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SHORT COMMUNICATION

Turmerin, the antioxidant protein from turmeric (Curcuma longa) exhibits antihyperglycaemic effects

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A wide range of proteinaceous inhibitors are present in plants to protect themselves from hydrolytic enzymes. In this study, turmerin, a water-soluble peptide in turmeric rhizomes, was evaluated for its inhibitory potential against glucosidase and its antioxidant (AO) capacity. Turmerin inhibited α-amylase and α-glucosidase activities with IC50 values 31 and 192 μg mL⁻¹, respectively. Under the experimental conditions, those values for a standard glucosidase inhibitor, acarbose, were 81 and 296 μg mL⁻¹, respectively. The AO capacity of turmerin was evaluated using in vitro assay systems. Turmerin showed good DPPH (IC50 = 29 μg mL⁻¹) and superoxide (IC50 = 48 μg mL⁻¹) and moderate ABTS (IC50 = 83 μg mL⁻¹) radical scavenging and Fe(II) chelation (IC50 = 101 μg mL⁻¹) capacities. The inhibitory potential showed by turmerin against enzymes linked to type 2 diabetes, as well as its moderate AO capacity, could rationalise the traditional usage of turmeric rhizome preparations against diabetes.

**Keywords:** Curcuma longa; turmerin; α-glucosidase; α-amylase; antidiabetic; antioxidant

1. Introduction

Diabetes, a state of improperly regulated homeostasis of carbohydrate and lipid metabolism is one of the major killers in recent times. The most prevalent form of diabetes is non-insulin-dependent diabetes mellitus. Rapid hydrolysis of starch mediated by pancreatic α-amylase and α-glucosidases followed by glucose uptake at intestine results in sudden rise in blood glucose levels, resulting in elevated postprandial hyperglycaemia (PPH) in type 2 diabetes patients (Gray, 1995). PPH is one of the risk factors inherent to diabetes, which complicates the treatment (Gin & Rigalleau, 2000). Glucosidase inhibitors play a major role in managing PPH in diabetic patients (Notkins, 2002). The conventionally used glucosidase inhibiting drugs such as acarbose and miglitol for the management of PPH in diabetic patients are known to be associated with a variety of side effects (Fujisawa, Ikegami, Inoue, Kawabata, & Oghara, 2005). In this context, the search for glucosidase inhibitors from natural sources with lesser side effects attracts more researchers’ interests.

In Indian traditional medicine ‘Ayurveda’, turmeric (Curcuma longa) rhizomes have been given a major importance in the treatment of diabetes and related disorders.

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A wide spectrum of physiological effects has been attributed to its rhizome both in traditional and modern medicinal systems. Curcuminoids and turmerin were reported to be the major bioactive constituents of the rhizome. Curcuminoids are reported to inhibit $\alpha$-amylase activity (Du et al., 2006). Turmerin, a water-soluble protein with a molecular weight of 34 kDa (Smitha, Dhananjaya, Dinesha, & Srinivas, 2009), has been shown to be an antioxidant (AO) protein (Srinivas, Shalini, & Shylaja, 1992). Its ability to protect organs from snake poison-induced oxidative damage is recently reported by Chethankumar (2010). Cohly et al. (2002) demonstrated endothelial denudation protection capacity of turmerin. Many plant proteins are reported to inhibit hydrolytic enzymes as a part of their defense mechanism (Dayler et al., 2005; Mclauchlan et al., 1999). Recent reports on the glucosidase inhibiting plant proteins are also available (Kumar et al., 2010; Tiengburanatam, Boonmee, Sangvanich, & Karnchanatat, 2010). In this context, this study was aimed at the evaluation of turmerin for its $\alpha$-amylase and $\alpha$-glucosidase inhibitory potentials to rationalise the usage of turmeric rhizomes in traditional antidiabetic preparations. Since the oxidative stress has a major role in the aetiology and progression of diabetes and related disorders (Greismacher et al., 1995), the in vitro AO potential of turmerin was also evaluated in this study.

2. Results and discussion

2.1. Composition of turmerin extract

The turmerin extract was subjected to composition analysis. The extract contained 76.7% protein, 18.7% carbohydrates and 0.28% phenolics.

