone density analyzer used in this study failed to analyze the details of the data since its precision was comparatively lower than a radiation bone density analyzer (Choi YJ 2007).

4. The correlation of bone density and serum lipid concentration

Examining the correlation of each variable before the experiment, it can be known that triglyceride had a negative correlation ($p<0.05$) with HDL-cholesterol and it reflects a typical characteristics of people with abdominal obesity. Considering the fact that 70% of females in A group never experienced menopausal, it suggests that the bone density for females with no menopausal is related to metabolic syndrome. It can be considered the same context with the result that triglyceride had a negative correlation with T-score and Z-score ($p<0.01$).

Based on the result of conducting the correlation analysis on each variable after the experiment, it is known that, like the results before the experiment, triglyceride and HDL-cholesterol showed a negative correlation and T-Score and Z-Score had a negative correlation with triglyceride (Table 6).

Table 4 Change of T and Z-score in C and A group

Variables	Group	Pre	Post	Change	t-value	p-value
T-score	C	1.479±1.469 ¹⁾	1.232±1.339	-0.247±0.321	-2.435**	0.038
	A	0.595±1.213	0.852±1.169	0.258±1.614	0.713	0.484
Z-score	C	1.727±1.717	1.495±1.529	-0.232±0.348	-2.106*	0.065
	A	0.787±1.320	1.058±1.304	0.271±1.667	0.727	0.476

¹⁾ Mean±S.D. ²⁾ * $p<0.05$, ** $p<0.01$.

Table 5. A correlation coefficient in bone density, and serum lipid before experiment

Variables	T-Score	Z-Score	Total cholesterol (mg/dl)	HDL-cholesterol (mg/dl)	LDL-cholesterol (mg/dl)	Triglyceride (mg/dl)
T-Score	1.000					
Z-Score	0.974*** (0.001)	1.000				
Total cholesterol	-0.095 (0.618)	-0.112 (0.554)	1.000			
HDL-cholesterol	-0.321* (0.084)	-0.240 (0.201)	0.209 (0.267)	1.000		
LDL-cholesterol	-0.093 (0.626)	-0.106 (0.578)	0.980*** (0.001)	0.273 (0.144)	1.000	
Triglyceride	0.149 (0.433)	0.125 (0.509)	0.253 (0.177)	-0.421** (0.020)	0.083 (0.665)	1.000

* $p<0.05$, ** $p<0.01$, *** $p<0.001$.

Table 6. A correlation coefficient in bone density and serum lipid after experiment

Variables	T-Score	Z-Score	Total cholesterol (mg/dℓ)	HDL-cholesterol (mg/dℓ)	LDL-cholesterol (mg/dℓ)	Triglyceride (mg/dℓ)
T-Score	1.000					
Z-Score	0.972***(0.001)	1.000				
Total cholesterol	-0.119(0.531)	-0.134(0.480)	1.000			
HDL-cholesterol	0.042(0.826)	0.105(0.582)	0.277(0.139)	1.000		
LDL-cholesterol	-0.049(0.796)	-0.071(0.709)	0.981***(0.001)	0.246(0.190)	1.000	
Triglyceride	-0.541***(0.002)	-0.538***(0.002)	0.206(0.275)	-0.399**(0.029)	0.083(0.661)	1.000

