Int J Pharm Bio Sci 2013 Apr; 4(2): (B) 511 - 517

Research Article **Biochemistry**

International Journal of Pharma and Bio Sciences **ISSN 0975-6299**

EFFECT OF APPLE ON FASTING BLOOD SUGAR AND PLASMA LIPIDS LEVELS IN TYPE II DIABETES

N. S. DANGE*[1] AND KEDAR DESHPANDE[2]

[1] Department of Biochemistry, GMC, Jagdalpur, Chhattisgarh.
[2] Department of Biochemistry, GMC, Nagpur, Maharastra

ABSTRACT

Apple products have been shown to prevent skin, mammary gland and colon carcinogenesis in animal models. Epidemiological observations indicate that regular consumption of one or more apples a day may reduce the risk for lung and colon cancer. The present study investigated the potential effects of apples on fasting blood sugar and lipid parameters in Type II diabetics' patients.Study includes 98 Type II diabetics' patients attending diabetic OPD, which was divided into two groups. Type II diabetic (n=54) who were willing to take an apple in the diet daily, consider as subjects and remaining (n=44) Type II diabetics taken as controls. FBS and lipid profile were measured at baseline and after four weeks and compared to that of controls.FBS levels highly significant ($p<0.0001$) decreases in Type II diabetics as compared to controls. This finding also found when compared to age and sex wise. Fasting total cholesterol, triglycerides, LDL cholesterol were significantly decreases as compared to controls. HDL cholesterol significantly increases in Type II diabetics, who consumed apple. Present study revealed that one medium size apple in diet of Type II diabetics reduces the fasting blood sugar levels and lipid parameters which are beneficial for normal health of diabetics along with anti-diabetic drugs.

KEYWORDS:- Apple, FBS-fasting blood sugar, LDL- low density lipoprotein, HDL- high density lipoprotein, anti-diabetic drugs.

N. S. DANGE
Department of Biochemistry, GMC, Jagdalpur, Chhattisgarh.

INTRODUCTION

Type 2 Diabetes Mellitus (T2DM) is one of the primary threats to human health due to its increasing prevalence, chronic course and disabling complications. Type 2 diabetes mellitus (T2DM) and dyslipidemia are important risk factors for cardiovascular disease [1,2]. Synthetic hypoglycaemic drugs cannot fully control glucose level as well as cause side effects prompting the patients stop taking the medication.Since the mid- 1970s, the hypotheses of Burkitt and Trowell [3] have stimulated a great deal of interest in dietary fiber, its physiological effect, and its possible role in prevention of common western diseases. This interest has now extended to the possibility that dietary fiber may be useful in the management of diabetes mellitus.Apples (MALUS sp., Rosaceae) are a rich source of nutrient as well as non-nutrient components and contain high levels of polyphenols and other phytochemicals. Main structural classes of apple constituents include hydroxycinnamic acids, dihydrochalcones, flavonols (quercetin glycosides), catechins and oligomeric procyanidins, as well as triterpenoids in apple peel and anthocyanins in red apples. Several lines of evidence suggest that apples and apple products possess a wide range of biological activities which may contribute to health beneficial effects against cardiovascular disease, asthma and pulmonary dysfunction, diabetes, obesity, and cancer [4]. However, there are convincing data suggesting an association between apple product and reduced risk of major diseases and indicating multiple possible mechanisms by which apple product might be protective in humans. Many recent studies demonstrate a beneficial effect of apple product on critical processes in the aetiology of disease at the metabolic and cellular level. There are current data suggesting that apple product might be linked to reduced risk of several forms of cancer, cardiovascular disease, and asthma. Apple product may also have beneficial effects on outcomes related to Alzheimer's disease, cognitive decline of normal aging, diabetes, weight management, bone health, and gastrointestinal protection from drug injury [5]Apple is one of the most valuable sub-acid fruit. It is rich in pectin content; which is a natural therapeutic ingredient and hence extremely beneficial in the treatment of diabetes. Pectin is found in the inner portion of ripe and pulp. It helps in detoxification of the body and eliminates harmful substan In recent time plant food had confirmed the effectiveness in treating diabetes. Apples are high in the soluble fiber pectin, making them good at controlling blood sugar by releasing it a little more slowly into the bloodstream. In addition to helping to regulate blood sugar and bowel function, soluble fiber is thought to have an anti-inflammatory affect that may help diabetics recover faster from infections.Asia, Europe, Middle East have been using garlic, raw onions as anti-diabetic since long. Europeans use common mushroom; the people of Iraq use barley bread.Some countries have been using bitter gourd and herb ginseng as anti-diabetic herb. Blueberry, fenugreek seeds, coriander seeds, beans, Gooseberry, cucumber, lettuce, cinnamon, cabbage etc are used in the treatment of diabetes in different countries. An Apple, in addition to fructose and water, contains the following ingredients: malic acid, [Apple Acid] sorbitol [initiates insulin secretion], lignin, pectin, minerals (potassium, magnesium, manganese, phosphorous, zinc, copper, selenium), Amino acids, Anti oxidants and flavonoids. A lot of medical literature suggests that malic acid serves as a chelating agent and plays an important role in ATP and Kreb's cycle in sugar metabolism and has also biocidal action. Some study reported that glucose tolerance improvement when fibre was added to diabetics or normal person meals [6,7,8]. Gums and viscous types of fibres(eg, guar & pectin) were found to be most effective. Glucose tolerance was also improved by methyl cellulose and wheat bran [8]. Monnier et al [9] reported similar effects with pectin and cellulose phosphate, but not with cellulose.Davis reported that daily consumptions of apples and apple juice may help reduce the damage caused by the "bad" type of cholesterol and protect against heart disease, based on the first human study of this

