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Hypoglycemic Effects of Korean Wild Vegetables*

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ABSTRACT

The hypoglycemic effects of Korean wild vegetables : *Capsella bursa-pastoris* Medicus(CBM), *Commelina communis* L.(CCL), *Calystegica japonica* Choisy(CJC), *Discorea japonica* Thunb(DJT) and *Persicaria perfoliata* Gross(PPG) in diabetic rats were determined.

Sixty male Sprague-Dawley diabetic rats(130~180g) induced by the streptozotocin(45mg/kg) injection into the tail vein were fed either a control or experimental diets for four weeks. The plasma levels of glucose and cholesterol were measured. The urinary glucose levels were monitored. Crude fiber, mineral(Ca, Fe, Zn and Cr) and ascorbic acid contents of the wild vegetables were analyzed.

The extents of blood glucose decrement in CCL, DJT or PPG fed rats were greater than that in the control group. This extents of decrement in CBM or CJC fed rats were not significantly different from that in the control group. The urinary glucose was shown to be negative to Band reagent strip in CCL or DJT group at the 4th week. The plasma cholesterol levels of all the groups including control group were not essentially different. It is suggested that the intakes of CCL or DJT could be useful for preventive and therapeutic approches to alleviate the hyperglycemic status in diabetes mellitus.

KEY WORDS : Korean wild vegetables · diabetes mellitus · plasma glucose · plasma cholesterol.

Introduction

Korean wild vegetables have long been used in the folk remedies for various purposes including treatment of diabetes. Many of them have also been used as the important food resources[1)2)]. Although the pharmacological effects of several wild vegetables have been reported[3-9)], the efficacy has not been proved scientifically.

It has been a tendency of steady increase in adult diseases resulting from lack of minerals and dietary fiber. Excessive intakes of the animal foods or fat is another matters of recent concern. Therefore more consumption of the plant foods has strongly been recommended.

This study was undertaken to investigate the hypoglycemic and cholesterol lowering effects of five Korean wild vegetables(*Capsella bursa-pastoris* Me-

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dicus(CBM), *Commelina communis* L.(CCL), *Calystegica japonica* Choisy(CJC), *Discorea japonica* Thunb(DJT) and *Persicaria perfoliata* Gross(PPG)) in diabetic rats induced by streptozotocin(STZ) injection. These vegetables are commonly seen in the fields and consumed as herb salad, soup or tea. Also the key nutrients such as crude fiber, some minerals and ascorbic acid which were known to hypoglycemic action were assayed in these vegetables.

Materials and Method

Capsella bursa-pastoris Medicus(CBM) was collected from Namyangju region, Kyungki province in March 1991. *Commelina communis* L.(CCL), *Calystegica japonica* Choisy(CJC) and *Persicaria perfoliata* Gross(PPG) were collected from Ssangmundong Dobongku, Seoul in May 1991. *Discorea japonica* Thunb(DJT) was purchased from Kyungdong market in Seoul. The wild vegetables were washed with tap water, dried in the shade, powdered with an electric grinder. The animals received a semisynthetic diet which conformed with AIN-76 recommendation[10] with the exception of corn starch and cellulose(Table 1). Control diet contained cellulose(10 %) and corn starch(10%). Experimental diets were combined with Korean wild vegetable powders, 10 % each instead of cellulose.

Table 1. Composition of the animal diet

Components	Percent
Casein	20.0
DL Methionine	0.3
Corn starch	10.0
Sucrose	50.0
Cellulose or dried Korean wild vegetable	10.0
Corn oil	5.0
Choline bitarrate	0.2
AIN mineral mixture[1)]	3.5
AIN vitamin mixture[1)]	1.0

1) American Institute of Nutrition(AIN) Ad Hoc Committe on Standards for Nutritional Studies Report

Sixty male Sprague-Dawley rats of 130~180g were divided into 6 groups. They were fasted for 16 hours before injection of streptozotocin(Sigma Chemical, 45mg/kg/2ml citrate buffer) into the tail vein[11]. This amount of streptozotocin was reported as sufficient to induce diabetes mellitus[12][13]. Plasma glucose was monitored weekly. Rats were considered to be diabetic when non-fasting plasma glucose concentrations were higher than 200mg/dL. One group was fed control diet and all the other groups were fed experimental diet for four weeks. Diet and water were fed ad libitum.

Blood for plasma glucose was collected weekly in heparinized tubes from eye vein. They were sacrificed immediately following decapitation under light ether anesthesia and then blood was collected in heparinized tubes and plasma was separated by centrifugation(15 min in the Sorball Ultracentrifuge Model RC-5C, 3000rpm). Twenty-four hour urine samples were collected over 1ml of 1% acetic acid just before sacrifice. Feed intake were measured daily and body weights were recorded weekly. Plasma glucose levels were determined by the enzymatic method[14] using glucose kit(Yeongdong Pharm. Co., Seoul). Plasma cholestrol levels were determined by the enzymatic method using cholesterol kit (Yeongdong Pharm. Co., Seoul). Urinary glucose were traced by Band reagent strip(Yeongdong Pharm. Co., Seoul).

