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Effects of potato and lotus leaf extract intake on body composition and blood lipid concentration

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Keuneil Lee, Jongkyu Kim, Namju Lee, Sok Park, Hyunchul Cho and Yoonseok Chun. Effects of potato and lotus leaf extract intake on body composition and blood lipid concentration. *JENB*., Vol. 19, No. 1, pp.25-30, 2015 **[Purpose]** The purpose of this study was to investigate the effects of potato and lotus leaf extract intake on body composition, abdominal fat, and blood lipid concentration in female university students. **[Methods]** A total of 19 female university students participated in this 8-week study, and they were randomly assigned into 2 groups; potato and lotus leaf extract (skinny-line) administered group (SKG, $n = 9$) and placebo group (PG, $n = 10$). The main results of the present study are presented below. **[Results]** 1) Body mass index, and percent body fat and abdominal fat in students of the SKG showed a decreasing tendency without significant interaction, 2) total cholesterol (TC), triglyceride (TG), and low density lipoprotein (LDL-C) in students of the SKG showed an averagely decreasing tendency and there was a significant interaction of TC only, 3) high density lipoprotein (HDL-C) in students of the SKG showed an increasing tendency without significant interaction, and 4) Z-score of fatness testing interaction in group × repetition did not show a significant interaction; however, there was a significant interaction of TC in group × repetition. Based on these results, 8-week intake of potato and lotus leaf extract had a positive effect of lowering TC. On the other hand, it had no significant effect on other types of lipids and percent body fat changes. **[Conclusion]** There was a positive tendency of blood lipids in students of the SKG and it seems that potato and lotus leaf extract intake might prevent obesity and improve obesity related syndromes. **[Key words]** Lotus leaves, potatoes, body fat, blood lipids

INTRODUCTION

Recently, studies on medical products, dietary supplements, and natural foods that help in reducing abdominal fat and various blood lipids have been actively conducted due to the increasing incidence of metabolic disorders. Based on the National Nutrition Survey in South Korea, dietary habits have gradually changed to the western style according to rapid economic growth and family types. Therefore, there is an increasing trend in the incidence of cardiovascular disease caused by increased animal product consumption and excessive sodium intake much more than recommended daily allowance compared to the 20th century in South Korea [1]. Moreover, it has been reported that obese people have 2 times higher risk of developing hypertension, diabetes, and hyperlipidemia compared to the normal population based on The National Nutrition Survey in 2010 [2]. Abdominal obesity, hyperlipidemia, and insulin resistance lead to the development of metabolic syndrome, and the metabolic syndrome is mainly caused by obesity [3]. Due to obesity, adipocyte accumulation and metabolic disorder in adipocytes can occur and this can increase the risk of chronic inflammation and insulin resistance, which may cause type-2 diabetes, cardiovascular disease, and hyperlipidemia [4]. Lifestyle factors may have an impact on these diseases.

Dietary treatment, exercise therapy, psychotherapy, and surgery have been used for treating obesity; however, the drugs used to treat obesity may cause serious side effects such insomnia, rash, nausea, and headache. Therefore, it seems that reasonable dietary habits and regular physical activity based

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on the daily energy expenditure would be the optimal fundamental treatment for obesity [5]. In addition, there is an urgent need to develop dietary supplements derived from natural plants for treating obesity.

Since the 1970s, the daily activity of people has decreased and carbohydrate (CHO) intake has also decreased; on the other hand, lipid intake has increased due to an increase in national income and simplification of living and dietary life [6,7]. CHOs have been considered as a major energy source in the human body; however, recent studies have reported that CHOs have various effects on physiological metabolism, which are more than that of a macronutrient [8]. Especially, potato starch has been widely used in industries to increase solubility, viscosity, and processability [9]. Moreover, the worldwide production of potatoes is 350 million tonnes per year9) and they have excellent eating quality with medicinal effects and various food ingredients [10]. Potatoes have been considered as a good food source because they contain high quality protein, minerals such as calcium and magnesium, and vitamin C [11]. It is also known that potatoes can reduce the sense of hunger and they are used in treatment of cancer, hypertension, atherosclerosis, cardiovascular disease, and liver disease [12].

