EFFECTS OF COOKED LENTILS ON GLYCEMIC CONTROL AND BLOOD LIPIDS OF PATIENTS WITH TYPE 2 DIABETES

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Abstract

INTRODUCTION: Diabetes mellitus is the most important endocrine disease worldwide. Scientists recommend consumption of low glycemic index (LGI) foods for prevention and control of diabetess. This study was designed to test the effects of cooked lentil as a LGI food on blood glucose and lipid profile among type 2 diabetic patients.

METHODS: In a randomized cross-over clinical trial, 30 individuals with type 2 diabetes were randomly divided into 2 groups (A and B). At the 1st step, group A followed the normal diet and group B followed normal diet plus 50 g cooked lentil and 6 g canula oil substitute of 30g bread and 20 g cheese. After 6 weeks these two groups stopped their diets and put on wash out period for 3 weeks and later the diets were switched between them and continued for another 6-week-period. Anthropometric measurements, dietary intakes, serum lipids and glucose levels were determined at the beginning and the end of each period. Data was analyzed by Food Processor II and SPSS-13 softwares.

RESULTS: Body mass index, LDL-C, HDL-C ,triglycerides and serum Fructozamine were not significantly influenced by treatment whereas total cholesterol and fasting blood glucose decreased significantly ($P < 0.05$).

CONCLUSION: Cooked lentil consumption as a LGI food in breakfast can control FBS and serum total cholesterol. It might be a good regimen for improving glycemic control in type 2 diabetic patients.

Keywords: Diabetes mellitus, Lentil, Lipid profiles, Blood glucose, Glycemic index.

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Introduction

Diabetes mellitus is one of the most important endocrine diseases all around the world. It is estimated that the number of diabetic patients will increase to 300 million by the end of 2025.[1] About 50% of all diabetic cases are in the Asia.[2]

The aim of diet therapy in diabetes is to control basic pathophysiology of disease such as hyperglycemia, hyperlipidemia, insulin resistance, neuropathy, disturbance in heart efficiency and blood circulation. It's possible to prevent cardiovascular events in diabetic patients by tight control of blood sugar, hyperlipidemia and blood pressure.[3] Consumption of low glycemic index (LGI) diets such as legumes and nuts can correct lipid profiles and control glycemic responses and improve glycemic control in diabetic patients.[4]

Some limited studies have been conducted to evaluate the effects of lentils consumption as a low glycemic index food on glycemic control and lipid profile in diabetic patients.

The aim of present study was investigating the effects of lentils consumption on glycemic control and lipid profile in type 2 diabetic patients. It's worthy to mention that, 100 g of lentils contains 116.7 kcal energy, 9.04 g protein, 20.1 g carbohydrates, 0.37 g fat and 4.94 g dietary fibers.[5]

Materials and Methods

Thirty patients with type 2 diabetes (45 to 60 years old) were recruited in a cross-over clinical trial (Al-

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zahra hospital affiliated to Isfahan University of Medical Sciences). Inclusion criteria were absence of thyroid, kidney and digestive diseases; Insulin therapy, usage of warfarin, aspirin, corticosteroids and lipid lowering agents.

After subject's agreement and justification, they were asked about a normal breakfast composition and if they normally consume bread and cheese in breakfast, they were included in study. All individuals were trained about cooking foods and also guided for food questionnaire filling.

They randomly allocated into two groups (A & B). At the 1st period of study, group A followed of general diet with some instructions about restriction of inordinate legumes consumption. Group B followed normal diet with 50 g cooked lentil and 6 g canula oil substitute of 30 g bread and 20 g cheese in an isocaloric breakfast with the same amount of macronutrients for six weeks.

After 6 weeks, these two groups stopped their diets and put on washout period for 3 weeks and later the diets where switched between them for another 6-week period. Anthropometric measurements, dietary intakes, serum lipids and glucose levels were determined at the beginning and the end of each period.

Nutritional intakes were analyzed by Food Processor II software and other data were analyzed by SPSS-13 software. The plasma glucose level was measured by enzymatic method (CHOD-PAP) administered by Pars azmoon Iran company. Lipid profiles include total cholesterol, HDL_C and TG were measured by enzymatic method[6] and LDL_C by Friedwald formula.[7] Fructozamine was measured by using Nitroblutetrazolin (NBT) method.

Results

General characteristics of patients are represented in table 1. Diets components in different periods of study which was collected by food questionnaire showed that there was not any significant difference in the amount of total calorie, protein, lipid, carbohydrate and dietary fiber between two groups before and after intervention.

