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ARTICLE

Effect of Duck-meat Intake on Adult Disease Risk Factors in Adult Human Males

Chang Jin Lee[1], Young Tae Lim[2], Sung Ho Kang[3], Ho Sung Jung[4], Oun Hyun Kim[5], Si Heung Sung[5], and Hyuk Song[5]*

[1]*Department of Sports and Leisure Studies, Konkuk Univerisity, Chung-ju 380-701, Korea*
[2]*Department of Golf Teaching, Konkuk Univerisity, Chung-ju 380-701, Korea*
[3]*Department of Otolaryngology, Konkuk University, Chungju 380-701, Korea*
[4]*Department of Emergency Medicine, Konkuk University, Chungju 380-701, Korea*
[5]*Department of Animal and Food Bioscience, Konkuk Univerisity, Chung-ju 380-701, Korea*

Abstract

This study was conducted to evaluate the effects of duck-meat consumption on adult disease risk factors, including body compositions, hematological variables, and serum metabolic and lipid profiles in adult human males. To obtain results, 20 adult males aged 20 to 25 were subjected to a diet of 600 g/day of duck-meat for 4 wk, after which body composition, hematological variables, and serum metabolic and lipid profiles were investigated to determine if there was a relationship between duck-meat consumption and adult disease risk factors. The results revealed that high amounts of duck-meat intake did not negatively alter body indices such as body weight, fat mass, body mass index (BMI), % body fat or waste-to-hip ratio (WHR). Furthermore, there were statistically insignificant changes in the number of blood cells, although this number did increase significantly following intake of duck-meat. Moreover, general decreases in serum metabolic parameters were observed, but none of these changes were significant with the exception of the concentration of blood urea nitrogen (BUN). The serum concentrations of LDL-cholesterol also showed a statistically significant decrease by 5.86%. Therefore, this study suggests that the ingestion of duck-meat not only significantly increased the RBC count but also decreased BUN and LDL-cholesterol concentrations in adult males.

Key words: duck-meat, adult disease risk factor, BUN, cholesterol, RBC, LDL-cholesterol

Introduction

Because of the antidote effects, duck-meat is generally used in traditional medicine in oriental countries. Besides of antidote effects, it has been applied to treat hypertension, stroke, neuralgia, atherosclerosis, obesity, tuberculosis, and gastritis in Korean medicine (Hu, 1994a,b). As a source of nutrition, duck meat contains a variety of essential amino acids and provides good quality proteins (Nam and Lee, 1981). Duck-meat also has a high ratio of phospholipids (particularly lecithin) and unsaturated fatty acids when compared to other meats (Nam, 1997). In addition, duck-meat is known as an alkaline food, therefore consumption of the duck-meat have an anti-aging effect by the prevention of acidification of the human body (Kim and Kim, 2003; Nam, 1997).

The serum cholesterol concentration in human adult males and females was significantly reduced by duck-meat consumption for nine days (Nam, 1979). In an animal study, consumption of duck oil decreased triglyceride concentrations, but did not alter total cholesterol or hepatic total lipid concentrations in male Sprague-Dawley rats (Koh *et al*., 1995). In a type I diabetes model mice, treatment of duck egg oil showed a decrease in blood glucose level and total cholesterol concentrations that occurred in a dose dependent manner (Kim and Ryu, 1998). Moreover, duck egg oil was found to have anti-proliferation effects in sarcoma-180 cancer cells (Kim and Ryu, 1998), mouse mammary carcinoma, mouse leukemia, and human hisocytic lymphoma cells (Ryu *et al*., 2002). Duck egg oil also significantly increased the numbers of CD 4^+ and CD 8^+ T cells and elevated the level of IL-2 receptor and TNF-α expression (Ryu *et al*., 2002).