2.2. $\alpha$-Amylase and $\alpha$-glucosidase inhibitory activities

The $\alpha$-amylase and $\alpha$-glucosidase inhibition capacities of turmerin extract were determined and compared with those of a potent glucosidase inhibitor acarbose. The dose response curves for $\alpha$-amylase and $\alpha$-glucosidase inhibition capacities by turmerin extract are shown in Figure 1. The $\alpha$-amylase inhibitory potential of turmerin (IC$_{50} = 31 \mu g mL^{-1}$) was higher ($p < 0.05$) than that of acarbose (IC$_{50} = 81 \mu g mL^{-1}$). The IC$_{50}$ values obtained for $\alpha$-glucosidase inhibition by turmerin and acarbose were 192 and 296 $\mu g mL^{-1}$, respectively. Both $\alpha$-amylase and $\alpha$-glucosidase inhibition capacities shown by turmerin were significantly higher than ($p < 0.05$) those of acarbose.

Pancreatic and intestinal glucosidases are the key enzymes of dietary carbohydrate digestion. Inhibition of these key enzymes of dietary carbohydrate digestion is effective in retarding glucose absorption and thereby suppresses PPH (Hirsh, Yao, Young, & Cheeseman, 1997). A wide range of proteinaceous inhibitors against hydrolytic effects of enzymes produced endogenously as well as from infecting micro-organisms are present in plants (Kumar et al., 2010, Mclauchlan et al., 1999). Reports on plant proteins as $\alpha$-amylase (Dayler et al., 2005; Mclauchlan et al., 1999) and $\alpha$-glucosidase (Tiengburanatam et al., 2010) inhibitors are also available. This study demonstrated the potent glucosidase inhibition capacity of turmerin for the first time. Studies to explore the nature and kinetics of the glucosidase enzyme inhibition offered by turmerin are in progress in our laboratory.

2.3. In vitro AO activities

The dose response curves for in vitro AO capacities of turmerin extract are shown in Figure 2. Turmerin showed considerably good DPPH radical-scavenging capacity with an IC$_{50}$ value of 29 $\mu g mL^{-1}$ against gallic acid (IC$_{50} = 4 \mu g mL^{-1}$). The IC$_{50}$ values obtained for ABTS radical-scavenging capacity of the extract and trolox were, respectively, 83 and 3 $\mu g mL^{-1}$. The superoxide radical-scavenging capacity of turmerin extract (IC$_{50} = 0$
Figure 1. Dose dependent inhibition of $\alpha$-amylase and $\alpha$-glucosidase shown by the turmerin-enriched extract (Mean ± SD, $n = 3$).

Figure 2. DPPH, superoxide and ABTS radical scavenging and Fe(II) chelation capacity of turmerin-enriched extract (Mean ± SD, $n = 3$).
48 μg mL\(^{-1}\)) was lower (\(p<0.05\)) than that of catechin (IC\(_{50} = 16 \mu g mL\(^{-1}\)). IC\(_{50}\) values obtained for Fe(II) chelation by turmerin and EDTA were 101 and 6 μg mL\(^{-1}\), respectively. A moderate AO potential of turmerin was demonstrated by these \textit{in vitro} assays. Though a number of AO compounds have been isolated and characterised from dietary sources as effective radical scavengers, very few reports are available on plant proteins showing AO activity. Smitha et al. (2009) reported hydroxyl radical scavenging and lipid peroxidation inhibitory capacities of turmerin. DPPH, ABTS and superoxide radical-scavenging and chelation capacities of turmerin demonstrated in this study further confirmed the AO nature of turmerin.

3. Conclusions
The turmeric protein, turmerin-enriched extract showed considerable glucosidase inhibition potential along with moderate AO capacity. Since diabetes and related disorders are largely associated with increased oxidative stress, therapeutic agents with both antidiabetic and AO efficacies gain special interest. Water solubility and non-toxic nature of turmerin might further enhance its potential as an antidiabetic agent. The high \(\alpha\)-amylase and \(\alpha\)-glucosidase inhibitory potentials of turmerin evidenced by this study along with the reports on the inhibitory potential of curcuminoids could rationalise the traditional usage of turmeric as an antidiabetic agent. Further \textit{in vivo} studies are warranted to fully elucidate the antidiabetic potential of turmerin.

Supplementary material
Experimental details relating to this article are available online.

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