Crude fiber in the wild vegetables were analyzed by AOAC method(modified Henneberg-Stohman method)[15]. The vegetables were laid to ashes at 500℃ for 24 hours and was dissolved in 6N-HNO_3(3 ml) and then diluted with distilled water to appropriate volume. The minerals were measured by ICPS (Inductively Coupled Plasma Spectrophotometer, Labtam Ltd., 8440 ICP)[16]. Ascorbic acid was measured by 2,4-dinitrophenylhydrazin method[17].

All data were expressed as the mean S.D.. Statisti-

cal significance was determined by the t-test[18].

Results and Discussion

1. Effects on Body Weight and Feed Efficiency Ratio

Table 2 shows the effects of Korean wild vegetables on diet intake and feed efficiency ratio(FER) in diabetic rats. The FER of all animals were essentially similar except CCL group. The FER of CCL group was even higher than that of control group. It suggests that the preference for a taste of specific vegetable had no effect on the body weight gain.

The effect of Korean wild vegetables on body weight in diabetic rats is shown in Fig. 1. The body weight of all the groups increased until the third week on diet and then showed plateau. After the third week, the body weight gain of all experimental guoups except CCL was a little lower than that of control group. It was reported that insulin stimulates the active transport of amino acids into the skeletal muscle, thereby making them to move into protein synthesis[19)20]. The body weight is reduced in diabetes due to a lack or an inefficiency of insulin. From the results of the study we can presume that the consumption of Korean wild vegetables recovered the inefficiency of insulin in STZ induced diabetic rats.

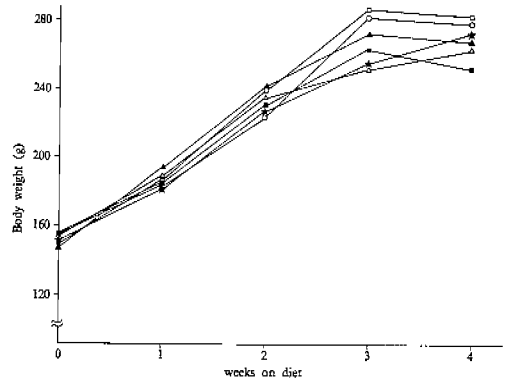

Fig. 1. Effect of Korean wild vegetables on body weight in diabetic rats.

2. Effects on Plasma and Urinary Glucose Levels

The effects of the wild vegetables on plasma glucose retention and urinary glucose in diabetic rats are shown in Fig. 2 and Table 3. It has been reported that the hyperglycemic state by STZ injection was due to the impairement of the pancreatic β-cell function[21] and followed 3 stages : the plasma glucose was decreased rapidly 7hrs after injection and increased slowly and maintained over 300mg

Table 2. Effects of Korean wild vegetables on diet intake and feed efficiency ratio(FER) in diabetic rats[1)]

Group	Diet intake (g/day)				FER
	1st week	2nd week	3rd week	4th week	
Control	14.3± 3.3	20.5± 2.9	22.3± 3.6	18.4± 3.0	0.236± 0.003
Capsella bursa-pastoris Medicus	16.9± 3.3	22.3± 5.5	23.7± 5.7	19.5± 4.4	0.206± 0.009
Commelina communis L.	11.7± 2.7	18.1± 3.7	19.9± 4.7	18.4± 1.6	0.271± 0.002*
Calystegica japonica Choisy	14.0± 3.1	20.6± 5.4	21.4± 3.1	20.4± 5.0	0.242± 0.087
Discorea japonica Thunb	15.8± 1.8	18.6± 3.6	18.6± 3.6	15.1± 3.6	0.245± 0.003
Persicaria perfoliata Gross	13.3± 4.6	19.7± 4.9	19.5± 4.9	17.8± 5.1	0.207± 0.104

1) Values are mean± S.D.(n=8)
An asterisk(*) indicates significantly different($p<0.05$) from the control value by the t-test

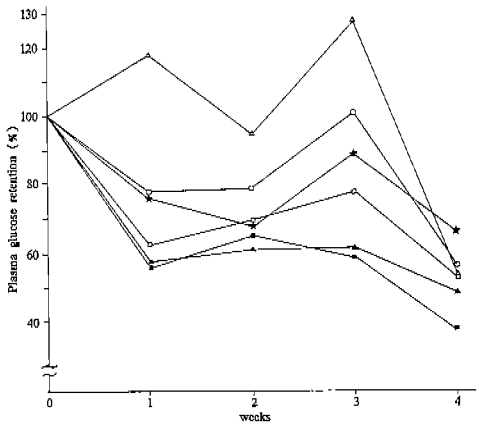

Fig. 2. Retention of plasma glucose fed with Korean wild vegetables in diabetic rats.

