

Food therapy for DM

김 범 택

아주의대 가정의학과

강의 내용

- General diet recommendation for DM
- Glycemic index and Glycemic load
- Functional Diet approach for DM



TREATMENT GOALS OF DIABETIC DIET

- Optimize blood glucose control.
- Achieve and maintain reasonable body weight.
- Optimize lipid and lipoprotein profile.
- Reduce blood pressure.
- Prevent or delay the progression of chronic complications.
- Promote overall health through optimal nutrition.

권고 내용	권고등급	근거수준	권고도출 자료원
• 당뇨병전단계나 당뇨병을 가진 환자는 개별화된 임상영양요법 교육을 받아야 한다. ¹⁾	I	A	1, 92
• 일반적으로 필요 칼로리의 50-60%는 탄수화물, 15-20%는 단백질로부터 섭취하도록 하며, 지방으로부터의 섭취는 25% 이내로 한다. 그러나 영양소 배분은 식사패턴, 선호도, 치료목표 등을 고려하여 개별화할 수 있다. ²⁾	II b	D	1
• 탄수화물은 가능한 당 지수가 낮은 음식(전곡류, 콩, 과일, 채소, 유제품 등)을 통해 섭취하도록 한다. ³⁾	II b	B	1, 76
• 불포화지방산이 풍부한 음식 섭취는 권장하나, 포화지방이나 트랜스지방의 섭취는 제한하도록 한다. ⁴⁾	II b	B	1, 76
• 음주는 금하는 것이 좋다. 부득이하다면 혈당조절이 잘 되는 경우에 한하여 하루 1-2잔으로 제한하며, 저혈당 발생에 주의를 기울이도록 한다. ⁵⁾	II b	D	76
• 비타민이나 무기질의 보충은 권고되지 않는다. 그러나 결핍 상태에 있거나 제한적식이섭취를 할 경우에는 보충을 고려할 수 있다. ⁶⁾	III	D	1, 76

SETTING UP THE DIABETIC DIET

1. Calculating caloric needs
2. Determining dietary distribution of



Carbohydrate



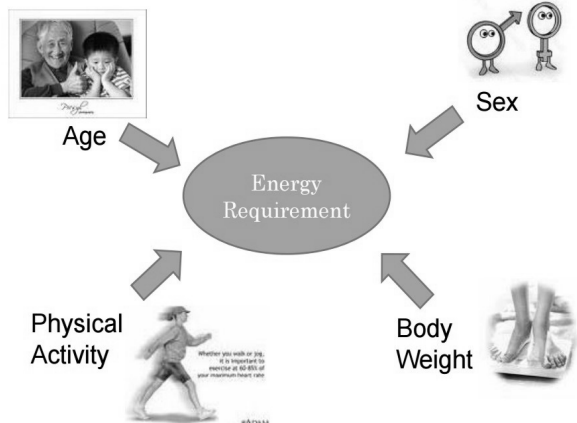
Protein



Fat

3. Dividing the daily prescription into practical, healthy meals.

HOW MUCH ENERGY DO WE NEED ?



ENERGY REQUIREMENT (KCAL / KG / DAY)

Weight Status	Activity Level		
	Light Activity	Moderate Activity	Heavy Activity
Obese (BMI ≥ 30.0)	20	25	30
Overweight (BMI 25.0 – 29.9)	25	30	35
Normal (BMI 18.5 – 24.9)	30	35	40
Underweight (BMI < 18.5)	35	40	45 - 50

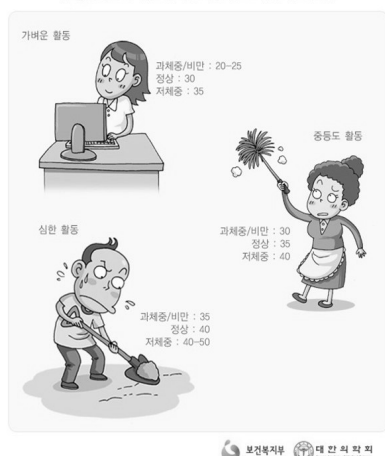
Calories allowance decrease with age:

18 – 39 years old: as above

40 – 59 years old: 5% less

> 60 years old: 10% less

(그림, 활동도와 비만도에 따른 체중 1킬로그램 당 필요 열량)



(그림, 식품군 교환표)

