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Studies on Glucose Adsorption Capacity of Some Indigenous Plants

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Abstract

In the present study, extracts of selected plants namely *Albizzia lebbeck, Berberis aristata, Mucuna pruriens, Myristica fragrans, Catharanthus roseus,* and *Caesalpinia bonducella* which are used in the Ayurvedic traditional system of medicine to treat diabetes were tested for their glucose adsorption capacity. It was observed that the adsorption capacities of all the plant extracts were directly proportional to the molar concentration of glucose and higher amounts of glucose was bound with increased glucose concentration. The samples were effective in adsorbing glucose at both low and higher concentrations of glucose used in the study (5mM/L and 100mM/L). The results demonstrated that extract of *C. bonducella* adsorbed 73.96% of glucose from a 100mM glucose solution. The amount of glucose adsorbed was highest when compared to other extracts used in the study. The extract of *B. aristata* and *M. pruriens* exhibited adsorption of 71.44% and 71.25% of glucose respectively from a 100mM glucose solution

Keywords: Glucose adsorption capacity; Indigenous plants; Diabetes mellitus

Abbreviations: *Albizzia lebbeck (AL); Berberis aristata (BA); Mucuna pruriens(MP); Myristica fragrans(MF); Catharanthus roseus (CR); Caesalpinia bonducella (CB)*;

Introduction

Diabetes is one of the commonest chronic illnesses to human beings. It is not a single disease but a syndrome that is characterized by a total or relative lack of insulin leading to persistent elevation of blood glucose as well as alteration in lipid and protein metabolism. It exhibits several complications including diabetic neuropathy, coronary heart disease and hypertension [1,2]. Currently treatments of diabetes, in addition to insulin supplement includes many oral hypoglycemic agents like sulfonylurea's, biguanides, thiazolidines, D-phenylalanine derivatives meglitinides and α-glucosidase inhibitors along with appropriate diet and exercise. However, none can be termed as an ideal one, due to their toxic side effects and sometimes diminution in response after prolonged use [3]. Thus, there exists an urgent need to design and develop new compounds or combinations, especially of herbal origin which will prove to be beneficial for effective management of diabetes. In the recent years, there has been a gradual revival of interest in the use of medicinal plants in developing countries because herbal medicines have been reported safe and relatively less adverse side effect especially when compared with synthetic drugs [4]. In Indian traditional system of medicine a variety of herbal remedies are prescribed for the treatment of diabetes which includes commonly consumed food materials such as legumes, fruits, vegetables, spices and condiments [5].

The following plants were selected for the study namely, *Albizzia lebbeck (AL), Berberis aristata (BA), Mucuna pruriens(MP), Myristica fragrans(MF), Catharanthus roseus (CR) and Caesalpinia bonducella (CB). Albizzia lebbeck (Leguminosae)* is a deciduous tree with several medicinal uses. Bark and seeds exhibit astringent effect and are used in piles and diarrhea. Ethanolic extract of pods have been shown to possesses antiprotozoal, hypoglycemic and anticancer properties [6,7]. *Berberis aristata* (*Berberidaceae*) have been known for a wide array of activities including febrifugal, hypotensive, immunostimulating, anti-inflammatory, antidiabetic, antimicrobial, antiprotozoal, anticholinergic, antiarrhythmic, antiplasmodial, hypolipidemic, anti-granuloma and anti-hemolytic activity [8-10]. *Mucuna pruriens* (*Fabaceae*) have been studied for the management of several free radical mediated diseases such as ageing, rheumatoid arthritis, diabetes, atherosclerosis, male infertility and nervous disorders [7].

