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Insulin Potentiating Factor (IPF) Present in Foods, Species and Natural Products*

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Abstract: Control of diabetes by diet and natural products is more appropriate and economical in developing countries, hence fruits, vegetables, tea, spices and homeopathic drugs were investigated for their insulin potentiating function in glucose metabolism in rat epididymal fat cells assay. Dried flesh and seed of jamon fruit (Eugenia jambulina), fresh and dried flesh and seed of bitter gourd (Momordica charantia), fresh and dried chaunga (Carulina tuberculate) and powdered fenugreek (Trigonella foenum-graecum) were extracted with 0.1 N NH_4OH or boiling water (1:20 w/v). Black, decaffeinated and green tea (*Thea* sp.) were prepared without milk and with milk. Sugar was not added to the tea. The supernatants of the extracts and the different prepared tea samples were used for insulin potentiation in the rat epididymal fat cells assay. Homeopathic drugs, diabene and diacure were tested for insulin potentiating activity in the above assay. Dried flesh of jamon fruit potentiated insulin 6.7 fold when boiled with water and 6.1 fold when extracted with 0.1N NH_4OH. Dried jamon seed potentiated insulin 2 and 5 fold when extracted with water and 0.1N NH_4OH respectively. Insulin potentiating activity was found in the dried seed of bitter ground but not in the fresh and dried flesh portion. Chaunga did not show any insulin potentiating activity. The water extract of fenugreek showed some activity. Black tea potentiated 5.2 fold insulin function in glucose metabolism and this activity was reduced to 3.7 fold with decaffeinating of tea. Green tea potentiated insulin 2 fold in glucose metabolism. Addition of milk to tea inhibited the insulin potentiating function of tea. Both the homeopathic drugs did not show any insulin potentiating activity. The result indicated that both flesh and seed of dried jamon fruit and tea had very good insulin potentiating function. In the light of these data, based on the vitro model of insulin function, the diabetic patients are advised to use both the flesh and seed of jamon fruit and tea without milk and sugar for their diabetic control.

Key words: Insulin potentiating factor, jamon fruit, vegetables, tea

Introduction

Diabetes mellitus is a major world health problem. Drug and diet therapies are the major approaches used in the treatment and control of the disease. Usually oral hypoglycemic drugs are used for the control of the disease. When hypoglycemic drugs are not working, then the treatment is shifted to insulin. Insulin therapy is successful in the beginning, but with course of time, insulin requirement increases. High doses of insulin is dangerous as high insulin circulation in the blood promotes diabetic complications and atherosclerosis. Drug therapy, whether using hypoglycemic agents or insulin, is costly, have side effects and keeps the diabetic individuals under constant medical supervision and the impression of being sick.

The diet therapy approach is economical and feasible in developing countries. Diet therapy does not create the impression of being sick in diabetic individuals. This therapy consists basically of precautions concerning diet composition, the amount, distribution and timing of food intake (Camerini-Davalos, 1987).The main focus in the diet approach is on the adjustment of macro nutrients particularly the contents of carbohydrates and fats and restrictions on simple sugars in the diet. Carbohydrates and fats are important in the etiology and control of diabetes (Khan *et al*., 1993), but fruits, vegetables and other natural products may have insulin potentiating factor (IPF) which has a direct role in the prevention and control of the disease. Khan *et al*. (1990) has reported that certain spices like cinnamon, cloves, bay leaves and turmeric have insulin potentiating factor which potentiates the function of insulin in glucose metabolism.

In 1979, Bever and Zahand published a list of plants which had oral hypoglycemic action. Almost a decade later, Rahman and Zaman (1989) and Ivorra *et al*. (1989) published lists of several hundred spices which had anti diabetic properties. Hypoglycemic property of bitter gourd has been reported by many researchers (Baldwa *et al*., 1977; Khanna, 1985; Satyavati *et al*., 1987).