식품군	교환 단위 1개	1인분 (g)	2인분 (g)	3인분 (g)
곡류군	밥 1인분, 잡곡밥 1인분, 식빵 1개, 삶은국수(2인분), 면 1인분	23	2	100
채소군	소, 배, 사과, 감, 오렌지, 귤, 자두, 복숭아, 사과, 감, 오렌지, 귤, 자두, 복숭아, 사과, 감, 오렌지, 귤, 자두, 복숭아	8	2	50
과일군	사과, 배, 사과, 감, 오렌지, 귤, 자두, 복숭아, 사과, 감, 오렌지, 귤, 자두, 복숭아	8	2	50
유제품군	우유 1인분, 우유 1인분, 우유 1인분, 우유 1인분, 우유 1인분	11	6	125
단백질군	계란 1개, 닭가슴살 1인분, 돼지고기 1인분, 소고기 1인분, 돼지고기 1인분, 소고기 1인분	5	45	

식품군	총 교환 단위수	아침	점심	저녁
곡류군	8	2	3	3
채소군	5	1	2	2
과일군	7	2	3	2
유제품군	4	1	1.5	1.5
단백질군	2	1	1	1
기타군	2	1	1	1

(저혈당이 발생한 경우의 응급조치)

① 의식이 없는 경우

포도당수치의 정맥주사가 필요(응급실 방문)

② 의식이 있는 경우

▶ 포도당 또는 설탕 15g 정도를 섭취

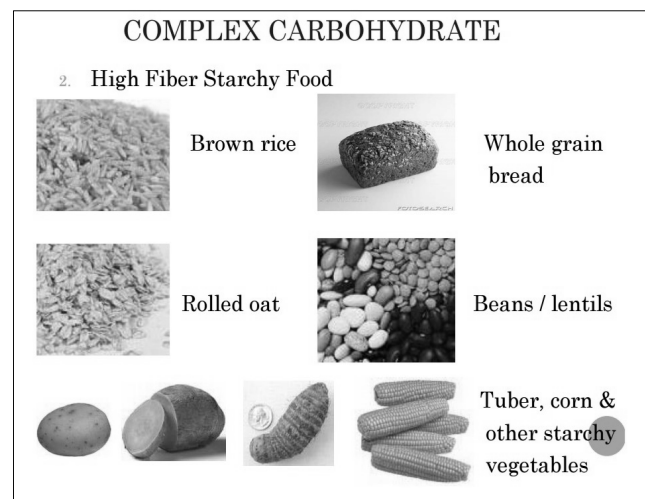
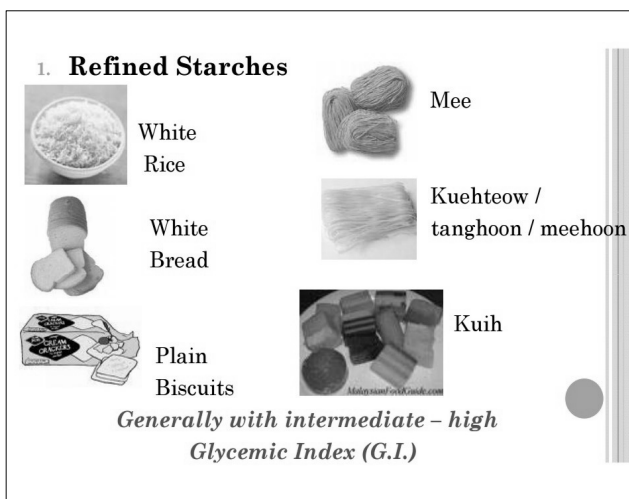
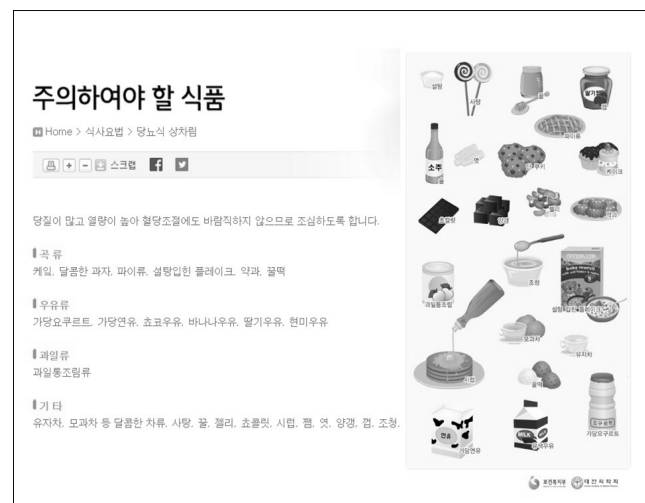
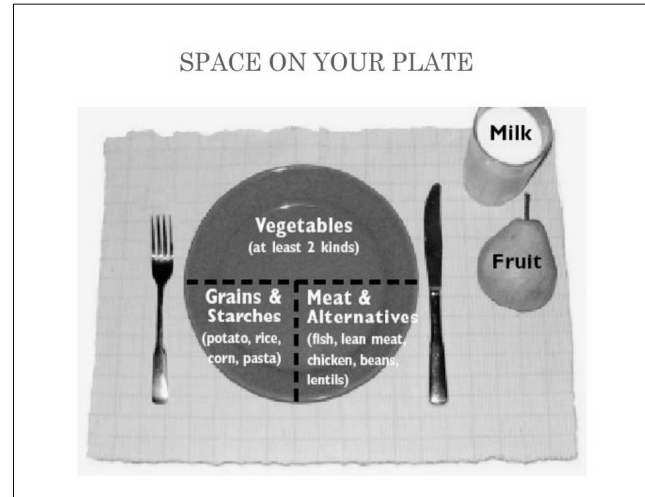
▶ 포도당 15g에 해당하는 음식



