Supplementation of Carrot Incorporated Paneer Attenuates Diabetes through its Antioxidant Potential in Streptozotocin-Nicotinamide-Induced Diabetic Rats

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Abstract: Background: The ideal medications for diabetes mellitus (DM) should have less or no adverse effects, thus screening on the antidiabetic activities of plant-based products is in urgent need. Paneer is the fundamental nutritious and complete native dairy products, and natural products incorporated paneer has greatly increased its therapeutic potential. Objective: The current study was undertaken to explore the effects of carrot incorporated paneer (CIP) on blood glucose, body weight, insulin, and enzymatic antioxidants such as superoxide dismutase, catalase, glutathione (GSH) peroxidase, and reduced GSH in streptozotocin (STZ) and nicotinamide (NAD)-induced diabetes in rats. Materials and Methods: Diabetic rats were orally supplemented with CIP (200 mg/kg body weight/day) for 1 month and the effects were compared with gliclazide (5 mg/kg body weight/day). Results: Supplementation of CIP or gliclazide was resulted in noteworthy diminish in the levels of blood glucose and increase in body weight and insulin levels. STZ-NAD administration caused the diminution in enzymatic antioxidant activities in diabetic rats and supplementation with CIP predominantly enhanced the levels of antioxidant enzymes in diabetic rats when contrasted to diabetic group. Conclusion: Hence, the results suggested that CIP has the potential antioxidant capability and may be believed as an efficient curative constituent for the management of DM.

Keywords: Carrot incorporated paneer, diabetes mellitus, natural products, metabolic disorders.

1. INTRODUCTION

Diabetes mellitus (DM) is a convoluted persistent disease needs a constant medical care with multifactorial risk diminution approaches away from glycemic control. Its escalating prevalence put a large trouble on civilization and the public health sector [1]. DM has been reached endemic proportions across the globe, and it is the most important risk aspects for many prolonged difficulties such as hypertension, dyslipidemia, coronary artery disease, and myocardial infarction [2,3]. All these complications result in overwhelming problems of financial and communal systems. Several synthetic drugs utilized nowadays are ineffective to fulfill a durable glycemic management and amend the line of DM complications. Scientifically, ideal medications with less or no adverse effects are wanted for
the management of DM and its associated complications. Consequently, there is an enormous necessity for the screen on antidiabetic activities through plant-based products [4]. Paneer is the fundamental nutritious and complete native dairy products [5] and incorporation of natural products into paneer to increase their therapeutical potential and it becomes a trend in nowadays [6]. In the previous study, we reported that carrot incorporated paneer (CIP) preparation to enhance nutritional values [7]. Therefore, the current study was intended to evaluate the antidiabetic prospective of CIP against streptozotocin (STZ)-nicotinamide (NAD)-induced diabetic rats.

2. MATERIALS AND METHODS

2.1. Animals

Male Wister albino rats with body weight 150–180 g were acquired and maintained in Central Animal House, KSRTC, Tiruchengode, Tamil Nadu, India, and fed on a regular pellet diet (ICMR-NARFBR, Hyderabad) and water ad libitum. The procedure of this research was permitted by IAEC of Muthayammal College of Arts and Science, Rasipuram, India (Approval No. IAEC/MCAS/10/2017) and conducted experiments according to the guidelines CPCSEA, India.

2.2. Preparation of Carrot Juice Incorporated Paneer

Fresh carrots were washed in distilled water; then, they were grounded to form a fine juice using a mixer. Carrot juice was incorporated in a fixed ratio of 20% to 1000 mL of cow milk and mixed well. The milk was heated to 85°C; then, temperature reduced to 80°C. All the froth and skim were removed and added two spoons of lemon juice. The milk was begun to curdle at 72°C and strained it with a muslin cloth. The curdled milk was then washed in a muslin cloth and a heavy weight was placed over it. After half an hour, all the particles of paneer came close together to form a firm block of paneer and stored at 4°C in a refrigerator for further analysis [7].