In 1988, working on purification of biologically active chromium, Khan *et al*. (1990) discovered that certain spices like cinnamon, cloves, bay leaves and turmeric had insulin potentiating activity in glucose metabolism. Broadhurst *et al*. (2000) evaluated the possible effects of 49 herb, spice, and medicinal plants extracts on insulin function in the insulin-dependent utilization of glucose using a rat epididymal adipocyte assay. Cinnamon was

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the most bioactive product followed by witch hazel, green and black teas, allspice, bay leaves, nutmeg, cloves, mushrooms, and brewer's yeast. They concluded that the extracts of specific plants had improved the glucose and insulin metabolism.

In Pakistan, jamon fruit (both flesh and seed), bitter gourd, chaunga, fenugreek seed and some homeopathic drugs are used for treatment of diabetic patients with the assumption that these plant products have hypoglycemic properties. This paper reports the insulin potentiating factor present in some fruits, vegetables, tea, spices and homeopathic drugs.

Materials and Methods

Introduction to the study: This study was conducted in the Nutrients Requirements and Functions Laboratory (NRFL) of the Beltsville Human Nutrition Research Center BHNRC), Beltsville, USDA, Maryland, USA. The U.S. Education Foundation in Islamabad financed the project in 1995-96 under its Fulbright senior research award program. The test materials namely jamon fruit also known as Java Plum (Eugenia jamoblana), bitter gourd also known as karela (Momordica charantia), Chaunga also know as Pamanni (Carulina tuberculate), tea (*Thea* sp.), fenugreek also known as methi seed (Trigonella foenum-graecum) and two homoeopathic drugs known as diabene and diacure were purchased in Peshawar, Pakistan and were taken to the above center for determination of insulin potentiating factor (IPF) present in these plant products. The results of the study were submitted to the U.S. Education Foundation, Islamabad in 1996, however the findings were not published in a scientific journal for some reasons.

Preparation of samples

Jamon fruit: The flesh portion of the dried jamon fruit was removed from the seed by hand. The flesh and seed were ground separately and oven dried. Both the flesh and seed were extracted separately with 0.1N NH_4OH (1:20 w/v) in autoclave under 15 lbs pressure for 30 minutes or with water by boiling the samples with water (1:20 w/v) for 10 minutes. The extracts of ammonium hydroxide and water were centrifuged at 6000 x g for 20 minutes. The residue were discarded and the supernatant were stored at 4 ^{o}C for bioactivity assay.

Bitter gourd and chaunga: Fresh bitter gourd and chaunga were divided into two portions. One portion was kept fresh while the other portion was dried. The flesh and seed of bitter gourd were dried separately. Both the fresh and dried portions were extracted with 0.1N NH_4OH (1:20 w/v) in autoclave under 15 lbs pressure for 30 minutes or with water by boiling the samples with water (1:20 ratio) for 10 minutes. The extracts of ammonium hydroxide and water were centrifuged at 6000 x g for 20 minutes. The residue were discarded and the supernatant were stored at 4 ^{o}C for bioactivity assay.

Tea: Regular and decaffeinated black (Lipton) and green tea were used for sample preparation. One bag of black tea in 240 ml water and one tea spoon of green tea in 240 ml water were boiled for 3 minutes without adding any sugar. To a similar preparation of black tea, 120 ml of milk was added and boiled for additional 2 minutes. Fresh prepared black, green and milk tea were checked for bioactivity.

Fenugreek: Fenugreek (powdered methi seed) was extracted with 0.1N NH_4OH (1:20 w/v) in autoclave under 15 lbs pressure for 30 minutes or with water by boiling the sample with water (1:20 ratio) for 10 minutes. The extracts of ammonium hydroxide and water were centrifuged at 6000 x g for 20 minutes. The residue were discarded and the supernatant were stored at 4 ^{o}C for bioassay.

Diabene and diacure: Diabene was mixed with 0.1N NH_4OH (1:20w/v) and then checked for bioactivity. Diacure was used as such for bioactivity test.