▶ 15분 뒤 측정된 혈당이 80 mg/dL 미만일 경우 설탕 15g 정도를 한번 더 섭취

▶ 혈당인 80 mg/dL 이상이라도 다음 식사시간까지 1시간 이상 남아있으면 다시 해당 분량을 한번 더 섭취

▶ 15분 후 다시 혈당을 측정하여 저혈당 반응이 끝났는지 확인



WHAT IS THE GLYCEMIC INDEX (G.I.)

- Numerical system that measures how fast a particular food will raise the blood glucose.
- The higher the blood glucose response, the higher the G.I.
- Glucose is given a value of 100, other CHOs are given a number relative to glucose.

G.I. for:  70  55  33

THE GLYCEMIC INDEX OF SOME COMMON FOODS

Sugars	G.I.	Grains	G.I.
Glucose	100	Rice – white (av)	72
Sucrose	65	brown (av)	60
Honey	58	basmati	58
Lactose	46	Oat – instant	66
Fructose	23	rolled	53
		Puffed rice	90
Bread		Cornflakes	83
White	70	Muesli	60
Wholemeal	68	Meehoon	58
Pita (wholemeal)	57	Corn	55
Mixed grain	45	Spaghetti	37

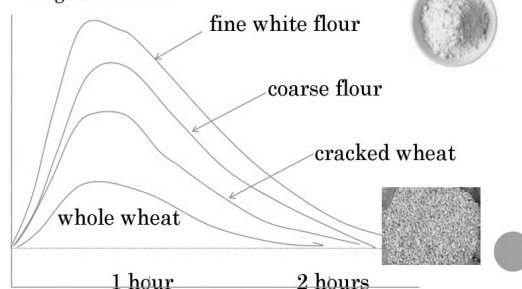
THE GLYCEMIC INDEX OF SOME COMMON FOODS

Root Veg	G.I.	Dairy Products	G.I.
Potato - baked	85	Ice cream	61
mashed	70	Milk – full cream	27
boiled	56	skim	32
Sweet potato	54	chocolate	34
Yam	51	flavour	
Legumes		Yogurt – low fat	33
Baked beans	48	(sweetened with	
Lentils (dal)	46	fruit sugar)	
Chick peas	33		
Kidney beans	27		
Soya beans	18		

FACTORS WHICH INFLUENCE THE G.I. OF A FOOD

1. The degree of processing / cooking

- The more processed / refined a food is, the higher the G.I.