kind [10]. Finish Epidemiologists concluded that high consumption of flavonoids from apples and onions was directly associated with lowest risk for coronary mortality [11]. Some researchers advocate the use of a low glycemic index, high carbohydrate diet to improve glucose and lipid profiles in people with Type 2 diabetes [12]. Various studies were done in diabetic to find the effect of apple fibre, juice or its products on lipid parameters and blood sugar, but effect of whole apple was less studied. Taking all above facts in considerations with apple, aim of this study was to evaluate the effect of apple in diet of Type II diabetes on fasting blood sugar level and lipid profile.

MATERIALS & METHODS

*Subjects:*Ninety eight subjects (women and men) with Type II diabetes mellitus treated with oral glucose-lowering medication, diet, or both were recruited for the study. Fifty four subjects were willing to take one medium size apple in diet daily and remaining 44 Type II diabetics were taken as controls. Baseline characteristics of the subjects are given in Table 1.

Table-1
The subjects(Type II diabetes with Apple) & controls(Type II diabetes without Apple) characteristics

Parameters	Type II diabetes with Apple (n=54)(Mean±S.D.)	Type II diabetes without Apple (n=44)(Mean±S.D.)
BMI(Kg/m^2)	23.8±0.9	24.1±0.3
Durations of diabetes(yrs)	6.4±3.4	5.9±5.8
Systolic pressure (mmHg)	122±3.0	121±4.0
Diastolic pressure (mmHg)	71±2.0	73±3.0
Glycated Hb(%)	6.89±0.8	7.26 ±0.5

Inclusion criteria

1- Their ages ranged from 42-70 years old.
2- Only Type II diabetes previously diagnosed & was regularly follow up.
3- Freely consented to participate this study.

Exclusion criteria

included insulin therapy within the previous 2 months, glycated haemoglobin A_{1c} (Hb A_{1c}) > 12%, medical conditions affecting plasma lipoprotein metabolism, use of lipid-lowering medication within the previous 6 wk, proliferative retinopathy or nephropathy, coronary events within the previous 6 months, treatment with oral glucocorticoids, or fasting plasma cholesterol concentrations > 300 mg/dl or triacylglycerol concentrations > 700 mg/dl. Stable doses of thiazide, ß-blocker, or other antihypertensive medication were permitted. No changes were made in oral glucose-lowering therapy during the study. Written informed consent was obtained from all subjects.

Consent of patients

We obtained the consents of the patients to this treatment by written or verbal by free will through explaining the contents to them before preceding the enforcement of this treatment.

Design

Approval from ethical committee of Govt. Medical College was taken before the actual study to start. It was designed to have a four week run-in phase during which all subjects consumed a medium size apple daily. Before administering apple in diet, each patient's body mass index was calculated (BMI=kg/m2), systolic and diastolic blood pressure were measured. Blood samples were taken & analyzed for fasting blood glucose (FBG), glycosylated haemoglobin (HbA1c), triglycerides (TG), cholesterol, HDL-c, LDL-C,

VLDL-c. These parameters were again analysed after 4 weeks.

