

# World Journal of *Gastroenterology*

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## Perspectives of traditional Chinese medicine in pancreas protection for acute pancreatitis

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### Abstract

Acute pancreatitis (AP) is one of the most common diseases. AP is associated with significant morbidity and mortality, but it lacks specific and effective therapies. Traditional Chinese medicine (TCM) is one of the most popular complementary and alternative medicine modalities worldwide for the treatment of AP. The current evidence from basic research and clinical studies has shown that TCM has good therapeutic effects on AP. This review summarizes the widely used formulas, single herbs and monomers that are used to treat AP and the potential underlying mechanisms of TCM. Because of the abundance, low cost, and safety of TCM as well as its ability to target various aspects of the pathogenesis, TCM provides potential clinical benefits and a new avenue with tremendous potential for the future treatment of AP.

**Key words:** Acute pancreatitis; Traditional Chinese medicine; Alternative therapy; Pancreas protection; Anti-inflammatory

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**Core tip:** Specific and effective therapies for the treatment of AP are lacking. Traditional Chinese

medicine (TCM) exhibits beneficial, curative effects in basic research and clinical studies of AP treatment. Because of its abundance, low cost, safety and ability to target various aspects of AP pathogenesis, TCM provides a promising complementary and alternative therapy for the treatment of AP.

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## INTRODUCTION

Acute pancreatitis (AP) is characterized by the activation of trypsinogen and the establishment of a local inflammatory response in the pancreas, with the risk of developing into severe acute pancreatitis (SAP), characterized by systemic inflammatory response syndrome (SIRS) and multiple organ dysfunction syndrome (MODS)<sup>[1-3]</sup>. The pathogenesis of AP is not clear. Research in recent decades has focused on trypsinogen activation, pancreatic microcirculation malfunction, calcium overload and inflammatory pathways<sup>[4]</sup>. Pancreatic exocrine secretion inhibitors, such as octreotide, demonstrate a modest preventative role in the treatment of AP<sup>[5]</sup>; however, specific and effective therapies are lacking. Given the limited treatment of option, patients seek additional therapies to improve the therapeutic effect, which leading many to focus on complementary and alternative therapies.

Based on the unique traditional Chinese medicine (TCM) theoretical system and effective treatment methods, people have used TCM to prevent and address diseases for centuries, and more attention has been directed to this medicinal approach in recent studies<sup>[6-9]</sup>. TCM has demonstrated its superiority in the management of AP and other inflammatory diseases in China for many years<sup>[10]</sup>. Under the guidance of TCM pharmaceutical theory, AP is categorized as epigastric pain, splenic precordial pain, splenopyretic disease and knotted chest disease. The principle of treatment in TCM is to clear away the heat-evil (heat as a pathogenic factor that causes heat pattern/syndrome) and expelling superficial evils, supplementing *qi* (vital energy) and nourishing *yin* (body fluid), activating blood circulation to dissipate blood stasis and inner communication and purgation.

The philosophical basis of TCM is influenced by a holistic view that aligns with a theory of organism balance regulation in modern medicine. The theory of TCM in AP treatment is localized not only in the pancreas but also in the integrity and functional regulation of the organism. TCM coincides with the concepts of modern medicine and has attracted

increasing attention as a combination therapy for AP<sup>[11]</sup>. As a complementary therapy, TCM that uses formulas and single herbs is increasingly considered to be effective and safe for treating AP<sup>[12]</sup>. Recently, the published guidelines for AP treatment in China stated that by using formulas and single herbs, TCM can be used as an alternative therapy for AP, and they acknowledged that TCM has exhibited good clinical effects. Accumulating evidence has demonstrated that TCM reduces the levels of serum and urinary amylase, decreases the permeability of capillaries, depresses the production of inflammatory cytokines, inhibits neutrophilic granulocyte activation and attenuates pancreatic injuries. These benefits block multiple steps in the development of AP according to experimental and clinical studies. Based on its characteristics of improved symptoms, reduced medical costs and increased satisfaction of AP patients, TCM appears to be a promising complementary and alternative therapy for the treatment of AP<sup>[7,13,14]</sup>. This review will provide a new understanding of the properties of TCM with an emphasis on the regulation of important molecular targets in AP in the context of basic and clinical research and the representative TCM approaches that can be combined with classic treatments of AP.