당도와 당지수

당도 : 사과(14.4Brix)→포도(13.46)→감(12.93)→참외(12.33)→귤(10.75)→복숭아(10.41)→수박(10.34)→배(10.31)



당지수 : 복숭아(56.5)→수박(53.5)→참외(51.2)→귤(50.4)→포도(48.1)→배(35.7)→사과(33.5)



RDA for fiber (gm)

Adults	
Men	
9–13 years	31
14–18 years	38
19–30 years	38
31–50 years	38
51–70 years	30
> 70 years	30
Women	
9–13 years	26
14–18 years	26
19–30 years	25
31–50 years	25
51–70 years	21
> 70 years	21

사과의 영양분 비교

껍질(-)

Nutrition Facts	
Serving Size 110 g	
Amount Per Serving	
Calories 53	Calories from Fat 1
% Daily Value*	
Total Fat 0g	0%
Saturated Fat 0g	0%
Trans Fat	
Cholesterol 0mg	0%
Sodium 0mg	0%
Total Carbohydrate 14g	5%
Dietary Fiber 1g	6%
Sugars 11g	
Protein 0g	
Vitamin A 1%	Vitamin C 7%
Calcium 1%	Iron 0%

*Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs.

NutritionData.com

껍질(+)

Nutrition Facts	
Serving Size 125 g	
Amount Per Serving	
Calories 65	Calories from Fat 2
% Daily Value*	
Total Fat 0g	0%
Saturated Fat 0g	0%
Trans Fat	
Cholesterol 0mg	0%
Sodium 1mg	0%
Total Carbohydrate 17g	6%
Dietary Fiber 3g	12%
Sugars 13g	
Protein 0g	
Vitamin A 1%	Vitamin C 10%
Calcium 1%	Iron 1%

*Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs.

NutritionData.com

The formula for calculating glycemic load (GL)

$$GL = (GI \times \text{carbohydrates less fiber}) / 100$$

The examples below are based on GL ranges of low, moderate, and high

Low GL < 10 Moderate GL 10–14 High GL > 15



Example of a high-GI/low-GL food

A 120-gram serving of watermelon has a GI of 72 and the available carbohydrate is 6 grams (the amount of fiber contained in this serving does not warrant inclusion in the calculation). Therefore, the GL of watermelon is $(72 \times 6) / 100 = 4.3$.



Example of a low-GI/high-GL food

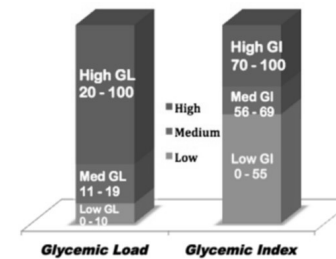
A 180-gram serving of cooked whole wheat spaghetti has a GI of 37. The amount of available carbohydrate is 36 grams (42 grams of carbohydrate minus the approximate 6 grams of fiber content). Therefore, the GL of whole wheat spaghetti is: $(37 \times 36) / 100 = 13$

Glycemic Load vs. Glycemic index

High GL
Pancakes (mix) - 38
White Rice - 26
Bagel (white) - 24
Cornflakes - 23

Medium GL
Basmati Rice - 18
Instant Oatmeal - 18
Banana - 16
Special K - 14
Raisin Bran - 12

Low GL
Oat Bran - 2
V8 Juice - 4
Carrots - 2.5
Apples - 6



High GI
Potato (boiled) - 78
White bread - 75
Whole Wheat Bread - 74
White Rice - 73
Table Sugar - 60

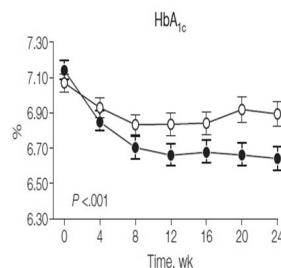
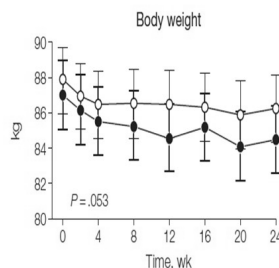
Medium GI
Special K - 69
Popcorn - 65
Honey - 61
Pineapple - 59
Banana - 47

Low GI
Oat Bran - 2
Lentils - 32
Apple - 36
Strawberries - 1

FOOD	Glycemic index (glucose = 100)	Serving size (grams)	Glycemic load per serving
FRUITS			
Apple, average	39	120	6
Banana, ripe	62	120	16
Dates, dried	42	60	18
Grapefruit	25	120	3
Grapes, average	59	120	11
Orange, average	40	120	4
Peach, average	42	120	5
Peach, canned in light syrup	40	120	5
Pear, average	38	120	4
Pear, canned in pear juice	43	120	5
Prunes, pitted	29	60	10
Raisins	64	60	28
Watermelon	72	120	4