Serum determinations

Fasting blood glucose and lipid parameters were determined by kit methods on fully Erba autoanylizer, in clinical biochemistry laboratory. LDL-cholesterol was calculated using the Friedewald equation [13]. Glycosylated Hb (% of total Hb) was measured by resin based kit methods.

Statistical analysis

Student's paired t-test was used to determine the difference in biochemical changes between the patients before and after the administration of Apple in diet. *P< 0.05 was taken as significant. Analysis was done by using graph pad prism software.

RESULTS

Total ninety eight Type II diabetes (55% male, Avr. Duration 6.4±3.4 yrs &45% Female, Avr. Duration 5.9±5.8 yrs) participated in the study. The subjects & controls characteristics are shown in Table 1. BMI values calculated for the both groups showed no significant difference. Duration of Type II diabetes with apple in diet group was 6.4±3.4 verses 5.9±5.8 in Type II diabetes without apple in diet group, which show no significant difference. Systolic and diastolic blood pressure was normal in both groups.Fasting blood sugar levels in Type II diabetes with apple in diet, shows highly significant decrease (p<0.0001) as compared to controls (in Type II diabetes without apple in diet) Table-2. When compared male & female of subjects group to that of controls Male & female, both the sexes of subject group found highly significant decrease in FBS Table-3. Significant decrease in FBS levels also found when compared to different age groups. Fig-1Table-2 also shows highly significant decrease (p<0.0001) of total cholesterol, triglycerides and LDL cholesterol in Type II diabetes with apple as compared to in Type II diabetes without apple. Slight significant increase levels (p<0.05) of HDL cholesterol was seen in Type II diabetes with apple in the diet group.

Table-2

FBS & Fasting Lipid parameters in Type II Diabetes with & without Apple

Parameters	Type II Diabetes with Apple		Type II Diabetes without Apple	
	Baseline	After 4 weeks	Baseline	After 4 weeks
Fasting Blood sugar(mg/dl)	120.5±17.16	99.91±12.18**	121.4±21.6	118.56±23.28
Total Cholesterol(mg/dl)	175.5±26.86	161.3±21.3**	178±12.48	176.21±15.16
Triglycerides(mg/dl)	187.7±33.17	163±33.9**	184.25±15.42	182.27±16.23
LDL(mg/dl)	95.07±23.38	85.8±20.19**	97.11±21.5	96.15±16.5
HDL(mg/dl)	41.52±4.56	42.72±5.45*	40.98±7.22	40.85±6.66
VLDL(mg/dl)	37.69±6.49	32.74±7.17*	36.74±6.94	35.69±6.8

P*<0.05, p**<0.001 compared to baseline

Table-3

FBS(mg/dl) levels in Male & Female in Type II Diabetes with & without Apple

	Type II Diabetes with Apple		Type II Diabetes without Apple	
	Male(n=31)	Female(n=23)	Male(n=26)	Female(n=18)
Baseline	123.5±18.6	118.24±10.21	120.43±12.36	122.31±12.32
After 4 weeks	98.5±19.21**	97.5±16.65**	121.26±18.57	118.5±20.58