## TCM FORMULAS

A TCM formula is the combination of several types of medicinal herbs or minerals that can amplify the therapeutic efficacies of each agent. The theory of the compatibility of medicinal ingredients is the principle of formula prescriptions. A formula commonly comprises various medicines, which are usually named sovereign (*jun*), minister (*chen*), assistant (*zuo*) and messenger (*shi*) ingredient drugs because of their different roles in the formula; these ingredients affect multiple targets and exert synergistic therapeutic effects, which lead to maximal therapeutic efficacy with minimal adverse effects<sup>[15]</sup>. The frequently used formulas for AP treatment are liquid medicines that are termed "decoction", such as dachengqi decoction, qingyi decoction, yinchenchengqi decoction, chaiqinchengqi decoction, huoxueqingyi decoction and dahuangfuzi decoction.

### **Dachengqi decoction**

Dachengqi decoction, one of the famous formulas in China for purgation, comprises rheum, immature bitter orange, natni sulfas natura, and *Magnolia officinalis* bark. Dachengqi decoction was first recorded in the classic TCM masterpiece *Shang Han Lun (Treatise on Febrile Diseases)* and has been widely used for acute abdominal pain throughout China<sup>[16-18]</sup>. Animal experiments have shown that dachengqi decoction increases cell viability, induces pancreatic acinar cell apoptosis, reduces acinar necrosis and protects from injuries to the pancreas *in vivo* and *in*

*vitro*. The likely therapeutic mechanisms of action of dachengqi decoction may operate through reducing ROS generation and regulating the nitric oxide pathway in a rat SAP model<sup>[19]</sup>. Randomized controlled trials have reported that dachengqi decoction decreases serum resistin levels, significantly reduces mortality and exerts a beneficial therapeutic effect in SAP patients<sup>[20,21]</sup>. Concerning intestinal mucosal permeability, Chen *et al*<sup>[18]</sup> found that dachengqi decoction promoted the recovery of intestinal mucosal permeability and decreased the incidence of MODS and pancreatic infection in patients with SAP, which is supported by other studies<sup>[22]</sup>. Regarding abdominal compartment syndrome in SAP patients, Zhang *et al*<sup>[23]</sup> found that the combination of dachengqi decoction and conventional therapy decreased the intra-abdominal pressure of SAP patients and provided therapeutic effects on the abdominal compartment syndrome of SAP. Wan *et al*<sup>[24]</sup> investigated the effects of combined therapy with a modified dachengqi decoction and dexamethasone in the treatment of SAP patients on survival, acute respiratory distress syndrome (ARDS), renal failure, haemorrhage, sepsis, pancreatic pseudocyst, pancreatic abscess, operability, and days of hospitalization. Their data demonstrated that the modified dachengqi decoction combined with dexamethasone can decrease the risk of developing ARDS in SAP patients with SIRS, and it shortened their length of hospitalisation. This finding suggests that the modified dachengqi decoction is a safe and beneficial treatment option for SAP patients with SIRS.

### **Qingyi decoction**

Qingyi decoction is the most famous formula for AP treatment and consists of rheum, Chinese thoroughwort root, white peony root, baikal skullcap root, *Coptis chinensis* and other herbs. Qingyi decoction was invented by Doctor Boyu Zhang of the Shanghai University of Traditional Chinese Medicine and has exhibited good therapeutic effects for AP, as demonstrated in many preclinical and clinical studies. By targeting the inflammatory reaction in AP, qingyi decoction down-regulated the levels of serum endotoxin,  $\alpha$ -amylase and tumour necrosis factor- $\alpha$  and reduced the expression of inflammatory factors in SAP rats. Moreover, the formula can ameliorate AP-induced intestinal barrier injury and lung injury. The mechanism may operate through inhibiting the overexpression of intestinal- and lung-secreted phospholipase A2<sup>[25,26]</sup>. Concerning bacterial translocation, qingyi decoction increased the density, altitude and area of intestinal mucosa and up-regulated the level of intestinal histone, which inhibited intestine permeability and bacterial translocation from the intestine. Wu *et al*<sup>[27]</sup> found that qingyi decoction combined with sodium sulfate was significantly superior to sodium sulfate alone in improving clinical

symptoms; it also shortened hospitalizations and reduced the recovery time in SAP patients. Combined with enteral nutrition, qingyi decoction displayed improved clinical benefits in promoting the recovery of intestinal function and in regulating the balance of inflammatory cytokines<sup>[28]</sup>.