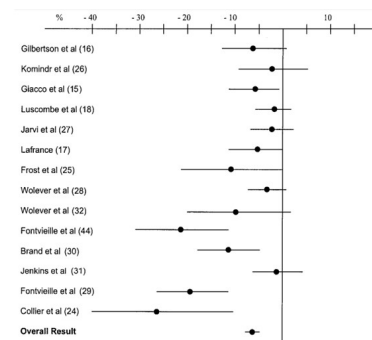
<http://www.health.harvard.edu/>

Effect of a Low-Glycemic Index or a High-Cereal Fiber Diet on Type 2 Diabetes



JAMA. 2008;300(23):2742-2753

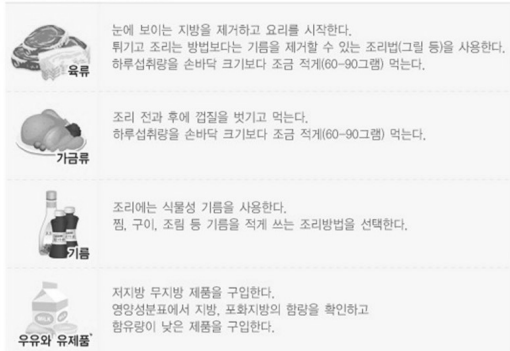
Effects of low glycemic food on Glucose control



Diabetes Care. 2003;26(8):2261-7

〈그림. 저지방 식이의 구체적 방법〉

저지방 식이의 구체적 방법

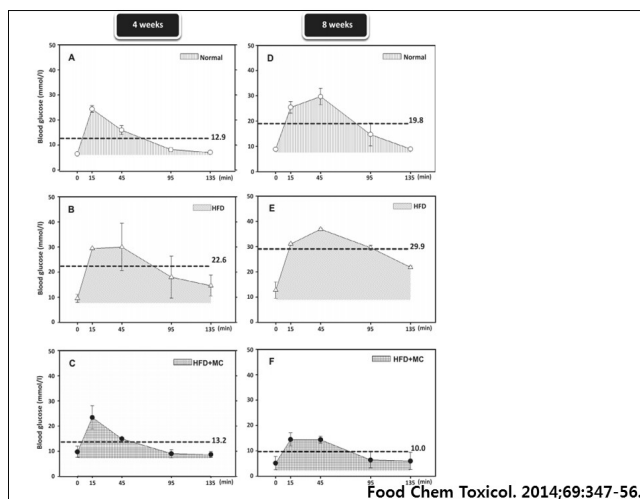


Bitter Melon



Bitter Melon

- Antidiabetic ingredients
 - Charantin : a blood glucose-lowering effect,
 - vicine
 - Polypeptide-p : an insulin-like compound
 - lectin : a major factor behind the hypoglycemic effect that develops after eating bitter melon.



Food Chem Toxicol. 2014;69:347-56.

Clinical trials of *M. charantia*.

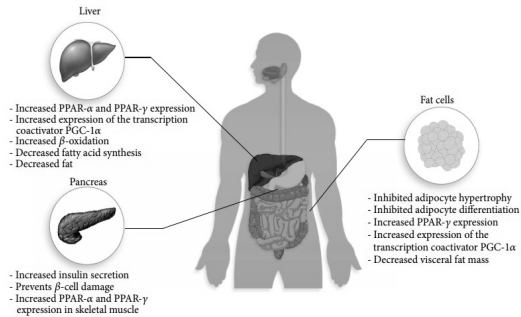
Study design	Subjects	Form of <i>M. charantia</i> administered	Treatment duration	Outcome measures	Statistical significance	Reference
Open-label uncontrolled supplementation trial	42 individuals	4.8 g lyophilized wild type bitter melon powder in capsules	3 months	MetS risk factors	Yes	[105]
Random design	26 subjects	Tablets	4 weeks	fructosamine assays	Yes	[60]
Multicenter, randomized, double-blind, active-control trial	4 groups	Capsule contained 500 mg of dried powder of the fruit pulp, containing 0.04-0.05% (w/w) of charantin	4 weeks	Fructose amine	Yes	[32]
Double-blind randomized controlled trial	40 with T2D (twenty trial and twenty control subjects)	Commercial herbal supplement capsules	3 months	HbA1c	No	[106]
Controlled trial	15 with T2D in 3 groups	Methanol extract of ground whole fruit	1 week	Fasting + postprandial blood glucose	Yes	[107]
Randomized controlled trial	50 with T2D (25 trial and 24 control subjects)	Tablets from dried whole fruit	4 weeks	(1) Fasting postprandial blood glucose (2) Fructose amine	No	[108]