*Corresponding author: Hyuk Song, Department of Animal and Food Science, Konkuk University, Chung-Ju 380-701, Korea. Tel: 82-43-840-3522, Fax: 82-43-842-3522, E-mail: lovelyhusband@kku.ac.kr

Anti-proliferative effects of the cancer cell line in response to treatment with sulfur fed duck extracts have also been studied in various cancer cell lines, that treatment with extracts from sulfur fed ducks effectively inhibited the proliferation of human and mouse cancer cell lines (Choi and Kim, 2002). Moreover, purified antitumor substances from sulfur fed ducks effectively reduced the growth rate of Hep-2 (human larynx) and KB (human epidermoid of mouth carcinoma) cells (Yoon *et al*., 2004).

The mitigation effect of duck extracts on heavy-metal exposure has been reported as a putative function of duck products. Feeding duck products to rats that were exposed to mercury (Hg), cadmium (Cd), and lead (Pb) resulted in decrease of these heavy-metals accumulation in tissues, and an increase of their excretion (Han *et al*., 2003). Indeed, the activities of GOT (glutamic oxalacetic transaminase), GPT (glutamic pyruvate transaminase) and BUN (blood urea nitrogen) of serum were significantly reduced in rats fed duck products, and suppressing effects of the accumulation of Hg and Pb in the serum of these animals were also observed (Park *et al*., 2005).

Although the beneficial effects of duck products in human and animal models are well known and their functional importance to the regulation of adult disease factors have been demonstrated in several studies, other functions of duck products are poorly understood in humans. In the present study, we provided duck-meat to human males for four weeks and then analyzed various adult disease factors to investigate the relationship between duck-meat consumption and adult disease factors.

Materials and Methods

Experimental subjects

Twenty students aged 20 to 25 from Konkuk university, Chungju, Korea, were subjected to a duck-meat diet consumption experiment. The participants were resided in dormitory that equipped an internal kitchen with a dietician. They were also carefully instructed not to change their diets or their lifestyle during the experimental period. Information on the healthy status of subjects was obtained by an interview on the lifestyle and medical history, and a physical examination. All study participants were in good health. They denied having dyspepsia or other gastrointestinal diseases, and did not take any medication. They also did not have the hypertension, diabetes mellitus and other chronic illness. The participants were informed of the objective and process of the experiment and gave their written consent.

Control of subjects

The subjects were controlled to avoid an irregular life pattern and excessive exercise to eliminate unexpected variations in the experimental results. Part of these controls included prohibition of alcohol and caffeine consumption during the experiment. In addition, the subjects were urged regulations that included living in a dormitory, prohibition of dining out and avoiding the excessive consumption of sweet things during the study.

Control of diet

All subjects in the experimental group were given three meals a day containing 600 g of duck-meat in various dish styles designed by a dietician for four weeks. The energy level of duck-meat is 134 kcal/100 g, therefore consumption of 600 g/day is equivalent to 804 kcal/day. The styles of duck-meat dishes were diverse, that included a smoked (boneless), fried, steamed and roast (boneless), etc. Dietician decided the dish style by the daily request of the subjects, and the subjects consumed the prepared duck-meat dishes. Total 12 kg/day of duck-meat was prepared for the subjects, and the subjects consumed all prepared dishes. However, the individual subject did not take exactly 600 g, but the subjects group consumed all prepared duck-meat dishes. In addition, the remains of meal were allowed, but the remains of duck-meat were not allowed.

Body composition analysis

The changes in body composition were also investigated. Body weight, body fat, percentage body fat (% fat), body mass index (BMI) and waste heap ratio (WHR) were measured before and after the duck-meat diet consumption using an InBody 4.0 body analyzing machine (Biospace, Seoul, Korea)

Adult disease factor analysis

Blood samples (10 mL) were collected one day prior to the experiment and one day after the experiment ended and then analyzed for adult disease risk factors. The blood samples were collected between 7:00 and 9:00 AM after a 10 h fast of last meal. Blood samples were collected in Heparin or EDTA containing tubes (Becton Dickinson, USA) and then incubated for one hour at room temperature. The samples were then centrifuged at 3,500 rpm for 15 min, after which they were subjected to further analysis. Specifically, the samples were analyzed for the following adult disease factors at Konkuk University Chungju Hospital: Hematological variables - WBC (white blood cells), RBC (red blood cells), HGB (hemoglobin), PLT (platelets), TP (total protein), ALB (albumin); Liver function test - AST aspartate aminotransferase), ALT (alanine aminotransferase), ALP (alkaline phosphatase), and GGT (gamma glutamyl transferase); Renal function test - BUN (blood urea nitrogen) and CRE (creatinine); Serum lipid profiles - TC (total cholesterol), TG (triglyceride), HDL (high density lipoprotein))-cholesterol, and LDL (low density lipoprotein)-cholesterol.

