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 (Caruina tuberculata) and powdered fenugreek (Trigonella foenum-graecum) were extracted with 0.1 N NH₄OH 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 potentiating 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 NH₄OH. Dried jamon seed potentiated insulin 2 and 5 fold when extracted with water and 0.1N NH₄OH 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 decaffeination 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 in 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 (Camenni-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 (BNHRC), 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 jamobiana), bitter
gourd also known as karela (Momordica charantia),
Chaunga also know as Pamanni (Carolina tuberculata),
tea (Thea sp.), fenugreek also known as methi seed
(Trigonella foenum-graecum) and two homeopathic
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
NH₄OH (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 °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 NH₄OH (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 °C for
bioassay.

Diabene and diacure: Diabene was mixed with 0.1N
NH₄OH (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 homeopathic 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

<table>
<thead>
<tr>
<th>Food Items</th>
<th>Insulin Potentiating Activity</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Boiling Water Extract</td>
</tr>
<tr>
<td>Jamon fruit (dried)</td>
<td>6.7</td>
</tr>
<tr>
<td>Jamon seed (dried)</td>
<td>2.3</td>
</tr>
<tr>
<td>Bitter gourd (dried flesh)</td>
<td>1.4</td>
</tr>
<tr>
<td>Bitter gourd (dried seed)</td>
<td>3.0</td>
</tr>
<tr>
<td>Bitter gourd whole fresh</td>
<td>1.7</td>
</tr>
<tr>
<td>Chaunga (dried)</td>
<td>1.1</td>
</tr>
<tr>
<td>Chaunga (fresh)</td>
<td>1.2</td>
</tr>
<tr>
<td>Black tea (without milk and sugar)</td>
<td>5.2</td>
</tr>
<tr>
<td>Decaffeinated black tea (without milk)</td>
<td>3.7</td>
</tr>
<tr>
<td>Black tea (with milk)</td>
<td>0.8</td>
</tr>
<tr>
<td>Green tea</td>
<td>2.0</td>
</tr>
<tr>
<td>Fenugreek seed</td>
<td>2.0</td>
</tr>
<tr>
<td>Diabene</td>
<td>-</td>
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<td>Diacure</td>
<td>-</td>
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</tbody>
</table>

Table 2: Trace Elements of Selected Food Items

<table>
<thead>
<tr>
<th>Food Items</th>
<th>Concentration (ng/g)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cr</td>
</tr>
<tr>
<td>Jamon fruit (dried)</td>
<td>1461.3 ± 49.3</td>
</tr>
<tr>
<td>Jamon seed (dried)</td>
<td>119.2 ± 44.2</td>
</tr>
<tr>
<td>Bitter gourd (dried flesh)</td>
<td>707.9 ± 53.2</td>
</tr>
<tr>
<td>Bitter gourd (dried seed)</td>
<td>60.8 ± 24.7</td>
</tr>
<tr>
<td>Bitter gourd (whole fresh)</td>
<td>29.3 ± 2.4</td>
</tr>
<tr>
<td>Chaunga (dried)</td>
<td>567.7 ± 92.0</td>
</tr>
<tr>
<td>Chaunga (fresh)</td>
<td>181.8 ± 52.8</td>
</tr>
</tbody>
</table>

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 Zahn (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; Baidwra 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 origin 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 another 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 jaman 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 jaman fruit is a good source of chromium, iron and zinc. Bitter gourd has also good amount of chromium, zinc and iron. Jaman 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