Effect of metformin and bitter melon on DM at 4 weeks

	Baseline	Week 1	Week 4	Mean change from baseline (95% CI)
Fructosamine ($\mu\text{mol/L}$)				
Metformin 1000 mg/day (n=33)	308.3 \pm 68.1	305.5 \pm 60.4	291.5 \pm 51.9	-16.8 \pm 40.6 (-31.2, -2.4)
Bitter melon 500 mg/day (n=32)	316.2 \pm 56.9	315.0 \pm 55.6	312.7 \pm 54.1	-3.5 \pm 22.7 (-11.7, 4.6)
Bitter melon 1000 mg/day (n=31)	323.7 \pm 51.0	318.7 \pm 51.3	313.5 \pm 54.1	-10.3 \pm 33.9 (-22.7, 2.2)
Bitter melon 2000 mg/day (n=29)	326.8 \pm 52.8	323.3 \pm 48.6	316.6 \pm 48.1	-10.2 \pm 23.3 (-19.1, -1.3)
Fasting plasma glucose (mg/dL)				
Metformin 1000 mg/day (n=33)	140.0 \pm 22.6	133.8 \pm 21.3	125.2 \pm 22.7	-14.7 \pm 15.4 (-20.3, -9.4)
Bitter melon 500 mg/day (n=32)	140.3 \pm 17.4	137.1 \pm 22.4	140.9 \pm 29.4	0.9 \pm 21.4 (-69.8, 6.6)
Bitter melon 1000 mg/day (n=32)	139.5 \pm 16.0	137.2 \pm 21.9	141.6 \pm 27.4	2.1 \pm 26.3 (-74.1, 11.5)
Bitter melon 2000 mg/day (n=30)	139.9 \pm 15.8	135.7 \pm 19.3	137.6 \pm 18.1	-2.3 \pm 15.5 (-8.0, 3.5)
2-h plasma glucose after OGTT (mg/dL)				
Metformin 1000 mg/day (n=32)	262.2 \pm 73.9	238.8 \pm 74.8	230.3 \pm 67.7	-32.6 \pm 46.8 (-49.5, -15.8)
Bitter melon 500 mg/day (n=32)	272.0 \pm 44.5	275.6 \pm 54.0	266.6 \pm 59.6	-5.3 \pm 48.1 (-22.7, 12.0)
Bitter melon 1000 mg/day (n=30)	271.2 \pm 50.4	262.4 \pm 58.3	255.4 \pm 74.6	-12.3 \pm 62.7 (-35.7, 11.1)
Bitter melon 2000 mg/day (n=28)	242.6 \pm 47.7	255.5 \pm 64.2	242.2 \pm 59.2	-0.43 \pm 56.7 (-22.4, 21.6)

J Ethnopharmacol. 2011;134(2):422-8

molecular targets of bitter melon for improving obesity and diabetes.