Lotus (Nelumbo nucifera Gaertner) is commonly found in South Korea and Japan. It is a plant from the Paleozoic era, belongs to the Nymphaeaceae family, and is a perennial herb [13]. Lotus flowers have been used for ornamental purposes, and tea ingredients and their leaves and roots have been used for edible purposes. Nelumbo nucifera leaves considered as lotus leaves have been used for treatment of diarrhea, edema, and bleeding disorders caused by hot and humid weather because they have been known to be effective in reducing heat, maintaining moisture inside the body, and achieving hemostasis [14]. Thus, the pharmacological action of lotus leaves has been investigated nationally and internationally. Especially, its anti-obesity action, effect on the endocrine system, and effect on the lipid metabolism have been reported in previous studies. Lotus extract has been reported to have an effect of reducing fasting blood glucose, total cholesterol, and triglyceride in diabetic animals, thus showing anti-diabetic and anti-lipid effects [15]. In addition, it has been reported that lotus extract has an effect of improving obesity and hyperlipidemia [16], reducing blood glucose [17], anti-oxidation, and protecting neurons [18] in animals with high fat diet-induced obesity. Also, it has been known that long-term use of lotus leaves might exert a suppressive effect on adipose tissue differentiation at the cellular level [19]. Although we can assume that lotus leaf intake may have a direct positive effect on lipid metabolism, it is still unclear whether lotus leaf consumption has an effect of reducing the food intake. Recently, proteinase inhibitor 2 (PI2), found in potatoes, has received great attention for effectively controlling cholecystokinin [20]; therefore, it can be expected that PI2 combined with lotus leaf intake will be able to induce cholecystokinin secretion and subsequently reduce body fat. Based on the previous reports, the purpose of this study was to investigate the effects of potato and lotus leaf extract intake on body composition, abdominal fat, and blood lipid concentration in female university students.

METHODS

Participants

A total of 19 female university students from Y university in Kyungki-do participated in this study and they were randomly assigned into 2 groups; potato and lotus leaf extract (skinny-line) administered group (SKG, $n = 9$) and placebo group (PG, $n = 10$). The minimum required number of participants was calculated by setting a significance level of 5%, type 2 error of $\beta = 0.2$, and power at 70%. Participants in the SKG consumed 230 ml of skinny-line, 3 times a day (total daily dose of 690 ml) after meals for 8 weeks and portion control was not conducted during the meal (Table 1).

Measurement items and methods

Body composition

To measure percent body fat and abdominal fat changes after 8 weeks, dual energy X-ray absorptiometry (DEXA, HV-PS 7681, Lunar, USA) was used. To avoid measurement error, participants were asked to remove all types of metal ornaments (necklace, watch etc.). In this study, measurement using DEXA was conducted 3 times at baseline, at 4 weeks, and at 8 weeks.

Blood withdrawal and analysis

Blood was obtained (5ml tube) from a vein in the antecubital fossa and samples were collected. All participants

Table 1. Characteristics of the study participants

Group	Age, yrs	Weight, kg	Height, cm	BMI, kg/m^2
SKG	20.55 ± 1.33	58.14 ± 1.04	1.59 ± 0.04	22.97 ± 1.81
PG	20.80 ± 1.14	61.69 ± 5.52	1.62 ± 0.04	23.54 ± 2.06
t value	0.43	-1.61	-1.59	-0.65

Values are expressed as mean and standard deviation
SKG = Skinny-line intake group, PG = placebo group

were fasted for 12 hours and blood withdrawal was conducted at 6:00 am. The blood samples were stored at 4℃ in anticoagulant EDTA tubes and serum tubes. Blood analysis was performed after centrifugation (at 3000 rpm for 15 mins).

Total cholesterol

Total cholesterol concentration was analyzed by the enzymatic colorimetric method using a spectrophotometer. Total cholesterol concentration was measured by using a quantified total cholesterol kit and 1,000 ml from the kit and 20 ml from the sample were combined and mixed. Then, the mixed sample was maintained at 37℃ for 5 minutes and total cholesterol concentration was measured.

Triglyceride

Blood triglyceride was analyzed by the enzymatic colorimetric method using a spectrophotometer. Blood triglyceride concentration was measured by using a triglyceride kit and 1,000 ml from the kit and 20 ml from the sample were combined and mixed. Then, the mixed sample was maintained at 37℃ for 5 minutes and triglyceride concentration was measured.

HDL-C

High density lipoprotein concentration was analyzed by using the serum collected in 6 ml vacutainer tubes containing SST gel and coagulation activator. Quantified kit (Nedin, Korea) under 505nm was used for analyzing and measuring HDL-C.

LDL-C

Low density lipoprotein concentration was analyzed by using the serum collected in 6 ml vacutainer tubes containing SST gel and coagulation activator. Quantified kit (Nedin, Korea) under 505nm was used for analyzing and measuring LDL-C.