### **Other formulas**

Yinchenchengqi decoction is another frequently used formula in China for the treatment of AP. This decoction consists of *Artemisia scoparia*, *Gardenia jasminoides*, *Magnolia officinalis* bark, immature bitter orange, rheum and natni sulfas natura. Yinchenchengqi decoction may protect the pancreas by up-regulating Bax gene expression to induce apoptosis in the pancreatic acinar cells that are already injured; this treatment prevented cell necrosis in haemorrhagic necrotizing pancreatitis in rats<sup>[29]</sup>. In addition to the induction of apoptosis, this formula may down-regulate the expression of inflammatory mediators by inhibiting nuclear factor-kappa B (NF- $\kappa$ B) activation<sup>[30]</sup>.

Consistent with its use in AP therapy for thousands of years in China, chaqinchengqi decoction has been shown to inhibit the pancreatic enzymes and anti-inflammatory activity in patients with AP. Wang *et al*<sup>[10]</sup> found that chaqinchengqi decoction significantly decreased the level of the serum pro-inflammatory cytokine interleukin-6 (IL-6) within the first 48 h of AP onset; it also improved symptoms and shortened hospitalization times in 107 AP patients.

Huoxueqingyi decoction, which comprises *Salvia miltiorrhiza* and qingyi decoction, is a modified qingyi decoction that has been widely used in the treatment of AP. It has been demonstrated that huoxueqingyi decoction that is administered rectally, intragastrically or orally shortens the hospital stay, reduces hospitalization costs and decreases the duration of SIRS and hyperamylasemia in patients with SAP. Furthermore, the formula did not induce any adverse effects such as liver injury. Therefore, huoxueqingyi decoction provides an effective, safe and economic therapeutic option<sup>[31]</sup>.

Dahuangfuzi decoction, which consists of rheum, aconite, and *Asarum sieboldii*, is a famous traditional Chinese prescription with strong anti-inflammatory effects. Wu *et al*<sup>[32]</sup> found that dahuangfuzi decoction reduced the serum alanine aminotransferase (ALT) level and attenuated pancreas and liver injuries that are induced by SAP, and the anti-inflammatory mechanism of dahuangfuzi decoction operates by inhibiting the JAK/STAT signal pathway in SAP rats.

Although the decoctions have evident effects on AP, the applications of most decoctions are oral, which limits their utility because patients in the acute stage of AP have no access to food or water. In addition, the multiplicity of formulations also leads to issues with TCM standardization. This dilemma has led to the prevalence of studies on single Chinese medicinal

herbs and monomers.

## SINGLE CHINESE MEDICINAL HERB

Single Chinese medicinal herbs such as rheum, *Salvia miltiorrhiza*, natrii sulfas, baikal skullcap root, Saiko and *Gardenia jasminoides* have also been applied to AP treatment.

### Rheum

As a classic TCM purgative, rheum has been widely used and has commonly served as the principal component in many traditional Chinese formulas for AP treatment. Rheum has been found to trigger enterokinesia, prevent translocation of intestinal bacteria, regulate intestinal flora, repair the intestinal mucosal barrier, and have an obvious therapeutic effect in SAP rats. Furthermore, rheum can inhibit the intestinal inflammatory response and ultimately improve the prognosis and outcome in SAP rats by down-regulating the signalling of the toll-like receptors (TLR)-2 and -4<sup>[33]</sup>. Currently, rheum is widely used as an adjunctive treatment in China's guidelines for AP therapy and demonstrates good clinical effects. Wan *et al.*<sup>[34]</sup> investigated the effects of a combined therapy using early enteral nutrition (EEN) and rhubarb. A randomized controlled trial showed that combined EEN and rhubarb significantly decreased white blood cell counts, plasma C-reactive proteins and IL-6 levels and increased plasma IL-11 levels, thus inhibiting systemic inflammation. Furthermore, the trial found that the time of abnormal bowel movements, recuperation from high fever, periods in intensive care units and duration of hospital stays were all shortened in the combined EEN and rhubarb group. In addition, combined EEN and rhubarb can reduce abnormally high levels of plasma alanine aminotransferase, aspartate aminotransferase, and creatinine (Cr) and mitigates SAP-related liver and kidney dysfunction. Zhou *et al.*<sup>[35]</sup> investigated the combined effect of rhubarb and somatostatin in AP patients and found that it significantly reduced the total complications and APACHE II scores in patients with AP; this finding reveals that rhubarb can serve as an adjunctive therapeutic tool in AP treatment.