J Lipids. 2015;2015:496169

Probiotics and DM

	Placebo (n=30)		P ^a	Placebo (n=30)		P ^a	Placebo (n=30)		P ^a
	Baseline	Probiotic (n=30)		Week 3	Probiotic (n=30)		Week 6	Probiotic (n=30)	
Energy (kcal/d)									
Crude	2389 ± 198	2443 ± 158	0.25	2450 ± 203	2504 ± 159	0.25	2509 ± 209	2565 ± 161	0.25
Adjusted ^b	2445 ± 179	2510 ± 179	0.17	2384 ± 177	2448 ± 177	0.17	2504 ± 182	2571 ± 182	0.16
Carbs (g/d)	330.6 ± 54.7	333.3 ± 36.9	0.82	339.0 ± 56.2	341.6 ± 37.6	0.83	347.1 ± 57.7	349.8 ± 38.4	0.83
Protein (g/d)	83.9 ± 17.8	86.6 ± 9.4	0.45	86.0 ± 18.3	88.8 ± 9.7	0.46	87.9 ± 18.7	90.9 ± 10.0	0.45
Fat (g/d)	85.2 ± 16.4	89.4 ± 12.9	0.27	87.3 ± 16.8	91.6 ± 13.1	0.27	89.4 ± 17.2	93.7 ± 13.1	0.27
SFAs (g/d)	25.2 ± 6.7	25.9 ± 5.1	0.64	25.8 ± 6.9	26.5 ± 5.3	0.63	26.3 ± 7.1	27.1 ± 5.4	0.62
PUFAs (g/d)	26.9 ± 6.9	28.8 ± 8.0	0.33	27.5 ± 6.9	29.5 ± 8.1	0.33	28.1 ± 6.9	30.1 ± 8.2	0.31
MUFAs (g/d)	23.7 ± 7.3	23.8 ± 4.7	0.99	24.3 ± 7.5	24.3 ± 4.8	0.99	24.9 ± 7.7	24.9 ± 4.8	0.99
Chol (mg/d)	224.9 ± 130.9	200.8 ± 98.0	0.42	230.4 ± 134.4	205.7 ± 100.8	0.42	235.8 ± 137.9	210.7 ± 103.6	0.42
TDF (g/d)	17.9 ± 4.3	19.4 ± 4.2	0.15	18.3 ± 4.5	19.9 ± 4.2	0.15	18.7 ± 4.7	20.3 ± 4.2	0.16
Mg (mg/d)	276.3 ± 76.6	305.0 ± 76.5	0.15	282.9 ± 78.3	312.4 ± 77.4	0.14	289.3 ± 80.4	318.5 ± 75.7	0.15
Zinc (mg/d)	10.0 ± 3.5	10.7 ± 2.3	0.40	10.2 ± 3.6	10.9 ± 2.4	0.40	10.5 ± 3.7	11.2 ± 2.4	0.40
Mn (mg/d)	2.1 ± 0.6	2.3 ± 0.7	0.27	2.2 ± 0.7	2.4 ± 0.8	0.24	2.2 ± 0.7	2.5 ± 0.7	0.23
Se (μg/d)	49.8 ± 5.1	51.6 ± 8.0	0.31	50.9 ± 5.1	52.7 ± 8.2	0.31	51.9 ± 5.4	53.9 ± 8.5	0.29

Diabetes Metab. 2016; S1262-3636(16)30396-2.

Probiotics and DM

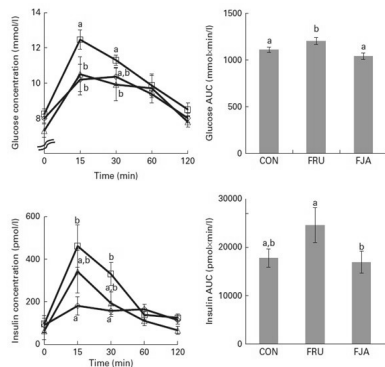
	Placebo group (n=30)				Probiotic group (n=30)				P ^b
	Baseline	Trial end	Change	P ^a	Baseline	Trial end	Change	P ^a	
FPG (mg/dL)	91.1 ± 9.6	92.2 ± 10.5	1.1 ± 12.2	0.60	96.9 ± 7.6	87.7 ± 7.1	-9.2 ± 9.2	<0.001	<0.001
Insulin (μIU/mL)	13.2 ± 5.5	17.8 ± 12.3	4.5 ± 10.6	0.02	12.0 ± 4.8	11.2 ± 4.4	-0.8 ± 3.1	0.19	0.01
HOMA-IR	3.0 ± 1.4	4.1 ± 2.7	1.1 ± 2.5	0.02	2.9 ± 1.2	2.5 ± 1.0	-0.4 ± 0.9	0.02	0.003
HOMA-B	48.7 ± 20.5	66.7 ± 50.6	18.0 ± 42.5	0.02	41.3 ± 18.5	42.4 ± 16.6	1.1 ± 9.8	0.55	0.03
QUICKI	0.33 ± 0.02	0.32 ± 0.02	-0.01 ± 0.02	0.11	0.33 ± 0.02	0.33 ± 0.02	0.007 ± 0.01	0.01	0.007
Triglycerides (mg/dL)	187.7 ± 63.7	214.8 ± 73.7	27.1 ± 37.9	<0.001	192.7 ± 84.9	191.1 ± 71.2	-1.6 ± 59.4	0.88	0.03
VLDL cholesterol (mg/dL)	37.5 ± 12.7	42.9 ± 14.7	5.4 ± 7.6	<0.001	38.5 ± 17.0	38.2 ± 14.2	-0.3 ± 11.9	0.88	0.03
Total cholesterol (mg/dL)	210.2 ± 46.4	213.7 ± 46.5	3.5 ± 20.4	0.35	188.7 ± 42.5	198.3 ± 47.5	9.6 ± 27.8	0.06	0.33
LDL cholesterol (mg/dL)	112.9 ± 32.2	113.4 ± 33.9	0.5 ± 16.5	0.88	100.0 ± 32.1	110.2 ± 37.7	10.2 ± 24.4	0.02	0.07
HDL cholesterol (mg/dL)	59.7 ± 14.0	57.4 ± 12.7	-2.3 ± 7.6	0.10	50.2 ± 8.4	49.9 ± 10.2	-0.3 ± 7.2	0.78	0.30