/dL at 24hrs later[13]. The plasma glucose was monitored in this experiment after 24hrs of STZ injection. The animals showed the hyperglycemic state and then decreased continuously but maintained over 140mg/dL. Since it was reported that the impaired pancreatic function by STZ injection could be recovered and insulin secretion is increased as time goes on[22], this decreasing tendency of plasma glucose in all the groups may not be the result of hypoglycemic effect of Korean wild vegetables per se. However, to exclude the individual variation of plasma glucose among animals after STZ injection, the retentions of plasma glucose(the percentage of an increase or a decrease from the first day plasma glucose concentration after the injection) were compared. The extents of decrement in CCL, DJT and PPG group were found to be greater than that in the control group. Moreover, the urinary glucose tests were negative in CCL and DJT group at the 4th week.

This suggests that CCL and DJT have the hypoglycemic effects in STZ induced diabetic animals. The extents of decrement of plasma glucose in CBM and CJC group were not significantly different from that in the control group and the urinary glucose test was still positive in several animals after the 4th week.

3. Effects on Plasma Cholesterol Level

Fig. 3 shows the effect of Korean wild vegetables on plasma cholesterol in diabetic rats. Although the plasma cholesterol level was elevated in PPG group, there was no significantly difference among all the groups compare to the control group. This result is consistent with the report observed in the other study with wild vegetables[23-25]. Although Yoshida et al.[26] reported that high fiber diet using

Table 3. Effect of Korean wild vegetables on urinary glucose in diabetic rats

Rat No.	Conurol	*Capsella bursa-pastoris* Medicus	*Commelina communis* L.	*Calystegica japonica* Choisy	*Discorea japonica* Thunb	*Persicaria perfoliata* Gross
1	–	+++	–	trace	–	–
2	–	+++	–	+	–	+++
3	–	+++	–	+	–	–
4	–	–	–	–	–	–
5	–	+++	–	+++	–	–
6	trace	–	–	–	–	–
7	trace	–	–	–	–	–
8	–	–	–	–	–	–

– : negative trace : 100mg/100ml of urine + : 250mg/100ml of urine
+++ : 1000mg/100ml of urine

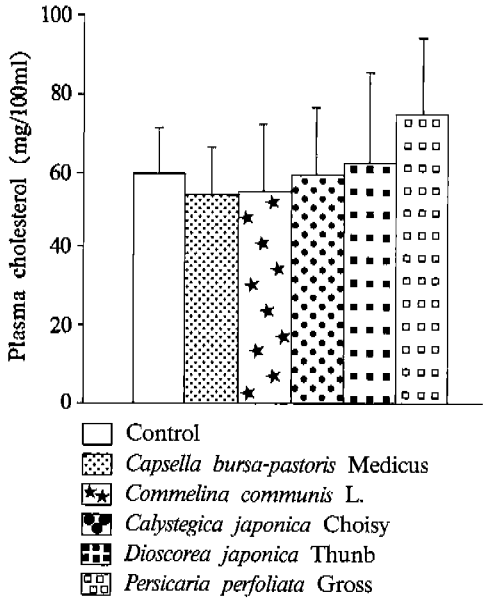

Fig. 3. Effect of Korean wild vegetables on plasma cholesterol in diabetic rats. All data are Mean± S.D. for the number of animals.

glucomannan as supplement confered beneficial effects on plasma cholesterol, it is supposed from our study that these five Korean wild vegetables have no effects on blood cholesterol levels in diabetic animals.

4. Contents of Crude fiber, Minerals and Ascorbic acid

The contents of crude fiber, minerals(Ca, Cr, Fe and Zn) and ascorbic acid in the wild vegetables are shown in Table 4. These nutrients have been reported to have the hypoglycemic effects in diabetes[27)28)]. The contents of crude fiber in dried materials were analyzed. The higher content was seen in PPG(24.4%) and the lower was in DJT(2.5%). The contents of crude fiber in Korean wild vegetables were higher than those in Korean other vegetables such as cabbage, spinach and lettuce although it was a little low in DJT. However, this difference of crude fiber is not supposed to be a factor of hypoglycemic effects in Korean wild vegetables. The level of ascorbic acid was high in fresh PPG(59.3 mg/100g) and low in fresh CBM (21.7mg/100g). Since ascorbic acid is considerably destroyed in drying and storage[29)], the level of ascorbic acid was at zero in DJT as we obtained dried sample. The contents of Ca, Fe, Zn and Cr were 196.73mg, 14.86 mg, 4.12mg and 0.71mg in CBM respectively and 24.67mg, 1.80mg, 1.31mg and 0.25mg in DJT respectively. All of these minerals in dried materials were observed the highest contents in CBM and the lowest contents in DJT. The contents of Fe in the wild vegetables were higher than those in the Korean tamed vegetables. The contents of Zn and Cr could not be compared because of an insufficient data.