Table 1: General characteristics of subjects (mean ± SD)

Age (year)	50.2 ± 3.8
BMI* (kg/m^2)	28.9 ± 4.1
Height (M)	1.6 ± 0.15
Weight (Kg)	74.2 ± 15.6

Body mass index

Mean of plasma glucose levels at the end of each period of study in comparison with beginning of each period showed a significant reduction. ($P < 0.05$) (Table 2, 3). Significant difference

Table2: Food component before and after of treatment in two groups.*

Food component	Control group		Treatment group	
	before	after	before	after
Energy (Kcal)	1794.6 ± 463.5*	1782.6 ± 441.3	1778.3 ± 424.7	1806.9 ± 492.6
Carbohydrate (g)	248.6 ± 68.3	232.4 ± 75.6	224.4 ± 85.8	216.7 ± 64.6
Protein (g)	83.8 ± 21.3	86.6 ± 26.2	76.4 ± 28.1	80.1 ± 19.8
Fat (g)	58.6 ± 24.9	56.6 ± 28.5	62.3 ± 24.1	61.4 ± 3.4
Dietary fiber (g)	24.6 ± 8.9	23.3 ± 6.4	24.4 ± 5.5	28.6 ± 3.4

* Mean ± SD

Table 3: Comparison of fasting blood sugar and lipid profiles in total study.*

Indexes	Control group			Treatment group		
	before	after	p	before	after	p
FBS (mg/dl)	154/6 ± 12.5*	153.1 ± 10.3	NS	154.3 ± 14.7	151.9 ± 12.6	< 0.05
Total cholesterol (mg/dl)	232.6 ± 15.3	236.4 ± 17.6	NS	228.07 ± 15.8	220.1±14.6	< 0.05
Triglycerides (mg/dl)	233.8 ± 64.3	232.6 ± 61.1	NS	223.4 ± 58.7	223.1 ± 62.2	NS
LDL_C (mg/dl)	142.4 ± 16.8	143.9 ± 14.5	NS	144.3 ± 13.1	145.1 ± 14.3	NS
HDL_C (mg/dl)	48.6 ± 24.9	48.9 ± 23.2	NS	46.4 ± 14.1	45.6 ± 18.9	NS

* Mean ± SD

was seen in plasma glucose level before and after the lentil regimen ($P < 0.05$).

there was not any significant difference about other biochemical parameters (Table 4).

Discussion

Results of this study showed that by substituting baked lentils in breakfast, it's possible to improve glycemic index and serum total cholesterol level in diabetic patients. As in current study consuming baked lentils cause a significant reduction in total cholesterol and fasting plasma glucose levels ($P < 0.05$). However it didn't have a significant influence on other lipid profiles include LDL_C, HDL_C and triglyceride.

Giaco R and Gilberson H studies like the current study proved that a low glycemic index diet (LGID) develops glycemic control of diabetic patients.[4,8] But unlike them Lafrance believes that this diet doesn't have any effect on glycemic control.[9]

Reduction of plasma glucose in current study is the same as other previous studies.[10-14] However, the result of Luscombe study was not the same.[10] In that study against expectation fasting plasma glucose increased after the LGI diet, which can be due to reduction of blood density in LGI diet as a result of water reservation, slower digestion of starch and lower availability to glucose.[10] In Kabir study like current study, there wasn't any significant influence on lipid profile levels except for the total cholesterol.[15] Many studies have defended the treatment effect of three meals in day of LGI diet.[3,4,8] The kind and structure of food is one of influencing factors on glucose absorption from starchy foods and as a result glycemic index of foods that can include amylase to amylopectin ratio found in raw foods, the amount of monosacharides, the amount and kind of dietary fiber, the amount and kind of food processing, great amounts of lipids and proteins and existence of anti nutrients such as fitic acid, lectin and tannin. Probable influences of LGI diets on glucose metabolism includes: 1-reduction of glucose poisoning or influence of great amounts of glucose on destruction of pancreas β cells.2-reduction of proteins and key enzymes glycozilation which are responsible for metabolic processes.