Statistical analysis

The SPSS statistical package ver. 15.0 for Windows was utilized and all data shown are the means ± the standard deviation. The values before and after the subject ate duck meat were compared by a paired t-test. The null hypothesis was rejected when the probability was less than 0.05.

Results and Discussion

Body compositions

The body weight, fat mass, BMI, % body fat and WHR were compared before and after daily consumption of 600 g of duck-meat. As shown in Table 1, the body weight, fat mass, BMI, % body fat and WHR increased by 0.16 kg, 0.03 kg, 0.05 kg/m^2, 0.04%, and 0.001%, respectively, following the consumption of duck meat; however, these changes were not significant. It is well known that obesity increases the risks of a number of chronic diseases, such as cardiovascular disorders, hypertention, diabetes, and certain types of cancer (Word health Organization, 2000). Moreover, meat consumption is associated with a higher intake of total fat, saturated fat and total calories, and an increased risk of chronic diseases such as cardiovascular disease (Nicklas *et al*., 1995). Recently, Wang and Beydoun reported that the risk for obesity and central obesity is positively associated with BMI and waist circumference (Wang and Beydoun, 2009). However, our data indicated that consumption of duck meat did not alter the parameters of body compositions or obesity indices such as BMI and WHR, even after a high intake of duck meat (600 g/day for 4 wk), which suggests that duck meat consumption does not pose a risk of obesity

Table 1. Changes in body composition pre- and post-consumption of duck meat[1)]

Variable	Item	Pre	Post
Body composition	Weight (kg)	82.54±7.39	82.70±7.31
	Fat mass (kg)	13.23±3.29	13.26±2.84
	BMI (kg/m^2)	25.43±1.64	25.48±1.59
	% Body fat (%)	15.96±3.26	16.00±2.78
	WHR (%)	0.86±0.02	0.86±0.02

[1)]Values are presented as the mean±SD.
BMI, body mass index; WHR, waste heap ratio.

Hematological variables

The concentrations of WBC (white blood cells), RBC (red blood cells), HGB (hemoglobin), PLT (platelets), TP (blood total protein) and ALB (albumin) were compared before and after daily consumption of 600 g of duck-meat (Table 2). The WBC, HGB and TP levels increased by 0.03×10^3 cells/uL, 0.06 g/dL and 0.04 g/dL, respectively, but these changes were not statistically significant. However, RBC increased significantly by 0.09×10^6 cells/uL. PLT and ALB were decreased by 2.55×10^3 cells/uL and 0.02 g/dL, respectively, but this difference was not significant. Generally, RBC are generated by erythrocytes produced in the kidney and are involved in the transportation of oxygen bound hemoglobin to tissues and cells in the bodies of animals (McMullin, 2009). In another study, increased RBC in rats following of the consumption of duck products was also detected that heavy metal exposed rats fed duck by-products supplemented with medicinal herbs showed a significant increase in RBC to levels that were even higher than in normal rats (Park *et al*., 2005). Therefore, the increase in RBC in response to the consumption of duck meat intake indicates that duck meat may positively influence oxygen metabolism by providing a sufficient supply of oxygen to the body. Accordingly, the intake of duck meat may help prevent or alleviate RBC deficiency related diseases such as anemia.