Bioactivity: The bioactivity of the prepared samples were determined by rat epididymal fat cells assay using no albumin in the incubation media (Lincoln *et al.*, 1992).

Mineral contents: Chromium, copper, zinc and iron content of flesh and seed of dried jamon fruit, bitter gourd and chaunga both (fresh and dried) were determined by atomic absorption using the procedure reported by Anderson *et al.* (1988).

Results

The insulin potentiating activity of flesh and seed of jamon fruit, bitter gourd (fresh, dried flesh and seed), tea (black, green and milk tea), fenugreek seed and homeopathic drugs is given in Table 1. Both the flesh and seed of dried jamon fruit had insulin potentiating activity. The seed of bitter gourd had insulin potentiating activity but the fruit portion both fresh and dried did not exhibit any bioactivity. Chaunga also did not potentiate insulin in glucose metabolism. The insulin potentiating activity of black, decaffeinated black and green tea were 5.2, 3.7 and 2.0. Addition of milk (milk tea) inhibited the insulin potentiating activity of tea. Fenugreek had insulin potentiating activity of 2.0 when extracted with boiling water. The activity dropped to 1.6 when the spice was extracted with ammonium hydroxide, indicating that ammonium hydroxide was reducing/inhibiting the activity of the spice. The homoeopathic drugs did not show any insulin potentiating activity in our assay.

The mineral content of flesh and seed of dried jamon fruit, bitter gourd (fresh, dried flesh and seed) and fresh and dried chaunga is given in Table 2.

Table 1: Insulin Potentiating Activity of Selected Foods, Spices and Natural products

Food Items	Insulin Potentiating Activity	
	Boiling Water Extract	0.1M NH_4OH Extract
Jamon fruit (dried)	6.7	6.1
Jamon seed (dried)	2.3	5.5
Bitter gourd (dried flesh)	1.4	1.0
Bitter gourd (dried seed)	3.0	1.0
Bitter gourd whole fresh	1.7	-
Chaunga (dried)	1.1	1.3
Chaunga (fresh)	1.2	1.5
Black tea (without milk and sugar)	5.2	-
Decaffeinated black tea (without milk)	3.7	-
Black tea (with milk)	0.8	1.1
Green tea	2.0	-
Fenugreek seed	2.0	1.6
Diabene	-	1.2
Diacure	-	1.7

Table 2: Trace Elements of Selected Food Items

Food Items	Concentration (ng/g)			
	Cr	Cu	Zn	Fe
Jamon fruit (dried)	1461.3 ± 49.3	8.5 ± 0.1	21.4 ± 0.1	857.8 ± 68.3
Jamon seed (dried)	119.2 ± 44.2	7.7 ± 0.4	3.4 ± 0.1	73.2 ± 28.0
Bitter gourd (dried flesh)	707.9 ± 53.2	11.2 ± 1.1	40.7 ± 2.5	369.4 ± 22.4
Bitter gourd (dried seed)	80.8 ± 24.7	16.1 ± 1.1	54.4 ± 0.5	91.4 ± 7.2
Bitter gourd (whole fresh)	29.3 ± 2.4	11.3 ± 1.2	49.5 ± 5.2	69.1 ± 5.7
Chaunga (dried)	567.7 ± 92.0	4.9 ± 0.2	26.9 ± 0.7	342.0 ± 38.7
Chaunga (fresh)	181.8 ± 52.8	2.4 ± 0.1	18.6 ± 3.5	119.0 ± 28.1

Value are on dry weight basis and the means±SD are of triplicate samples.

Discussion

Control of diabetes through diet is a more appropriate approach in terms of applicability and cost in developing countries. Identification of foods, spices and other natural products that have insulin potentiating factor (IPF) are important for improving glucose metabolism in diabetes. Also nutrition education in terms of restriction for certain food items, eating pattern and diet composition are essential for control of diabetes. Both foods with IPF and nutrition education will lead to decrease in the incidence and severity of the disease.