The matrix and natural plant nets of LGI foods surround granules of carbohydrate and limits digestive enzymes access and distribution of solutions to inside of these nets. So they prevent the immediate increasing of postprandial blood glucose. One of the mechanisms of LGI diets in blood lipids reduction is greater amounts of amylose in comparison to amylopectin in these diets. Because digestion and absorption of amylose part of starchy foods are much slower than amylopectin. In other hand, Glycemic index of amylase is less than amylopectin. Many of researchers believe that branching of amylopectin is the reason for increasing of accessible surface of digestive enzymes and as a result, increasing of amylopectin digestion and absorption compare to amylase.[17]

Table 4: Comparison of differences of fasting blood sugar and lipid profiles in total study

Indexes	Control group		Treatment group	
	Differences	p	Differences	p
FBS(mg/dl)	1.2 ± 4.39*	NS	2.57 ± 4.7	< 0.05
Total cholesterol (mg/dl)	-4.8 ± 7.8	NS	7.0 ± 6.31	< 0.05
Triglycerides (mg/dl)	1.03 ± 6.6	NS	0.39 ± 5.7	NS
LDL_C (mg/dl)	-1.53 ± 6.8	NS	-0.71 ± 4.3	NS
HDL_C (mg/dl)	-0.4 ± 5.1	NS	1.0 ± 6.8	NS

* Mean ± SD

LGI diets are richer than HGI diets in anti nutrients (include fitic acid, lectin and tannin).These materials cause reduction of starch digestion and balance postprandial glycemia increasing.[18] Other probable mechanisms of LGI diets in altering blood lipids are as follow: 1- Reduction of activity of HMG-coA reductase enzyme dependent on insulin as a result of reduction of carbohydrate absorption. 2-Disturbance in reabsorbing of bilious acids and cholesterol from ileum because of high dietary fiber content of LGI diets.3-hinderance of hepatic cholesterol synthesis by propionate(SCFA) which is one of the byproduct of colonic fermentation.[19]

Lentil is one of the richest sources of β-glucan wich is capable of total cholesterol reduction by increasing steroids excretion in stool or increasing production of Short chain escapable fatty acids (SCFA) such as propionates. In some researcher's point of view, since it contains lots of insoluble fibers, little fermentation of them isn't capable of producing large amounts of SCFAs. Lentil containes 70% carbohydrates which 38% of is made up of oligosacharids. Other carbohydrate which exist in lentil is (RS) resistance starch.[20]

Insignificant change in serum TG and HDL_C levels in current study is similar to most of results reported by previous studies. Among previous studies Luscombe et al[10] and Wolever et al[21] were the only ones that reported reduction of TG by LGI diet. Beside this, great biological differences in TG levels among different persons can be due to influence of diet (amount of dietary fibers and carbohydrates), exercise, alcohol consumption, season and periodic differences, smoking and etc.

Insignificant changes in serum fructosamine levels is similar to Kabir et al study[15] but is converse to Fontvielli's results.[22] Fructosamine is indicator of plasma glycozilated proteins and as a results showes plasma glucose levels in the life duration of plasma proteins.It seems that reduction of diet's glycemic loud just by change in glycemic index of breakfast or little changes in glycemic index of diet isn't enough for creation of significant changes in serum fructosamine. In fact change of diet's GI in current study is much less than changes in studies such as Fontvielli[22] which reported reduction of serum fructosamine. Because in those studies this change was administrated in each three meals.[21] Maybe if there was a bigger change in serum glucose, we could observe reduction of serum fructosamine.

It seems that in current study and many similar studies which didn't achieve powerful results; more time is needed to observe effects of LGI diets. The difference between current study and some other similar studies is consumption of more than one kind of LGI foods in breakfast in other studies, which caused to intensification of effects of these foods. There is need to more long term studies for a better evaluation of these hypothesizes.

This study, in the same direction of results of many previous studies, showed that LGI diet which contains intermediate amount of carbohydrates from LGI sources is likely to function more effectively in reduction of risk factors of cardiovascular diseases in comparison with many other diets (such as low fat diet).