p**<0.001 compared to baseline

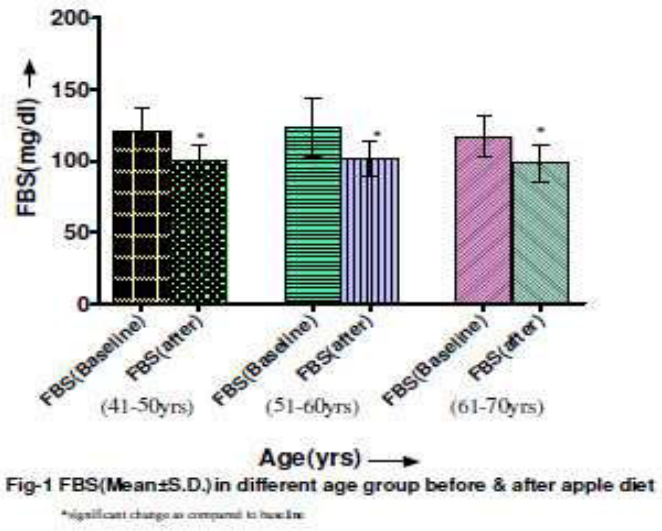

Fig-1 FBS(Mean±S.D.) in different age group before & after apple diet

*significant change as compared to baseline

Figure 1

DISCUSSION

Very few studies are done regarding effect of apple or its product or fibre on FBS & lipid levels. Parsons SR suggests significant plasma glucose reductions with bran or bran and whole apple [14]. In the present study also show highly significant decrease in FBS levels with a medium size apple in diet of Type II diabetes subjects. It was show significant decrease when compared in different age group and in both the sex of diabetic subjects. This decrease in FBS might due to fibre content of apple along with malic acid, polyphenols and other phytochemicals. Soluble fiber pectin in apple releases sugar little more slowly into the bloodstream. In the previously discussed Finnish study of 10,000 people, a reduced risk of Type II diabetes was associated with apple consumption [15]. Higher quercetin intake, a major component of apple peels, was also associated with a decreased risk in Type II diabetes. Kay et al demonstrated that 14 days of increased fibre intake in elderly institutionalized NIDDM patient improved parameters of glucose metabolism[16]. The repeated and readily noticeable improvement in plasma glucose levels associated with apple powder consumption in one subject may indicate a subpopulation of persons with Type II diabetes uniquely responsive to this fibre source. Beneficial effects may be due to pectic substances or some other constituent of apple powder[17]..Effect of apple in diet of Type II diabetes show significant change in lipid parameters. Total cholesterol, LDL-c, & triglycerides levels found highly significant ($p<0.0001$) change compared to controls diabetics. These finding were Aprikian et al. found that when cholesterol fed rats were supplemented with lyophilized apples, there was a significant drop in plasma cholesterol and liver cholesterols and an increase in high-density lipoproteins (HDL). Furthermore, they found that cholesterol excretion increased in the faeces of rats fed apples, suggesting reduced cholesterol absorption [18]. In vitro work in cultured human intestinal cells suggested that apple or apple product may directly alter the lipid absorption and metabolism [19].Cholesterol lowering effect was seen in cholesterol fed rats when rats were fed apples, pears, and peaches. Apples had a greater cholesterol lowering affect than the other two fruits [20]. The three fruits also increased the plasma antioxidant potential, with apple having the greatest effect [20]. Apples, pears, and peaches all had similar fiber content, but apples contained more phenolic compounds suggesting that perhaps the phenolics in apples contribute to this effect

[20]However one study by Mahalko JR et al showed apposite results, that the consumption of 52 g corn bran decreased very low-density lipoprotein cholesterol, triglycerides, and glycosylated Hb, but subject tolerance was poor with the particle size used. Consumption of 52 g apple powder increased low-density lipoprotein and total cholesterol levels [21]. Apples were identified as the only flavonoid-rich food that might be protective. There was a 27 and 28% lower risk of Type 2 diabetes associated with the consumption of 2–6 apples/wk or 1 apple/d, respectively, compared to no apple consumption. The highest quartile of intake was > 47 g of apple/d, which approximates one-third of a medium-sized apple [22] Based on these epidemiological studies, it appears that apples may play a large role in reducing the risk of a wide variety of chronic disease and maintaining a healthy lifestyle in general. Apples were most consistently associated with reduced risk of cancer, heart disease, asthma, and Type II diabetes when compared to other fruits and vegetables and other sources of flavonoid In conclusion present study revealed that one medium size apple in diet of Type II diabetics alter the fasting blood sugar levels and lipid parameters which are beneficial for normal health of diabetics along with antidiabetic drugs. More study on large scale requried for the evaluating the role of apple in reducing the blood sugar levels and lipids.