The result indicated that boiling water and ammonium hydroxide extracts of dried flesh of jamon fruit had similar insulin potentiating activity, 6.7 vs 6.1, therefore boiling water extraction would be preferred for consumptive use. The insulin potentiating activity of the boiling water extract of jamon seed was less than the insulin potentiating activity of the seed extracted with ammonium hydroxide 2.3 vs 5.5. The data indicated that jamon fruit has very high insulin potentiating activity, therefore, it must be used for diabetic control. The beneficial effect of jamon on diabetes has been reported by Bever and Zahnd (1979).

Jamon grows wild in Pakistan and therefore its fruit is cheap, but the consumption is not very common. The knowledge that jamon fruit has beneficial effect on diabetes will increase the consumption of this fruit. Jamon fruit is delicious and the diabetics can make it a permanent item of their lunch and dinner during the season. Jamon is seasonal fruit and is not available in all seasons. Dried jamon fruit and seed are available in all season, and the diabetic individual can use it. The dried fruit of jamon can be cooked with some spices like cinnamon, fenugreek and bay leaves and can be taken in lunch or dinner. Also the dried fruit can be boiled with water and the extract can be taken. The flesh of the dried fruit and seed in the ground form can be taken with water before or after meals.

Bitter gourd is a very popular seasonal vegetable in Pakistan. The local notion is that bitter gourd is very good for diabetes and many investigators have reported the hypoglycemic effect of bitter gourd (Srivastava *et al.*, 1993; Baldwa *et al.*, 1977; Khanna, 1985; Satyavati *et al.*, 1987). In our assay and experimental conditions, only the seed of bitter gourd when extracted with boiling water (10 min cooking) showed insulin potentiating activity. We did not find insulin potentiating activity in dried and fresh bitter gourd irrespective of extraction with boiling water or with ammonium hydroxide (Table 1). Stage of maturity and location may be playing a role in distribution and origination of insulin potentiating activity in bitter gourd or the function of bitter gourd may not be via insulin function which was determined in this bioassay.

Chaunga is an other seasonal vegetable not very much popular in general public, but people with diabetes and heart problems eat this vegetable with the belief that it helps in reducing the severity of these diseases. In our set up chaunga did not show any bioactivity, hence eating of chaunga as vegetable may not reduce glucose in diabetic individuals.

Tea is drunk all over the world, however, its consumption varies amongst counties and regions. In Pakistan, almost every household take tea in the breakfast. Intake of tea during mid day and after noon is the routine of almost all families. Tea is primarily taken to give the feeling of freshness along with some gain of energy. The insulin potentiating activities of black, decaffeinated and green tea were 5.2, 3.7 and 2.0. Addition of milk to the tea (milk tea) inhibited the insulin potentiating activity of tea (Table 1). In Pakistan and perhaps in many other countries tea is prepared with milk and sugar. As shown above, milk inhibits the insulin potentiating activity, so diabetes should not use milk in the tea. Also sugar adds to the hyperglycemic condition of diabetes so they should not use sugar in tea. Tea without milk and sugar may help in controlling their hyperglycemia.

Fenugreek (methi seed) is a common spice used for taste and flavor in food preparations. It has insulin potentiating activity of 2.0 when extracted with boiling water. The activity dropped to 1.6 when the spice was extracted with ammonium hydroxide indicating that ammonium hydroxide was reducing/inhibiting the activity of the spice. Khan *et al.* (1990) have reported that spices like cinnamon, clove, bay leaves and turmeric have very good insulin potentiating activity. Though spices are generally used in foods preparation for taste and flavor, however, some of the spices may have therapeutic role in certain diseases like diabetes. The diabetic patients can use fenugreek seed in their diet preparation for their blood glucose control.

As shown in Table 1, homeopathic drugs did not show any insulin potentiating activity. Controlled study on human must be carried out to know whether these drugs have effect or not. Spending money on these drugs without checking its validity is not advisable.