References

1. Wild S, Roglic G, Green A, Sicree R, King H. Global prevalence of diabetes: estimates for the year 2000 and projections for 2030. Diabetes Care 2004; 27(5): 1047-53.
2. Rizkalla SW, Taghrid L, Laromiguiere M, Huet D, Boillot J, Rigoir A, et al. Improved plasma glucose control, whole-body glucose utilization, and lipid profile on a low-glycemic index diet in type 2 diabetic men: a randomized controlled trial. Diabetes Care 2004; 27(8): 1866-72.
3. Giacco R, Parillo M, Rivellese AA, Lasorella G, Giacco A, D'Episcopo L, et al. Long-term dietary treatment with increased amounts of fiber-rich low-glycemic index natural foods improves blood glucose control and reduces the number of hypoglycemic events in type 1 diabetic patients. Diabetes Care 2000; 23(10): 1461-6.
4. Movahhedi A, Rusta R. Table of food Components. Iranian. Tehran: Institude of nutrition and food science research; 2000. p. 17.
5. Burtis CA, Ashwood ER, Tietz NW. Tiets textbook of clinical chemistry. 3rd ed. Philadelphia: WB. Saunders; 1999. p. 778-980.
6. Friedewald WT, Levy RI, Fredrickson DS. Estimation of the concentration of low-density lipoprotein cholesterol in plasma, without use of the preparative ultracentrifuge. Clin Chem 1972; 18(6): 499-502.
7. Gilbertson HR, Brand-Miller JC, Thorburn AW, Evans S, Chondros P, Werther GA. The effect of flexible low glycemic index dietary advice versus measured carbohydrate exchange diets on glycemic control in children with type 1 diabetes. Diabetes Care 2001; 24(7): 1137-43.
8. Lafrance L, Rabasa-Lhoret R, Poisson D, Ducros F, Chiasson JL. Effects of different glycaemic index foods and dietary fibre intake on glycaemic control in type 1 diabetic patients on intensive insulin therapy. Diabet Med 1998; 15(11): 972-8.
9. Luscombe ND, Noakes M, Clifton PM. Diets high and low in glycemic index versus high monounsaturated fat diets: effects on glucose and lipid metabolism in NIDDM. Eur J Clin Nutr 1999; 53(6): 473-8.

10. Heilbronn LK, Noakes M, Clifton PM. The effect of high- and low-glycemic index energy restricted diets on plasma lipid and glucose profiles in type 2 diabetic subjects with varying glycemic control. J Am Coll Nutr 2002; 21(2): 120-7.

11. Jarvi AE, Karlstrom BE, Granfeldt YE, Bjorck IE, Asp NG, Vessby BO. Improved glycemic control and lipid profile and normalized fibrinolytic activity on a low-glycemic index diet in type 2 diabetic patients. Diabetes Care 1999; 22(1): 10-8.

12. Jenkins DJ, Wolever TM, Collier GR, Ocana A, Rao AV, Buckley G, et al. Metabolic effects of a low-glycemic-index diet. Am J Clin Nutr 1987; 46(6): 968-75.

13. Kim JI, Kim JC, Kang MJ, Lee MS, Kim JJ, Cha IJ. Effects of pinitol isolated from soybeans on glycaemic control and cardiovascular risk factors in Korean patients with type II diabetes mellitus: a randomized controlled study. Eur J Clin Nutr 2005; 59(3): 456-8.

14. Kabir M, Oppert JM, Vidal H, Bruzzo F, Fiquet C, Wursch P, et al. Four-week low-glycemic index breakfast with a modest amount of soluble fibers in type 2 diabetic men. Metabolism 2002; 51(7): 819-26.

15. Paolisso G, Giugliano D, Pizza G, Gambardella A, Tesauro P, Varricchio M, et al. Glutathione infusion potentiates glucose-induced insulin secretion in aged patients with impaired glucose tolerance. Diabetes Care 1992; 15(1): 1-7.

16. Byrnes SE, Miller JC, Denyer GS. Amylopectin starch promotes the development of insulin resistance in rats. J Nutr 1995; 125(6): 1430-7.

17. Rea RL, Thompson LU, Jenkins D. Lectins in foods and their relation to starch digestibility. Nutr-Res 1985; 5(9): 919-29.

18. Garg A. Insulin resistance in the pathogenesis of dyslipidemia. Diabetes Care 1996; 19(4): 387-9.

19. Stephen AM, Dahl WJ, Sieber GM, van Blaricom JA, Morgan DR. Effect of green lentils on colonic function, nitrogen balance, and serum lipids in healthy human subjects. Am J Clin Nutr 1995; 62(6): 1261-7.

20. Wolever TM, Jenkins DJ, Vuksan V, Jenkins AL, Buckley GC, Wong GS, et al. Beneficial effect of a low glycaemic index diet in type 2 diabetes. Diabet Med 1992; 9(5): 451-8.

21. Fontvieille AM, Rizkalla SW, Penfornis A, Acosta M, Bornet FR, Slama G. The use of low glycaemic index foods improves metabolic control of diabetic patients over five weeks. Diabet Med 1992; 9(5): 444-50.

22. Tsihlias EB, Gibbs AL, McBurney MI, Wolever TM. Comparison of high- and low-glycemic-index breakfast cereals with monounsaturated fat in the long-term dietary management of type 2 diabetes. Am J Clin Nutr 2000; 72(2): 439-49.