REFERENCES

1. Turner RC, Millns H, Neil HA, Stratton IM, Manley SE, et al. (1998) United Kingdom Prospective Diabetes Study Group. UK Prospective Diabetes Study 23: risk factors for coronary artery disease in non-insulin dependent diabetes. BMJ 316: 823–828.
2. Stamler J, Vaccaro O, Neaton JD, Wentworth D (1993) Diabetes, other risk factors, and 12-yr cardiovascular mortality for men screenend in the Multiple Risk Factor Intervention Trial. Diabetes Care 16: 434–444.
3. Burkitt DP, Towell HC. Refined carbohydrate food and disease; some implications of dietary fibre. New York, NY: Academic press, 1975.
4. Boyer J, Liu RH. Apple phytochemicals and their health benefits. Nutr J. 2004 May 12;3:5.
5. A Comprehensive Review of Apples and Apple Components and Their Relationship to Human Health. Adv Nutr. 2011 September; 2(5): 408–420.
6. Jenkins DJA, Goff DV, Leeds AR, et al. Unabsorbable carbohydrates and diabetes: decreased postprandial hyperglycemia. Lancet 1976;2:172-4.
7. Jenkins DJA, Leeds AR,Gassull MA, Cochet B, Alberti KGMM. Decrease in postprandial insulin and glucose concentrations by guar and pectin. Ann Intern Med 1977;86:20-3.
8. Jenkins DJA, Wolever TMS, Leeds AR, et al. Dietary fibres, fibre analogues, and glucose tolerance: importance of viscosity. Br. Med J 1978;1:1392-4.
9. Monnier L, Pham TC, Aguirre L, Orsetti A, Mirouze J. Influence of ingestible fibres on glucose tolerance. Diabetes Care 1978;1:83-8.
10. Hyson, D. et al. Apple Juice Consumption Reduces Plasma Low-Density Lipoprotein Oxidation in Healthy Men and Women. Journal of Medicinal Food. 2000, 3:159-165.
11. Knekt, P. et al. Flavonoid Intake and Coronary Mortality in Finland: A Cohort Study. British Medical Journal. 1996. 312: 478-481.
12. Brand Miller JC. The importance of glycemic index in diabetes. Am J Clin Nutr 59(Suppl): 747S–752S, 1994.
13. Friedewald WT, Levy RI, Fredickson DS (1972) Estimation of the concentration
14. of low-density lipoprotein cholesterol in plasma, without the use of the preparative ultracentrifuge. Clin Chem 18: 499–502.
15. Parsons SR. Effects of high fiber breakfasts on glucose metabolism in noninsulin-dependent diabetics.Am J Cli Nutri, 1984 jul;40(1):66-71.

16. Knekt P, Kumpulainen J, Jarvinen R, Rissanen H, Heliovaara M, Reunanen A, Hakulinen T, Aromaa A: Flavonoid intake and risk of chronic diseases**.** *Am J Clin Nutr* 2002, 76**:**560-568.
17. Key RM, Grobin W, Track NS. Diets rich in natural fiber improve carbohydrate tolerance in maturity-onset, non insulin-dependent diabetics. Diabetologia 1981;20:18-21.
18. Janet R Mahalko, Harold H Sandstead, LuAnn K Johnson, Linda F Inman, David B Milne, Robert C Warner, Edgar A Haunz. Effect of consuming fiber bran, soy hulls, or apple powder on glucose tolerance and plasma lipids in Type II diabetes; The American Journal of Clinical Nutrition;39Jan1984:25-34.
19. Aprikian O, Levrat-Verny M, Besson C, Busserolles J, Remesy C, Demigne C. Apple favourably affects parameters of cholesterol metabolism and of anti-oxidative protection in cholesterol fed rats. Food Chem. 2001;75:445–452. doi: 10.1016/S0308-8146(01)00235-7.
20. Vidal R, Hernandez-Vallejo S, Pauquai T, Texier O, Rousset M, Chambaz J, Demignot S, Lacorte J-M. Apple procyanidins decrease cholesterol esterification and lipoprotein secretion in Caco-2/TC7 enterocytes. J Lipid Res. 2005;46:258–68.
21. Leontowicz H, Gorinstein S, Lojek A, Leontowicz M, Ciz M, Soliva-Fortuny R, Park Y, Jung S, Trakhtenberg S, Martin-Belloso O. Comparative content of some bioactive compounds in apples, peaches, and pears and their influence on lipids and antioxidant capacity in rats. J Nutr Biochem. 2002;13:603–610.
22. Song Y, Manson J, Buring J, Sesson H, Lin S. Associations of dietary flavonoids with risk of Type 2 diabetes, and markers of insulin resistance and systemic inflammation in women: a prospective and cross-sectional analysis. J Am Coll Nutr. 2005;24:376–84.