Myristica fragrans (*Myristicaceae*) has been reported to exhibit several activities namely cytotoxic, hepatoprotective, antioxidant, anti-inflammatory, antithrombotic, hypolipidaemic, antiatherosclerotic, hypoglycaemic and antidiabetic [11-13]. *Catharanthus roseus* (*Apocynaceae*) is an important source of indole alkaloids. Traditionally it has been used for the treatment of diabetes, fever, malaria, throat infections, and chest complaints. It is also used for the regulation of menstrual cycles, and as a euphoriant [14,15]. *Caesalpinia bonducella* (*Caesalpiniaceae*) has been known to possess various activities such as antidiabetic, adaptogenic, anthelmintic, antifilarial, antibacterial, antifungal, antispasmodic activity, antioxidant, antipsoriatic and antitumor [16-18]. *Myristica fragrans* (*H.*) (*Myristicaceae*) has been studied for its cytotoxic, hepatoprotective, antioxidant, anti-inflammatory, antithrombotic, hypolipidaemic, antiatherosclerotic, hypoglycaemic and antidiabetic activities [19-21]. The present study thus aimed to make a comparative study for the glucose adsorption capacity of the selected plant extracts.

Materials and methods

Chemicals and reagents

All the chemicals used during the experimental work were of analytical grade obtained from S.D. Fine Chemicals Pvt. Ltd., Mumbai, Sigma chemical company, USA and Loba chemicals, Mumbai.

Plant material

The seeds of *M. pruriens*, and *C. bonducella* were collected from local areas of Kasegaon, District Sangli, (MS), India, whereas the seeds of *M. fragrans* and roots of *B. aristata* were purchased from the local market. Bark of *A. lebbeck* and roots of *C. roseus* were collected from local areas of Karad, District Satara, (MS) and India. The plant material was further identified and authenticated by the Department of Botany, YC College of Science, Karad. The plant material was cleaned thoroughly, dried in a hot air oven (50°C) separately powdered, passed through 60 mesh sieve (BS) and thereafter stored in an airtight container at 4°C till further use.

Preparation of plant extracts

About 500gm of the powdered drug samples were separately extracted successively using ethanol and water by Soxhlet apparatus. The extraction was carried out until the drug becomes exhausted. The solvents were recovered from their extract by distillation under reduced pressure. The dried extract thus obtained was kept in a desicator and was used for further experiments

Determination of Glucose adsorption capacity [22-24]

Samples of plant extracts (1%) were added to 25ml of glucose solution of increasing concentration (5,10,20,50 and 100mM), the mixture was stirred well, incubated in a shaker water bath at 37°C for 6 hours, centrifuged at 4,000×g for 20min and the glucose content in the supernatant was determined. Glucose bound was calculated using the following formula:

$$Glu\cos ebound = \frac{G_1 - G_6}{Wightofthesample \times Volumeofsolution}$$

G1 is the glucose concentration of original solution

G6 is the glucose concentration after 6 hours

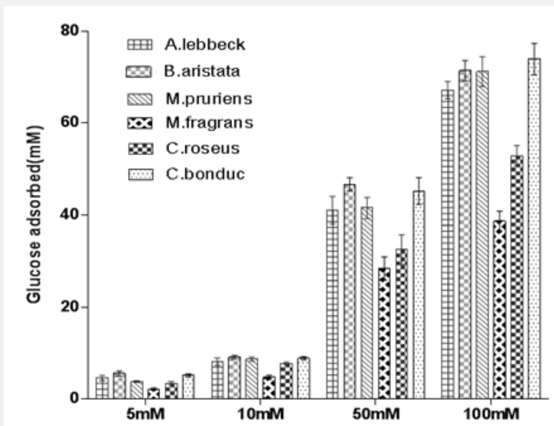
Statistical analysis

All the analyses were carried out in triplicate and the results were expressed in mean±SD.

Results and Discussion

Diabetes mellitus is a common and very prevalent disease affecting the citizens of both developed and developing countries. It is characterized by a group of metabolic disorders. The deficiency or insensitivity of insulin causes glucose to accumulate in the blood, leading to various complications [25]. Currently available pharmacotherapies for the treatment of diabetes mellitus include oral hypoglycemic agents and insulin. However, these current drugs do not restore normal glucose homeostasis and they are not free from side effects [26]. Plants represent a vast source of potentially useful dietary supplements for improving blood glucose control and preventing long-term complications in Type 2 diabetes mellitus [27].