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

According to the results, taking *Auricularia auricula-judae* for 4 weeks had a positive effect on the improvement of the serum lipid concentration for females with abdominal obesity. Although this study failed to examine a significant increase in the bone density after taking *Auricularia auricula-judae*, T-score and Z-score in C group were reduced based on the results of a pairwise t-test and an increase was observed in A group. Therefore, if Dual Energy X-ray Absorptiometry; DEXA most generally used in measuring bone density is used to measure more precise bone density in further researches, it is expected to achieve the results that this study tried to get. Furthermore, taking the amount of Ca for females in Korea is less than the recommended levels and *Auricularia auricula-judae* can be an excellent food to prevent osteoporosis beforehand since they are easily exposed to osteoporosis while taking less plant foods with low Ca, taking excessive salt and leading the excretion of Ca. In addition, *Auricularia auricula-judae* prevents cosmetic troubles caused by malnutrition and unbalanced nutrition during the diet since it is rich in antioxidant nutrition, prevents aging process due to the excellent antioxidant activities by anthocyanin, and has an effect in reducing active oxygen generated after exercise. Above all, as people in today's society want to prevent and treat disease and keep health by taking health functional foods rather than medicine, it is expected that *Auricularia auricula-judae* proved as a safe food will become an excellent diet food for healthy obesity management for the abdominal obese women.

CONCLUSION

This study is an research in order to examine the effects of *Auricularia auricula-judae* consumption on body fat of the abdominal obese women by selecting *Auricularia auricula-judae* as a food material that helps reduce obesity effectively and is safe

for health for a long period of time.

Thirty women with abdominal obesity aged from 30 to 50 and the experimental (A) group was asked to take 12 g of *Auricularia auricula-judae* with a meal 3 times a day after soaking *Auricularia auricula-judae* in the water and blanching *Auricularia auricula-judae* in boiling water. With regard to measurement tools, bone density (T-score, Z-score) were measured by a quantitative ultrasonic bone density diagnostic system, the components of blood (total cholesterol, HDL-cholesterol, LDL-cholesterol, triglyceride) were measured by an automatic serum analyzer, and a basic survey for the characteristics of sociology of population, life attitude, eating habits was conducted.

After A group took *Auricularia auricula-judae* for 4 weeks, the levels of the LDL-cholesterol ($p < 0.05$) and triglyceride ($p < 0.01$) were significantly decreased. The significant differences between A group and C group were shown in the total cholesterol ($p < 0.05$) and LDL-cholesterol ($p < 0.1$).

Considering the results, it was found that taking *Auricularia auricula-judae* had a positive effect in improving blood LDL-cholesterol, TG, and bone density of the abdominal obese women.

REFERENCES

- Choi EJ. 2005. The effect of soluble dietary fiber from cassia tora. Seed on lipid metabolism *in vivo*. Master Degree, Thesis, Chang Ang Uni. Seoul. Korea
- Choi YJ. 2007. The factors associated with bone mineral density in premenopausal and postmenopausal women. Master Degree, Thesis, Konkuk Uni. Seoul. Korea
- Fehily AM, Coles RJ, Evans WD, Elwood PC. 1992. Factors affecting bone density in young adults. *Am J Clin Nutr* 56: 579-586
- Grundy SM, Grundy SM, Cleeman JI, Merz CN, Brewer HB Jr,