Potato and lotus leaf extract (skinny-line) intake

Skinny-line extracted from potato and lotus leaves was prepared for suppressing lipid synthesis during CHO ingestion. This study pre-tested skinny-line, and it showed improved utility. Therefore, skinny-line intake period was set as 8 weeks [20]. Skinny-line was mainly made up of potato and lotus leaves combined with hydroxycitric acid and purified water. Natural ingredients extracted from potato and lotus leaves were prepared by the health functional food development laboratory in Aribio Company (Republic of Korea), and all participants consumed the extract by using a 230 ml container that provided the exact dose. Monitoring of skinny-line intake during 8 weeks was conducted every day over the phone and daily monitoring of safety of skinny-line intake was also performed. Ingestant for the PG was prepared in a manner similar to skinny-line, considering the color, taste, and flavor.

Data analysis

All data are expressed as mean and standard deviation. Descriptive statistics were used for changes in variables. Two-way mixed ANOVA (group; SKG = Skinny-line intake group, PG = placebo group × repeated; pre, post 4 weeks, and post 8 weeks) was used to test the interaction between the SKG and the PG in terms of body composition, abdominal fat, and blood lipids following skinny-line intake. All statistical analyses were conducted by using SPSS 21.0 for Windows (Chicago, IL, USA) and statistical significance was set at $p < 0.05$ for all tests.

RESULTS

Body composition changes

Body mass index, percent body fat, and abdominal fat in students of the SKG showed a decreasing tendency following skinny-line intake when compared to that in students of the PG; however, there was no significant interaction between the two groups <Table 2>.

Table 2. Percent body fat changes induced by skinny-line intake

	Group	pre	4 weeks	8 weeks	*F*	Group × Time
I, kg/m^2	SKG	23.52 ± 2.36	22.92 ± 1.69	22.84 ± 1.79	2.18	0.13
	PG	22.97 ± 1.81	23.09 ± 2.01	23.18 ± 1.54		
percent fat, %	SKG	37.19 ± 5.52	36.91 ± 5.57	36.85 ± 6.94	0.19	0.83
	PG	32.33 ± 4.56	31.47 ± 4.00	31.57 ± 3.91		
Android	SKG	38.13 ± 7.65	37.28 ± 6.83	37.57 ± 6.77	1.55	0.23
	PG	41.72 ± 6.51	42.42 ± 6.23	42.23 ± 5.87		
Gynoid	SKG	40.04 ± 3.74	39.11 ± 3.45	39.04 ± 3.17	1.22	0.31
	PG	42.98 ± 4.85	42.95 ± 4.73	43.09 ± 4.90		

Table 3. Blood cholesterol concentration changes induced by skinny-line intake

	Group	pre	4 weeks	8 weeks	F	Group × Time
Total cholesterol, mg/dl	SKG	185.48 ± 16.51	172.62 ± 18.42	167.78 ± 16.51	3.40	0.04
	PG	189.10 ± 29.88	193.91 ± 25.41	194.43 ± 27.35		
Triglyceride, mg/dl	SKG	95.38 ± 44.19	86.87 ± 29.38	84.75 ± 21.10	0.52	0.60
	PG	105.50 ± 55.16	112.87 ± 49.57	117.44 ± 63.62		
HDL-cholesterol, mg/dl	SKG	62.92 ± 15.01	64.56 ± 15.65	64.47 ± 9.87	0.21	0.81
	PG	63.15 ± 15.45	62.13 ± 14.80	64.31 ± 14.98		
LDL-cholesterol, mg/dl	SKG	91.34 ± 19.69	87.10 ± 24.84	80.27 ± 17.74	1.62	0.21
	PG	92.38 ± 21.76	90.77 ± 23.23	96.01 ± 19.19		

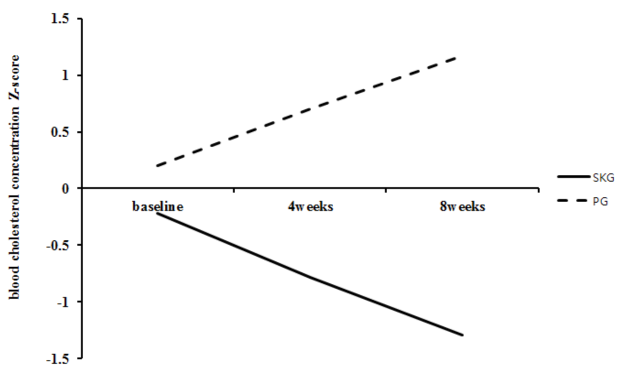

Fig. 1. Z-score changes in blood cholesterol concentration induced by skinny-line intake ($F = 4.824$, $p = 0.041$; calculating Z-scores of TC, TG, HDL-C, and LDL-C and then summation of each period value before treatment, after 4 weeks, and after 8 weeks)

Blood lipid changes

TC, TG, and LDL-C in students of the SKG showed an averagely decreasing tendency and there was a significant interaction of TC only ($p < 0.05$). HDL-C in students of the SKG showed an increasing tendency; however, there was no significant interaction between the two groups <Table 3>.