2.3. Induction of DM

DM was induced by a single injection of STZ (45 mg/kg BW) in citrate buffer, then 15 min later, NAD (110 mg/kg BW) in 0.9% normal saline was administered intraperitoneally to the overnight fasted rats. The blood glucose levels more than 250 mg/dL which were confirmed after 7 days of STZ-NAD administration were taken for the study (n = 6).

2.4. Experimental Design

- Group 1: Normal control rats (non-diabetic)
- Group 2: STZ-NAD-induced diabetic control rats
- Group 3: STZ-NAD-induced diabetic rats supplemented with CIP (200 mg/kg body weight/day) in dimethyl sulfoxide (DMSO) orally for 30 days.
- Group 4: Diabetic rats administered with gliclazide (5 mg/kg body weight/day) in DMSO orally for 30 days.

At the end of the treatment period, the overnight fasted rats were anesthetized and then sacrificed by cervical decapitation. The blood was obtained from the rats using retro-orbital sinus puncture method for further biochemical estimation.

2.5. Estimation of Biochemical Markers

Effect on the condition of hyperglycemic markers such as insulin and glucose in experimental DM (antihyperglycemic) was measured by the respective kits (Span Diagnostics, Mumbai).

2.6. Estimation of Antioxidants

The liver was dissected out at the end of the experiment and estimated the antioxidant enzymes such as superoxide dismutase (SOD) by Kakkar et al. [8] method, catalase (CAT) by Aebi [9] colorimetric method, glutathione peroxidase (GPx) by Paglia and Valentine’s [10] method, and reduced GSH as per the method of Beutler and Kelley [11].

2.7. Statistical Analysis

All the results were expressed as the mean ± S.D, n = 6. All the experimental group data were statistically evaluated with SPSS/10.0 software. Hypothesis testing methods included ANOVA followed by LSD test; significance level at $P < 0.05$ was considered to authorize statistical significance.

3. RESULTS AND DISCUSSION

The STZ-NAD-induced DM rat is one among the substantial models of human being DM. Injection together with STZ and NAD has been reported to the induction of experimental DM in rats. Studies on STZ-NAD-induced diabetic rats have demonstrated that the antioxidative defense system is impaired in these animals. Accordingly, this model of diabetes is also an excellent tool for finding the antioxidative potential of various compounds [12]. Fig. 1a and b showed the blood glucose levels, body weight, and insulin levels in treated and untreated groups. There was a noteworthy ($P < 0.05$) rise in blood glucose level and diminution in body weight (Fig. 1a) and insulin (Fig. 1b) as well in STZ-NAD-induced DM rats when compared to normal rats. Supplementation of CIP or gliclazide brought back blood glucose levels toward near standard levels concurrently increased the body weight and insulin levels. The diminution in body weight in DM rats exposed that the deprivation or thrashing of structural proteins is owed to DM, and structural proteins are acknowledged to furnish the body weight. DM rats treated with CIP gained the body weight. A raise in the body weight of CIP-treated rats might be due to its hypoglycemic potential and CIP may increase the synthesis of structural proteins [13]. Insulin is the single hormone which controls the blood glucose; thus, it has an essential role in glucose metabolism. The elementary mechanism underlying hyperglycemia in DM involves in unnecessary hepatic gluconeogenesis and glycogenolysis and reduced expenditure of glucose by the tissues [14]. According to these results, it is observed that still insulin-secreting β-cells
are working in STZ-NAD-treated DM rats and stimulate insulin release which might be accountable for the majority of the noticed metabolic activities. In addition, the observed blood glucose reduction effect in standard and STZ-NAD-induced DM rats could conceivably due to the enhanced peripheral glucose utilization.