### Salvia miltiorrhizae

*Salvia miltiorrhizae* is a commonly used traditional Chinese herb to activate blood and remove stasis. It has been proven that *Salvia miltiorrhizae* has anti-inflammatory properties, and in SAP rats, it cleared reactive oxygen species, induced apoptosis, and improved microcirculation, thus demonstrating some protective effects<sup>[36]</sup>. *Salvia miltiorrhizae* can protect multiple organs, strengthen immune function and thereby decrease the mortality of SAP rats. The mechanism may be through a reduction in plasma endotoxin levels, the inhibition of intercellular cell adhesion molecule-1, TLR4, and NF- $\kappa$ B expression,

and the regulation of the protein levels of apoptosis-related gene Bax<sup>[37,38]</sup>.

### Natrii sulfas

Natrii sulfas plastering therapy is a common adjunctive treatment of AP therapy that has been used in recent years with a rheum application and conventional therapy. The data from clinical research that was conducted in 60 AP patients showed that conventional therapy combined with intragastric rhubarb administration and natrii sulfas plastering therapy can relieve the symptoms of abdominal pain and distention, decrease serum and urine amylase levels, and reduce the APACHE II score compared with a control group<sup>[39]</sup>. Because sodium sulfate is the major component of natrii sulfas and has diuretic, detumescent and anti-inflammatory properties, natrii sulfas plastering therapy can adsorb moisture from the abdomen and thus disperse the swelling of the abdominal wall and intestinal canal.

## TCM MONOMERS

### Emodin

Emodin (1,3,8-trihydroxy-6-methyl-anthraquinone), an anthraquinone, with the molecular formula of C<sub>15</sub>H<sub>10</sub>O<sub>5</sub> and a molecular mass of 270.23, is isolated from the traditional Chinese herb of rheum. Emodin has exhibited excellent biological activities in inflammatory diseases, such as antibacterial, anti-inflammatory, antioxidant, antitumour and immunomodulatory properties, and it inhibits trypsinogen secretion and improves the microcirculation<sup>[40,41]</sup>. Regarding the systemic inflammatory responses in AP, researchers have investigated the anti-inflammatory pharmacological mechanism that is induced by emodin in AP rats. The data showed that emodin reduced serum trypsinogen, serum pro-inflammatory factor tumour necrosis factor- $\alpha$  (TNF- $\alpha$ ), and IL-6 and IL-1 $\beta$  levels, and it inhibited NF- $\kappa$ B DNA-binding activity and enhanced peritoneal macrophage phagocytosis and apoptotic cell clearance. Emodin attenuated pancreatic damage through the inhibition of the TLR4 signal pathway, NF- $\kappa$ B and endoplasmic reticulum stress<sup>[42-45]</sup>. Emodin has also been reported to inhibit the abnormal metabolism of gadoleic acid and to improve pancreatic ischaemia in SAP. Concerning lung injury in AP, emodin intervention has been shown to up-regulate the expression of aquaporin-1, aquaporin-5, claudin-4, claudin-5 and occludin in lung tissue and decrease the histopathologic score. Emodin has also been reported to improve blood gas indexes, pulmonary oedema, vascular leakage, and alveolar epithelial barrier function, which ameliorated the acute lung injury that was induced by SAP<sup>[46,47]</sup>. Emodin has also been shown to up-regulate the mRNA expression of the apoptosis-related gene Bax, induce apoptosis in pancreatic acinar cells, and reduce cell necrosis in the pancreas. Its underlying mechanisms

may operate through the inhibition of the TLR2 and TLR4 signal pathways and immune inflammation regulation<sup>[48,49]</sup>. Moreover, emodin has induced NO liberation, improved microcirculation of the pancreas, promoted cell regeneration and prevented pancreatic fibrosis. Gong *et al.*<sup>[50]</sup> reported that emodin increased transforming growth factor  $\beta$ 1 and epidermal growth factor gene expression, which subsequently increased DNA synthesis and protein content and thereby accelerated pancreatic repair and regeneration<sup>[51]</sup>. In addition, Wang *et al.*<sup>[52,53]</sup> investigated the combined effect of emodin and EEN on SAP. Their data showed that the combination of emodin and EEN reduced the severity of experimental SAP in rats, and the combined strategy was rational, safe and more effective than the use of either EEN or emodin alone. In our previous study, we similarly confirmed the therapeutic effects of emodin *in vivo*<sup>[49,54]</sup>.