Liver and renal function test (Serum metabolic)

The concentrations of AST, ALT, ALP, and GGT were compared before and after daily consumption of 600 g of duck-meat (Table 3). Although no significant differences

Table 2. Changes in hematological variables of pre- and post-consumption of duck meat[1)]

Variable	Item	Pre	Post
Hematological variables	WBC (10^3 cells/uL)	6.33± 1.10	6.36± 1.10
	RBC (10^6 cells /uL)	5.21± 0.21	5.30± 0.21*
	HGB (g/dL)	15.96± 0.60	16.02± 3.27
	PLT (10^3 cells/uL)	258.70±40.51	256.15±42.76
	TP (g/dL)	7.24± 0.25	7.28± 0.38
	ALB (g/dL)	4.50± 0.14	4.48± 0.16

[1)]Values shown represent the mean±SD, and asterisks indicate statistical significance, *p<0.05
WBC, white blood cell; RBC, red blood cell; Hb, hemoglobin; PLT, platelet; TP, total protein; ALB, albumin.

Table 3. Changes in serum metabolic enzymes (liver function) pre- and post-consumption of duck meat

Variable	Item	Pre	Post
Liver activity	AST (iu/L)	24.25±12.78	23.95± 6.54
	ALT (iu/L)	19.45± 7.15	18.60± 5.63
	ALP (iu/L)	293.65±81.09	291.55±85.32
	GGT (iu/L)	18.45± 6.05	17.10± 6.27

Values shown are the mean±SD.
AST: aspartate aminotransferase, ALT: alanine aminotransferase, ALP: alkaline phosphatase, GGT: gamma glutamyl transferase.

were observed in any of the examined liver enzymes, AST, ALT, ALP, and GGT decreased by 0.3, 0.85, 2.10, and 1.35 iu/L, respectively. ALT is liver specific and increases in response to chronic and acute hepatitis, fatty liver, alcoholic hepatitis, and liver cancer, whereas AST increases in response to heart, liver, skeleton, renal, and pancreatic disorders (Kim *et al*., 2001; Lee *et al*., 1999). In other studies, it has been reported that feeding duck-extracts to mice exposed to heavy metals induced a significant decrease in AST and ALT, but that ALP and LDH (lactate dehydrogenase) were not changed (Han *et al*., 2003; Park *et al*., 2005).

For the renal function test, the blood concentration of BUN and creatinine were analyzed. The concentrations of both enzymes were reduced, with that of BUN being significantly reduced by 1.38 mg/dL (Table 4). However, the concentration of creatinine was reduced by 0.02 mg/dL, but did not show any significant. According to a Korean traditional medicinal book, 'Dong Ui Bo Gam', duck meat has an outstanding effect on deintoxication (Hu, 1994a,b). Generally, BUN increases in response to renal disorders, and it is used as an indicator of renal activity (Kim *et al*., 2001). It has been reported that intake of duck by-products supplemented with medicinal herbs effectively diminished the concentration of BUN and that of heavy-metals in rats exposed to mercury chloride ($HgCl_2$) and lead acetate [$Pb(CH_3COO)_2$] (Han *et al*., 2003; Park *et al*., 2005). In this study, BUN was also significantly reduced in response to the intake of duck meat.

Table 4. Changes in serum metabolic enzymes (renal function) pre- and post-consumption of duck meat

Variable	Item	Pre	Post
Kidney function test	BUN (mg/dL)	19.70±1.81	18.32±2.12*
	CRE (mg/dL)	1.13±0.07	1.11±0.08

Values shown are the mean±SD, and asterisks indicate statistical significance, *p<0.05
BUN: blood urea nitrogen, CRE: creatinine.

Taken together, the results of these previous studies and the present investigation provide evidence for the role of duck-meat intake on deintoxication that is reported in Korean traditional medicinal books. Overall, these results indicate that the intake of duck-meat by adult humans has a positive influence on renal function that occurs via a decrease in BUN, which suggests that intake of duck-meat may enhance renal ability or prevent renal disorder through a decrease in BUN.