Conclusion

The observations from this study have shown that CCL and DJT have the evident hypoglycemic effect

Table 4. Contents of crude fiber, vitamin C and minerals(Ca, Cr, Fe and Zn) in Korean wild vegetables[1)]

	Capsella bursa-pastoris Medicus	*Commelina communis* L.	*Calystegica japonica* Choisy	*Discorea japonica* Thunb	*Persicaria perfoliata* Gross
Crude fiber(%)	13.40± 1.30	17.70± 2.20	14.10± 2.70	2.50± 0.40	24.40± 1.20
Vit. C(mg/100g)	21.70± 2.40	25.30± 7.50	46.00± 7.10	0 ± 0	59.30± 13.70
Ca(mg/100g)	196.73± 22.56	130.07± 13.04	99.07± 18.10	24.67± 1.25	107.60± 23.24
Cr(mg/100g)	0.71± 0.04	0.59± 0.12	0.45± 0.07	0.25± 0.08	0.41± 0.06
Fe(mg/100g)	14.86± 3.53	7.29± 0.97	3.87± 0.33	1.80± 0.61	3.09± 0.25
Zn(mg/100g)	4.12± 2.26	2.63± 0.31	2.56± 1.02	1.31± 0.19	3.82± 2.67

[1)] Values are mean± S.D.

and PPG has some effect in diabetic animals. Analysis of crude fiber, some minerals and ascorbic acid revealed that these interesting nutrients were contained a quite extent comparably to the Korean tamed vegetables such as cabbage, spinach or lettuce. The significantly higher amounts of crude fiber and Fe were assayed from the wild vegetables. This study suggests that the intakes of CCL and DJT could be useful for preventive and therapeutic approaches to alleviate the hyperglycemic status in diabetes mellitus.

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=국 문 초 록=

한국산 야생식용식물의 혈당강하효과

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한국산 야생식용식물의 혈당강하 효과를 보기위해서 일차적으로 5가지 식물(냉이, 닭의장풀, 메꽃, 며느리배꼽 및 참마)을 채집하였다. Streptozotocin(45mg/kg)을 미정맥으로 주사하여 당뇨병을 유발시킨 130~180g Sprague-Dawley계 흰쥐를 대조군과 실험군으로 나누어 이들 5가지 식물을 ad libitum으로 공급하였다. 식용식물섭취에 따른 각군의 체중변화는 제3주까지는 점차 증가하다가 냉이군과 메꽃군을 제외하고는 제4주째에 증가추세가 둔화되었다. 식이이용효율은 닭의장풀군이 대조군에 비해 유의적으로 높게 나타났으며($p<0.05$) 냉이군, 메꽃군, 참마군과 며느리배꼽군에서는 식이이용효율에 차이가 없었다. 닭의장풀군, 참마군과 며느리배꼽군은 대조군에 비해 혈당 감소 경향이 지속적으로 나타났고, 뇨당의 경우에서도 닭의장풀군과 참마군에서는 검출되지 않았으며 며느리배꼽군에서도 한마리를 제외하고는 뇨당이 검출되지 않아 당뇨유발쥐에서 혈당강하에 효과가 있는 것으로 추정된다. 혈장 중의 cholesterol수준은 대조군에 비해 며느리배꼽군에서 약간 높은 경향을 보였으나 유의적인 차이는 없었다.

야생식용식물의 건조시료 중 조섬유의 함량은 며느리배꼽이 24.4%로 가장 높았고, 가장 낮은 것은 참마로 2.5%였다. 생시료 중 Vitamin C의 함량분석에서는 며느리배꼽에서 100g당 59.3mg으로 가장 높았고 냉이가 21.7mg으로 가장 낮았다. Mineral중 Ca의 함량은 냉이가 193.73mg으로 가장 높았고 닭의장풀, 며느리배꼽, 메꽃순이었고 참마가 24.6mg으로 가장 낮았다. Fe의 함량도 냉이가 14.86mg으로 높았고 참마가 가장 낮았다. Cr과 Zn의 함량도 냉이에서 높았고 참마에서 낮았다.

앞으로 야생식용산채류에 대한 성인병 예방 및 치료에 대하여 영양학적인 연구가 더 많이 이루어져야 할 것이다.