Z-scores of percent body fat and blood lipid changes

Z-score of fatness testing interaction in group × repetition did not show a significant interaction; however, there was a significant interaction of TC in group × repetition ($F = 4.824$, $p = 0.041$) <Fig. 1>.

DISCUSSION

Studies with the use of plants focusing on the anti-oxidant effect have been conducted in South Korea [21,22]; however, there are few systematic studies assessing the effects of physiological intake of natural plant ingredients. Therefore, this present study investigated the physiological effects on body composition and blood lipid changes in female university students following potato and lotus leaf extract intake.

Total cholesterol plays an important role in formation of the cell membrane and production of hormones; however, an excessive amount of total cholesterol may cause hyper-cholesterolemia and it is an important risk factor for coronary heart disease (CHD). Lowering TC concentration would be effective in decreasing the incidence of CHD according to several previous studies, and a decrease in TC concentration by 1% has been known to decrease the incidence of CHD by 2% [23,24]. Results of the present study showed that there was a significant interaction of TC in the SKG and PG with regard to groups and treatment period. Moreover, values of TC in the SKG showed a decreasing tendency and this confirms the positive effect of potato and lotus leaf extract intake. This result was similar to that in previous studies, which showed positive effects of lotus leaf intake on obesity, endocrine system, and lipid metabolism [25].

Lotus leaves (Nelumbo nucifera) are commonly found in South Korea and have been used as a natural remedy. Lotus flowers have been used for ornamental purposes, and tea ingredients and their leaves and roots have been used for edible purposes [26]. Dried lotus leaves have a bitter taste and have healing effects on bleeding stomach ulcer, gastritis, hemorrhoids, diarrhea, headache, hemoptysis, gynecological blood stasis after delivery, nocturia, and deintoxication [27]. However, few studies on lotus have been conducted so far. Recent research on lotus by Bhat and Sridhar [28] reported about the nutrients present in lotus seeds, Rai and colleagues [29] showed the anti-oxidant effect of lotus seeds, and Chiang and Luo [30] reported on changes in lotus root components while cooking. Most of these recent studies focused on lotus seeds and roots. Currently, most of the lotus leaves are usually discarded, and thus, studies on lotus leaves would provide information on new bioactive substances, which would be useful for developing natural dietary supplements.

Moreover, Rha and colleagues [31] reported that small colored potato extract intake in rats caused a significant decrease in TC compared to that in controls, which supports the results of the present study. The present study showed that there was a significant difference in android and gynoid fat distribution between the two groups; however, there was no significant interaction between the groups and there were no trend changes in the groups. Also, there was no significant difference in the interaction effect, group difference effect, and periodic changes in HDL-C, LDL-C, and TG between the two groups.

Similar to the results of the present study, the animal study by Cha and Cho [32] reported that potato extract added by 0.5% level of the meal caused no changes in body weight during 2 weeks. The study by Lee and Lee [33] reported that there was a decreased trend of body weight gain in the lotus leaf extract intake group compared to the high fat diet group. In other words, potato and lotus leaf extract intake might have caused a decreased trend of body weight gain in participants of this present study without controlling the dietary habit and daily activity. To obtain more accurate and basic study results, further studies are needed for evaluating different doses of potato and lotus leaf extract intake combined with a diet program and a physical activity program. Such studies might show more definite effects of potato and lotus leaf extract intake.

CONCLUSION

The purpose of this study was to investigate the effects of potato and lotus leaf extract intake on body composition, abdominal fat, and blood lipid concentration in female university students. Eight-week intake of potato and lotus leaf extract had a positive effect of decreasing TC. This study confirmed a positive trend in lowering blood lipids following potato and lotus leaf extract intake. Therefore, a further similar study is needed to obtain more detailed effects of potato and lotus leaf extract intake by considering the effective dose condition such as minimum dose, administration period, and administration type.

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