Serum lipid profile

Changes in the serum lipid levels were identified following the ingestion of duck meat (Table 5). Specifically, the HDL-cholesterol increased by 1.60 mg/dL, however the TC, TG, and LDL-cholesterol levels decreased by 3.75, 2.90, and 5.45 mg/dL, respectively. Among the analyzed serum lipids, the LDL-cholesterol was significantly decreased by 5.86%. In Korea, body activity has recently been reduced in response to a more convenient life style, and cardiovascular disorders have been rapidly increasing as a result of arteriosclerosis following the introduction of westernized foods (Khor, 1997; Hu *et al*, 1997; Moon and Jung, 1994). Indeed, death by cardiovascular disorder now accounts for 23.8% of all deaths in Korea (National statistical office, 2006). Furthermore, hypertension, low levels of HDL-cholesterol and high levels of LDL-cholesterol, family history, and older age are regarded as risk factors for cardiovascular disorder (The 3rd report of the NCEP, 2001), but an imbalance of serum lipid levels has been reported as the most important risk factor (Castelli, 1984; Castelli *et al*., 1986; Connor *et al*, 1994; Preuss, 1993). Hypercholesterol caused by food intake has been shown to cause an increase in TG through an increase of serum cholesterol and VLDL-cholesterol via the upregulation of LDL-cholesterol as a consequence of eating foods with high amounts of fat, saturated fatty acid and cholesterol, and this has often been associated with increased LDL-cholesterol and decreased HDL-choles-

Table 5. Changes in serum lipids profile pre- and post-consumption of duck meat

Variable	Item	Pre	Post
Serum lipid	TC (mg/dL)	162.80±20.04	159.05±23.67
	TG (mg/dL)	66.00±15.49	63.10±22.73
	HDL-cholesterol (mg/dL)	60.60±14.87	62.20± 8.64
	LDL-cholesterol (mg/dL)	92.95±17.87	87.50±18.84*

Values shown are the mean±SD, and asterisks indicate statistical significance, *p<0.05
TC: total cholesterol, TG: triglyceride, HDL: high density lipoprotein, LDL: low density lipoprotein.

terol (Guide for clinical nutrition, 2002).

In this study, we found decreased TC and TG, and increased HDL-cholesterol following the intake of duck-meat, although these differences were not significant. Additionally, a significant difference in LDL-cholesterol concentration was observed in healthy adult humans following the ingestion of duck-meat, indicating that it may have a positive effect for preventing cardiovascular disorders mediated by hypercholesterol.

Duck-meat has been identified as an excellent source of niacin (vitamin B3), and 100 gram of duck-meat provides about 50% of the daily requirements for niacin. Interestingly, this vitamin played an important role in the metabolism of fats by cholesterol-lowering effects (Costet, 2010). Clinical demonstration study revealed that patient with high level of TG and LDL-cholesterol ingested 500-1500 mg/day of niacin for 16 wk, showed a significant decrease in total cholesterol, TG and LDL-cholesterol (Wi *et al*, 2010). Although the precise mechanism of duck-meat intake in lowering LDL-cholesterol level was not determined, the therapeutic effect of niacin in certain patients may provide the indirect evidence of duck-meat in lowering blood lipids. Support of this, decreased human blood cholesterol levels in response to the intake of duck-meat were also reported after nine days of intake of canned duck-meat, which was associated with decreases in the blood cholesterol of 187 mg% to 178.8 mg% in human males and 184 mg% to 173.8 mg% in human females (Nam, 1979). Furthermore, an animal study revealed that feeding duck oil to male Sprague-Dawley rats induced a decrease in triglyceride and total cholesterol (Koh *et al*, 1995). Taken together, our results indicated that duck-meat consumption may prevent or treat cardiovascular disorders via a decrease in blood lipids.

In summary, this study investigated the effects of duck-meat consumption by human males on body composition, hematological variables, liver and renal function, and changes in serum lipids changes. High amounts (600 g/day/man) of duck-meat intake did not increase the body indices such as body weight, fat mass, BMI, % body fat and WHR, but the RBC count was significantly increased by 1.7% following the intake of duck-meat. Moreover, the intake of duck-meat generally decreased the serum metabolic parameters, but this difference was not significant, except for the BUN concentration which was significantly decreased by 7%. Regarding the serum lipids concentrations, high risk factors for cardiovascular disorders such as TC, TG and LDL-cholesterol were generally decreased, but LDL-cholesterol was significantly decreased by 5.38%. Therefore, duck-meat may be a healthy food that is able to enhance the body metabolism by the increase of RBC number, and the decrease of BUN and LDL-cholesterol concentrations.

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