In the DM state, insulin scarcity causes the devastation of glucose consumption, foremost to an augmented production of oxygen free radicals [15]. Table 1 demonstrated the activities of SOD, CAT, GPx, and GSH in treated and untreated rats. There was a momentous \( P < 0.05 \) reduction in the activities of SOD, CAT, GPx, and GSH in STZ-NAD-induced DM rats when compared non-diabetic rats. Supplementation of CIP and gliclazide made \( P < 0.05 \) the levels of enzymatic antioxidants close to normal which revealed that CIP has a good antioxidant potential. Oxidative stress-induced DM plays a significant function in the progress of DM complications [16]. SOD, the standard enzymatic antioxidant in cells, delivers an important role in oxygen defense metabolism by reducing and intercepting the superoxide radical to \( \text{H}_2\text{O}_2 \). CAT is well documented to be concerned in the detoxification of high \( \text{H}_2\text{O}_2 \) concentrations and shielding the tissues from tremendously reactive hydroxyl radicals [4]. GPx is a tetrameric glycoprotein, present in cells, and it detoxifies \( \text{H}_2\text{O}_2 \) as water and molecular oxygen through the oxidation of reduced GSH. GPx has been exposed to be a noteworthy adaptive reaction to a position of long-lasting peroxidative stress. GSH is well recognized that concerns in the defense of normal structure and cell function by sustaining the extinguishing of free radicals, redox equilibrium, and contributing in reactions of detoxification [13]. From this experiments, we found that the administration of CIP improved the levels of antioxidant enzymes and it might be due doing its potential capability as an antioxidant. Our study revealed that administration of CIP to diabetic rats successfully prevented the oxidative stress. Hence, these results suggested that CIP can be effectively fought against DM. This action is principally due to the antioxidant potential of carrot [17] and incorporation of carrot juice to the paneer confirmed that the presence of antioxidants in CIP could involve a mechanism associated with scavenging activity to prevent DM.

**Table 1. Effect of CIP on liver antioxidant enzymes in control and STZ-NAD-induced diabetic rats**

<table>
<thead>
<tr>
<th>Group</th>
<th>SOD (units/mg protein)</th>
<th>CAT (units/mg protein)</th>
<th>GPx (µg of GSH oxidized/min/mg protein)</th>
<th>GSH (mg/mg protein)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal control</td>
<td>24.48±3.25</td>
<td>23.45±3.44</td>
<td>7.85±3.01</td>
<td>12.5±2.55</td>
</tr>
<tr>
<td>Diabetic control</td>
<td>16.28±2.41*</td>
<td>12.29±2.58*</td>
<td>3.97±1.09*</td>
<td>5.89±1.40*</td>
</tr>
<tr>
<td>Diabetic+CIP</td>
<td>21.56±3.02**</td>
<td>21.99±3.48**</td>
<td>6.42±2.44**</td>
<td>10.94±2.10**</td>
</tr>
<tr>
<td>Diabetic+gliclazide</td>
<td>23.02±2.49**</td>
<td>23.28±1.99**</td>
<td>7.37±2.80**</td>
<td>11.58±1.79**</td>
</tr>
</tbody>
</table>

Values are expressed as mean ± S.D for six animals in each group. Values are statistically significant at \( *P < 0.05 \), \*significantly different from control, \#significantly different from diabetic control, STZ: Streptozotocin, NAD: Nicotinamide, CIP: Carrot incorporated paneer, SOD: Superoxide dismutase, CAT: Catalase, GSH: Glutathione, GPx: Glutathione peroxidase

4. CONCLUSION

The current study provided evidence indicating that the CIP notably decreases the glucose levels and increases the insulin level in DM rats. Furthermore, supplementation with CIP restored distorted antioxidant enzyme activities of diabetic animals. Hence, these outcomes could throw into a superior perceptive of the antidiabetic activity of
CIP, highlighting the authority of this antioxidant food for individual healthiness, perhaps in the management of DM.

CONSENT FOR PUBLICATION
Not applicable.

CONFLICTS OF INTEREST
The study was self-financed and authors declare no conflict with any individual or organization.

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REFERENCES