Numerous plants have been documented as beneficial in the treatment of diabetes. However, the majority of traditional antidiabetic plants still await proper scientific and medical evaluation for their ability to improve blood glucose control and or to prevent the diabetic complications. *In vitro* tests can play a very important role in the evaluation of antidiabetic activity of drugs as initial screening tools where the screening of large number of potential therapeutic candidates may be necessary. They might provide useful information on the mechanism of action of therapeutic agent. Thus, the present study was undertaken to assess glucose adsorption capacity of the selected plant extracts. The glucose adsorption capacity of the selected plant extracts at different glucose concentrations (5mM, 10mM, 50mM and 100mM) have been presented in Table 1. All the plant extracts could bind glucose effectively and the glucose-binding capacity was directly proportional to the glucose concentration as depicted in Figure 1.



Values are mean±SD of triplicate determinations.

Figure 1: Glucose binding capacity of the plant extracts at different concentrations of glucose.

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Table 1: Glucose adsorption capacity of the selected plant extracts.

Glucose Conc.	*A. lebbeck*	*B. aristata*	*M. pruriens*	*M. Fragrans*	*C. roseus*	*C. bonduc*
Glucose adsorbed mM						
5mM	4.62±0.56	4.93±0.55	3.86±0.19	2.21±0.25	3.44±0.36	4.92±0.37
10mM	8.16±0.79	9.14±0.38	8.71±0.42	4.78±0.45	7.77±0.29	8.90±0.35
50mM	41.10±3.01	46.76±1.43	41.58±2.27	28.46±2.51	32.53±3.23	45.27±2.89
100mM	67.23±1.88	71.44±2.22	71.25±3.23	38.74±2.13	52.97±2.18	73.96±3.40

Values are mean±SD of triplicate determinations.

It was observed that the adsorption capacities of all the plant extracts were directly proportional to the molar concentration of glucose and higher amounts of glucose was bound with increased glucose concentration. The samples were effective in adsorbing glucose at both low and higher concentrations of glucose used in the study (5mM/L and 100mM/L). The results demonstrated that extract of *C. bonducella* adsorbed 73.96% of glucose from a 100mM glucose solution. The amount of glucose adsorbed was highest when compared to other extracts used in the study. The extract of *B. aristata* and *M. pruriens* exhibited adsorption of 71.44% and 71.25% of glucose respectively from a 100mM glucose solution.

The results also indicated that the samples could bind glucose even at lower concentrations of glucose (5mM) thereby reducing the amount of glucose available for transport across the intestinal lumen, consequently blunting the postprandial hyperglycemia. *In vivo* and *in vitro* studies of glucose adsorption have shown that the delay in glucose adsorption in the gastrointestinal tract is determined mainly by the viscosity of soluble polysaccharides [28]. Similar observations are reported for insoluble fiber-rich fractions isolated from *Averrhoa carambola* [29]. It is known that both insoluble and soluble fibers from different sources are reported to adsorb glucose. However, the dietary fibres that can bind to glucose may not show adsorption capacity for glucose when the concentration of glucose is decreased [22]. In our study the increased ability of the extracts to adsorb glucose may be attributed to the phytoconstituent (s) present in the extract that readily adsorbs glucose even when the concentration of glucose is decreased.

Conclusion

The results of the present study indicate that all the selected plant extracts could bind glucose effectively and the glucose-binding capacity was found to be directly proportional to the glucose concentration. These plant extracts may essentially contain herbal bioactive compounds which are responsible for their glucose adsorption capacity. Thus, further structural elucidation and characterization methodologies have to be carried out in order to identify the bioactive constituents to facilitate their use in effective management of diabetes.

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