Diabetes Metab. 2016; S1262-3636(16)30396-2.

Prebiotics and DM

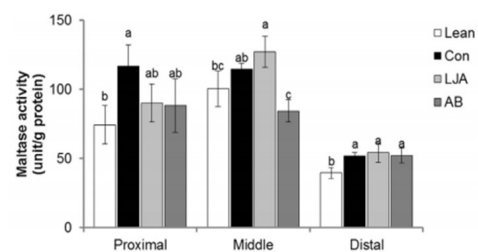


Antidiabetic effects of antichoke



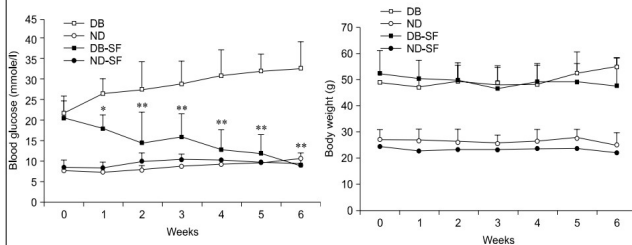
Br J Nutr. 2014;112(5):709-17

α-Glucosidase inhibition by antichoke



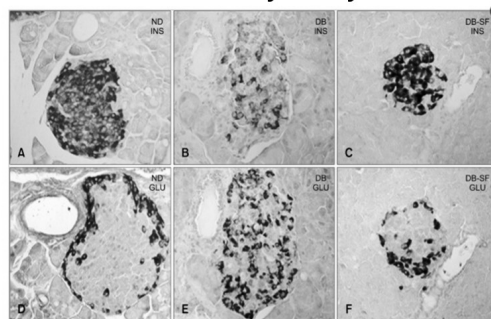
Nutr Res Pract. 2016;10(3):282-7

Anti-diabetic effect of Silk fibroin hydrolysate



J Vet Sci. 2012;13(4):339-44.

B-Cell sparing effect of Silk fibroin hydrolysate

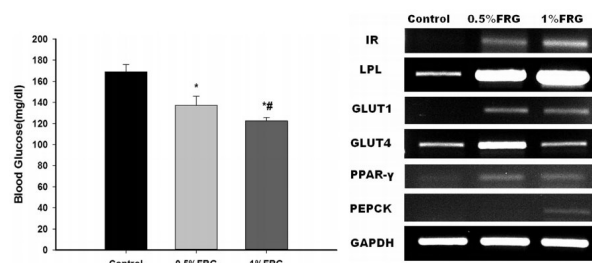


J Vet Sci. 2012;13(4):339-44.

홍삼

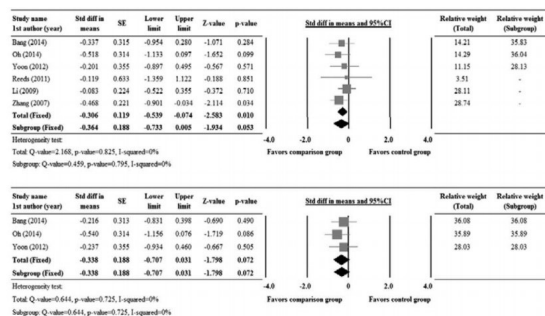


Ginseng vs. DM



J Ginseng Res. 2015 ;39(4):331-7

Glucose lowering of Ginseng



Medicine (Baltimore). 2016 Feb;95(6):e2584.

Take Home Message

- 당뇨병 음식 치료에서 가장 중요한 것은 과식을 피하는 것이다
- 혈당 조절을 위해서는 탄수화물, 특히 단 순당의 섭취를 줄이고, 저 당지수 식사를 하는 것이 유리하다
- Probiotics와 Prebiotics는 혈당조절과 베타 세포 기능 보전에 도움이 될 수 있다