EFFECT OF CURCUMIN ON GLUCOSE ABSORPTION:
AN EXPERIMENTAL STUDY ON ALBINO RATS

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Abstract: Curcumin derived from the rhizome Curcuma longa is one of the primary ingredient in turmeric. Turmeric is used frequently as food additive in Asia, specially the Indian subcontinent. The daily intake of turmeric in the diet may therefore expose the gut to curcumin and affect its physiological functions, including the absorption of nutrients from small intestine. However, no published reports are available on the effect curcumin on absorption of nutrients from small intestine. To explore this possibility, transport of glucose from small intestine was studied in adult albino rats following feeding the animals curcumin intragastrically for five consecutive days. The controls were fed simultaneously, the vehicular fluid intragastrically in the identical volume. Transport of glucose from small intestine was studied using everted sac technique of Wilson and Wiseman (1954) on animals fasted for 16-20 hrs. Everted sacs were prepared from both jejunal and ileal portion of small intestine.

Observations showed a significant increase in glucose transport from jejunal and upper ileal portion of small intestine suggesting that curcumin does influence the transport of nutrients from the gut.

Key words: curcumin glucose absorption GOD/POD jejunal sac ileal sac

INTRODUCTION

Turmeric (CURCUMA LONGA L.) is a medicinal plant extensively used in Ayurveda, Unani, and Siddha medicine as a home remedy for various diseases. For that reason a number of references to the plant are found in classical ayurvedic text such as Charaka Samhita, Sushuruta Samhita, Ashtanga Hridya and Sharangdhar Samhita. These texts have described the use of turmeric for a number of systemic disorders and local disorders pertaining to many systems (1–5).

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antiseptic, astringent, carminative, digestive, and diuretics (6–14).

In the human being and the experimental animals curcumin is found to be having beneficial effect on the function of gastrointestinal tract. It increases bile secretion in anaesthetized dogs and rats. It elevates the activity of pancreatic lipase, amylase, trypsin and chymotrypsin. It acts as a hypoglycaemic agent. Pari L, Murugan P. reported that curcumin has also been shown to lower blood glucose levels in type 2 diabetic KK·Ay mice and STZ treated rats (15–19).

Since turmeric is the main ingredient of many food additives, the mucosal surface of the gastrointestinal tract is periodically but regularly exposed to turmeric. Because of continued exposure of absorptive surface of mucosa of small intestine, there is a distinct probability of changes in the absorptive property of mucosa of small intestine, which may also be affected. However, there is scarcity of studies which show the possible effect of turmeric or its constituents on absorption of nutrients from small intestine. The present study was therefore aimed at studying the effect of Curcumin on glucose absorption in small intestine in albino rats.

MATERIAL AND METHODS

The present study was conducted on 72 albino wistar rats weighing 180-220 gms, following approval of Ethical committee of H.I.M.S. (over a period of 12 months).

Animals

The rats were housed in polycarbonate cages of size 35 cm × 23 cm × 16 cm with 4 rats per cage in a room temperature of 24±2°C, and humidity of 45% to 64% with normal day light cycle. During the entire experimental period, animals were fed with a freshly prepared balanced cooked diet and water ad libitum. Animals were divided into 6 major groups (Group I – Group VI), according to the glucose concentration. Each group was further divided into 2 subgroups ‘A’ and ‘B’, containing 6 rats each. The Group ‘A’ animals were treated as control, while Group ‘B’ animals were treated with drug curcumin 1 gm/kg body weight. 6 everted intestinal sacs were made from each rat, 3 from jejunum and 3 from ileum.

Curcumin dose schedule

Curcumin was dissolved in the freshly prepared normal saline 0.9%. The concentration of the drug solution was kept at 100 mg/ml. The animals were fed curcumin intragastrically in the dose of 1 gm/kg body weight, twice daily at 8 am and 8 pm daily for five consecutive days. The intragastric feeding was done using infant feeding tube (no-6) reaching up to the lower l/3rd of the oesophagus. The control group of animals were fed simultaneously, the vehicular fluid intragastrically in the identical volume twice daily for five consecutive days.

Experimental protocol for absorption studies

The animals were fasted for 16-20 hr before being subjected for absorption studies. The animals were killed by cervical dislocation. The abdomen was opened by midline incision, and the small intestine was washed of its contents with normal saline and stripped of its mesentry and transferred to the container with Krebs-Bicarbonate Ringer buffer solution Krebs and Hansleit (20). Everted sacs were prepared from the jejunum and ileal segments of the small intestine following the technique of Wilson and Wiseman (Fig. 1) (21).
absorbance was measured at 540 nm and glucose concentration was calculated by putting values on standard curve. The coefficient of variation for standard glucose determination was 2–2.7%. The net glucose transport was calculated as difference between incubatory and serosal fluid concentration.

Statistical analysis was performed with two way analysis of variance (ANOVA) followed by paired Student “t” test to see the difference in control and experiment groups and results were expressed in Mean±SE.