Chromium is an essential part of a dietary factor that improves glucose tolerance in chromium deficient rats. Chromium has been postulated as an essential part of an insulin potentiating factor, but is not yet proven. The beneficial effect of chromium is related to a usable form of chromium and not total chromium. This usable form of chromium may be present in foods as such, or can be synthesized within the body by most people (Mertz *et al.,* 1989*)* For this reason, the mineral contents of jamon fruit and some vegetables were determined to see if the mineral contents of these food products correlate with bioactivity or not. The result indicated (Table 2) that jamon fruit is a good source of chromium, iron and zinc. Bitter gourd has also good amount of chromium, zinc and iron. Jamon as fruit and bitter gourd as vegetable can be taken in sufficient amount and can add substantial amount of these elements to the dietary intake of these elements. From data in Table 1 and 2, the biological activity do not seem to be correlated with total chromium or the other elements.

References

Andeson, R.A., J.S. Borel, M.M. Polansky, N.A. Bryden, T.C. Majerus and P.B. Moser, 1988. Chromium intake and excretion of patients receiving total parental nutrition: effect of supplemental chromium. J. Trace Elem. Exptl. Med., 1: 9-18.

Baldwa, V.S., C.M. Bhandari, A. Pangaria and R.K. Goyal, 1977. Clinical trails in patients of diabetes mellitus with insulin like compound obtained from plant sources. Ups. J. Med. Sci., 82: 39-41.

Bever, O.B. and G.R. Zahnd, 1979. Plants with oral concepts in the diet therapy of diabetes mellitus In: S.L. Halper (ed), Quick Reference to Clinical Nutrition. 2nd Edition, PP: 263269. J.B. Lippincott Company Philadelphia, USA.

Broadhurst, C.L., Polansky, M.M. and Anderson, R.A., 2000. Insulin-like biological activity of culinary and medicinal plants aqueous extracts *in vitro*. J. Agri. Food chem., 48: 849-852.

Camerini-Davalos, R.A. and H.S. Cole, 1987. Current concepts in the diet therapy of diabetes mellitus. In: S. L. Halper (ed), Quick reference to clinical Nutrition. Second Ed. pp: 263-269. J.B. Lippincott Comp. Philadelphia, USA.

Ivorra, M.D., M. Paya and A. Villar, 1989. A review of natural products and plants as potential antidiabetic drugs. J. Ethnopharmacol., 27: 243-275.

Khan, A., I. Ahmad and Z. M. Wazir, 1993. Epidemiological study of diabetes mellitus in the North West Frontier Province of Pakistan-I. J. Med. Sci., (JMS) 3: 35-44.

Khan, A., A.B. Noella, M.M. Polansky and R.A. Anderson, 1990. Insulin potentiating factor and chromium content of selected foods and spices. Biol. Trace Elem. Res., 24: 183-187.

Khanna, P., 1985. Insulin from bitter gourd – herbal drug. Eastern Pharmacist: PP: 101-103.

Lincoln, F.B., M.M. Polansky and R.A. Anderson, 1992. Insulin activity: stimulatory effects of cinnamon and brewers yeast as influenced by albumin. Hormone Res., 37: 225-229.

Mertz, W., E.R. Morris, J.C. Smith, Jr., E. Udomkesmalee, M. Fields, O.A. levander and R.A. Anderson, 1989. In: H.N. Munro and D.E. danford, (eds.), Nutrition, aging and the Elderly, pp: 222-227. Plenum, NY, New York. USA.

Rahman, A.U. and K. Zaman, 1989. Medicinal plants with hypoglycemic activity. J. Ethnopharmacol., 26: 1-55.

Satyavati, G.V., A.K. Gupta and N. Tandan, 1987. Medicinal plants of India. Vol. 2: 261, Indian Council of Medical Research, New Delhi.

Srivastava, Y., H. Vankatakrishna, V. Verma and B.H. Raval, 1993. Momordica charantia extract: An experimental and clinical evaluation. Phytotherapy Res., 7: 285-288.