- Clark LT, Hunninghake DB, Pasternak RC, Smith SC Jr, Stone NJ. 2004 A summary of implications of recent clinical trials for the National Cholesterol Education Program Adult Treatment Panel III guidelines. 110:227-239
- Ha JM. 2004. Effect of soluble dietary fiber on plasma lipid metabolism in patients with NIDDM. Master Degree Thesis, EWha Uni. Seoul. Korea
- Han JS. 2010 Nutrition and Nursing. pp.78-79. Ji-Gu Publishing Co
- Han YB. 2009. Dietary Mushroom. pp.249-258. Korea University Publishing Co
- Heo YH, Kim EJ, Seo HS, Kim SM, Choi KM, Hwang TG, Choi GJ, Park YS. 2010. The effect of 16 week exercise program on abdominal fat, serum lipids, blood glucose, and blood pressure in obese women. *J of Korean Soc for the Study of Obesity* 19:16-23
- Kang MS. 2000. Factors related to the obesity of the married women. Master Degree Thesis, Gyeongsang Uni. Gyeongsang Korea
- Kim ES. 2010. Relationship between bone mineral density and body composition in East Asian teenagers. Ph.D. Thesis, Kyung Won Uni. Seongnam. Korea
- Kim GJ, Kim HS, Chung SY. 1992. Effects of varied mushroom on lipid compositions in dietary hypercholesterolemic rats. *J of the Korean Soc of Food Sci and Nutr* 21:131-135
- Kim MK. 2008. Functional Food. Seoul Kyumoon Publishing Co
- Kim YN. 2008. The evaluation of the bone density and the nutritional status of female college students with the experience of diet control. Master Degree Thesis, Wonkyung Uni. Iksan. Korea
- Korean Society for the Study of Obesity. 2008 Clinical Obesity. 3rd Ed. Seoul. Koru Medical Publishing Co
- Lee EJ. 2009. The survey of nutrient intake by body mass index and broadband ultrasound attenuation among university students. Master Degree Thesis, Sun Chun Hang Uni. Asan. Korea
- Lee HS. 2007. A study on the effect of dietary fiber about the disease of these days' people: Focused on lifestyle-related disease. Master Degree Thesis, Seoul Jang Shin Uni. Seoul. Korea
- Lee JS, Ahn RM, Choi HS. 1997 Determinations of ergocalciferol and cholecalciferol in mushrooms. *Korean Soc of Food & Cookery Sci* 13:173-178
- Lee YJ. 2005. The relationship of bone density and eating habits/nutritional intake in adult females. Master Degree Thesis, Kyung Myung Uni. Daegu. Korea
- Mauricio HA, Stampfer MJ, Ravnika VA, Hernandez-Avila M, Stamfer MJ, Ravnika VA, Willett WC, Schiff I, Francis M, Longscope C, Mckinlay SM. 1993 Caffeine and other predictors of bone density among pre-and perimenopausal women. *Epidemiology* 4:28-134
- Michaelsson K, Bergstrom R, Holmberg L, Mallmin H, Wolk A, Ljunghall S, 1997. A high dietary calcium intake is needed for a positive effect on density in Swedish postmenopausal women. *Osteoporos Int* 11:155-161
- Michelle M, Kathy AB. 2010 Nutritional Sciences from Fundamentals to Food. pp.534-542. Wadsworth Cengage Learning
- Ministry of Health, Welfare and Family, Korea Centers for Disease Control and Prevention. 2009
- Ministry of Health, Welfare and Family, Korea Centers for Disease Control and Prevention. 2010
- Morenga LT, Williams S, Brown R, Mann. 2010. Effect of a relatively high-protein, high-fiber diet on body composition and metabolic risk factors in overweight women. *J Eur J Clin Nutr* 64:1323-1331
- National Rural Science Institute. 2008. Food Composition Table.
- Oh JJ, Hong ES, Baik IK, Lee HS, Lim HS. 1996. Effects of dietary calcium, protein, and phosphorus intakes on bone mineral density in Korean premenopausal women. *The Korean J Nutr* 29:59-69
- Rolls BJ, Roe LS, Meengs JS. 2006. Reduction in portion size and energy density of foods are additive and lead to sustained decreases in energy intake. *Am J Clin Nutr* 83:11-17
- Rozen GS, Rennert G, Dodiuk-Gad RP, Rennert HS, Ish-Shalom N, Diad G, Raz B, Ish-Shlaom S. 2003. Calcium supplementation provides an extended window of opportunity for bone mass accretion after menarche. *Am J Clin Nutr* 78: 993-998
- Song BJ. 2010. Effects of low calorie dietary fiber diet on the reduction of human body weight. Master Degree. Thesis, Kyunggi Uni. Seoul. Korea
- Van Loan MD, Johnson HL, Barbieri TF. 1998 Effect of weight loss on bone mineral content and bone mineral density in obese women, *Am J Clin Nutr* 67:738-748
- Wang F, McDonald T, Reffitt B, Edington DW. 2005. BMI physical activity, and health care utilization/costs among medicare retirees. *Obes Res* 13:1450-1457