RESULTS

The results are summarised in Table I and Fig. 2. The experimental animals showed statistically significant rise in the net glucose transfer at all concentrations of glucose in majority of sacs. It was observed that the
## TABLE I: Analysis of variance for mean net glucose transport in intestinal sacs at varying glucose concentrations (µg/mg of wet weight of sac).

<table>
<thead>
<tr>
<th>Concentration of glucose in incubatory solution (mg/dl)</th>
<th>Jejunum Control (Mean)</th>
<th>Jejunum Experimental (Mean)</th>
<th>Ileum</th>
<th>Ileum</th>
<th>Two way ANOVA</th>
</tr>
</thead>
<tbody>
<tr>
<td>45</td>
<td>80.99</td>
<td>141.2</td>
<td>56.41</td>
<td>81.00</td>
<td>Column Factor – 37.70</td>
</tr>
<tr>
<td>90</td>
<td>88.88</td>
<td>163.5</td>
<td>65.06</td>
<td>119.00</td>
<td>P Value:***</td>
</tr>
<tr>
<td>135</td>
<td>156.00</td>
<td>231.9</td>
<td>128.30</td>
<td>186.00</td>
<td></td>
</tr>
<tr>
<td>180</td>
<td>170.60</td>
<td>254.2</td>
<td>134.50</td>
<td>185.00</td>
<td></td>
</tr>
<tr>
<td>225</td>
<td>212.10</td>
<td>282.1</td>
<td>176.50</td>
<td>208.00</td>
<td></td>
</tr>
<tr>
<td>270</td>
<td>129.20</td>
<td>176.0</td>
<td>117.20</td>
<td>138.00</td>
<td></td>
</tr>
</tbody>
</table>

*P<0.05, **P<0.001, ***P<0.0001

net glucose transport (µg/dl) in all jejunal sacs in experimental groups was significantly higher than control groups, at all concentrations, while only in ileal sac, the experimental groups showed significantly higher glucose transfer. The maximum glucose transfer was found at 225 mg/dl in all sacs, in all the groups. The net glucose transport µg/mg wet weight of sacs in jejunum and ileum at varying concentration of glucose showed column factor 37.70, P<0.001 and row factor 59.83, P<0.0001 after applying two way analysis of variance.

**DISCUSSIONS**

In the present study the technique described by Wilson and Wiseman was used because the eversion exposes the highly active mucosa to the well oxygenated suspending medium while the distension increases the surface area of the sac and reduces the thickness of the sac wall (21). These factors facilitate glucose absorption from small intestine.

Curcumin and turmeric have been evaluated for acceptable daily intake by the joint FAR/WHO expert committee on food additives in 1969, 1974 and 1979. In the present study, curcumin was given in the dose of 1 gm/kg (1 mg/gm) of body weight twice a day. In previous studies curcumin was found to having no adverse effect up to the dose of 5 gm/kg body weight/day (22, 23).

The net glucose transport in jejunum and ileum increases with increase in glucose concentration up to the 225 mg/dl in KRB buffer in all the groups of control and experimental animals and after that net glucose transport decreased with further increase in concentration of glucose in our study. Also the Glucose net transport against concentration gradient across the intestinal mucosa showed significant increase in the experimental animals, after administration of Curcumin in a dose of 1 mg/kg b.w. twice a day, as compared to control groups in all
groups (i.e. at all concentrations).

It is well known that prostaglandin inhibit the glucose absorption from small intestine and it also inhibits sodium and chloride absorption from mucosal surface. It has been reported that PGE2 added in vitro to the serosal side of the small intestine of animals inhibits sodium and chloride absorption (24, 25).

Curcumin was found to cause inhibition of prostaglandin synthesis and COX 2 (26).

Hari et al. (27) found in their study that following administration of Curcumin, there was initially decrease in Na⁺ K⁺ ATPase. After seven days, there were twofold increases in Na⁺ K⁺ ATPase activity. Srivastava & Srimal found that Curcumin potentiated the activity of liver ATPase (28). Curcumin reportedly enhances insulin secretion and increase in hepatic glycogen concentration and skeletal muscle lipase activity (29).

Pari et al. showed in their studies that tetrahydrocurcumin (THC) decreased blood glucose in STZ diabetic rats. They concluded that the possible mechanism by which THC mediates its antidiabetic action may be the potentiating of pancreatic secretion of insulin from existing β-cell or due to enhanced transport of blood glucose to peripheral tissue. As we know that insulin potentiates the action of sodium potassium ATPase (30).

The present study has also reported that glucose transport was more in jejunum as compared to ileum. In the jejunum, net glucose transport was maximum in jejunal sac 3 while in ileal sac-2 and sac-3 glucose transport was minimum at all the concentrations. These findings are supported by the findings of the previous studies (21, 31-33).

Thus the increase in the absorption rate of glucose, found in the present study can be attributed to decrease in level of local PGE2, the increased in absorptive area, increase in activity of sodium potassium ATPase, and the increase in secretion of insulin from P cells of pancreas.

ACKNOWLEDGEMENTS

The authors are grateful to H.I.M.S., Dehradun to provide facilities to conduct this study. The authors are grateful to Prof. (Dr.) R. K. Sharma for their kind support and valuable guidance.

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