### **Baicalein**

Baicalein (5,6,7-trihydroxyflavone-7-O-D-glucuronic acid) is a flavonoid that is extracted from baikal skullcap root, a traditional Chinese herb. Baicalein has excellent antioxidant and anti-inflammatory activities and can be an anti-inflammatory agent<sup>[55]</sup>. In our previous study, we found that baicalein exerted an anti-inflammatory capability and showed a therapeutic effect in SAP rats. We investigated changes in pancreatic histopathology, ascites fluid and serum inflammatory mediators after baicalein treatment and found that baicalein was effective in decreasing the pancreatic histopathology score, reducing ascites fluid production and balancing the network between pro-inflammatory mediators and anti-inflammatory mediators. In addition, our study indicated that baicalein protected against pancreatic injury and led to improved survival in SAP rats<sup>[56]</sup>. Moreover, based on the theory of TCM, modern medicine, and the theory of the compatibility of medicinal ingredients, we have refined the classic qingyi decoction and selected baicalein and emodin for a combination treatment approach. We propose that the combined use of baicalein and emodin blocks multiple steps in the development of AP and exerts more profound therapeutic effects on pancreatic injuries in SAP rats without adverse effects<sup>[54,57]</sup>. The glycoside of baicalein that was mentioned above, which is called baicalin (5,6-dihydroxyflavon-7-yl  $\beta$ -D-glucopyranosiduronic acid), also has many biological properties, including antioxidant, anti-bacterial, antiviral, and anti-inflammatory effects<sup>[58]</sup>. Zhang *et al.*<sup>[59]</sup> showed that baicalin inhibited serum P-selectin expression, decreased serum inflammatory cytokine levels and induced apoptosis of thymocytes in SAP rats.

### **Scutellarin**

Scutellarin is extracted from the plants of the *Scutellaria* genus and has effective bioactivity. Scutellarin

has been reported to dilate blood vessels, improve cardiovascular and cerebrovascular ischaemia, and inhibit activation of NF- $\kappa$ B from acute lung injury in mice<sup>[60,61]</sup>. Chen *et al.*<sup>[62]</sup> investigated the pharmacological mechanisms of serum amylase inhibition and the protection of multiple organs (pancreas, liver, kidneys and lungs) by scutellarin in SAP rats. The data showed that scutellarin decreased serum ALT, Cr and amylase levels and relieved the pathologic changes of multiple organs. Furthermore, acute and subacute toxicity studies were performed to evaluate the safety of scutellarin. These data showed that scutellarin has a sufficient margin of safety for therapeutic use in rodents<sup>[63]</sup>.

### **Ligustrazine**

Ligustrazine is an alkaloid that is isolated from the traditional Chinese herb Szechuan lovage rhizome. Ligustrazine is a new type of calcium antagonist that has antiplatelet properties, improves microcirculation and enhances cerebral blood flow<sup>[64]</sup>. Ligustrazine has been shown to effectively induce pancreatic acinar cell apoptosis and prevent the apoptosis of cells in the liver and kidneys, which decreased the pathological score of these organs in SAP rats<sup>[65]</sup>. The mechanism of ligustrazine may operate by suppressing the p38 and ERK/MAPK pathways<sup>[66]</sup>. Moreover, ligustrazine has been shown to effectively decrease serum amylase levels and inflammatory cytokines and alleviate pathological changes in the pancreas, liver, kidney, small intestinal mucosa, thymus and spleen, which protect the body from multiple organ injuries<sup>[66,67]</sup>.

### **Resveratrol**

Resveratrol is a polyphenol that is isolated from the herb *Polygonum cuspidatum*, and it has high bioactivity, such as anti-inflammatory, antioxidative and anti-platelet aggregation activities. Resveratrol has been shown to effectively induce apoptosis in the pancreas, inhibit serum amylase release and inflammatory reactions, suppress microcirculatory disturbances, and alleviate pancreatic pathological injuries through the up-regulation of FasL expression and the down-regulation of the levels of angiotensin II, endothelin, nitric oxide and TNF- $\alpha$ <sup>[68-70]</sup>. In addition, the antioxidant and immunomodulatory properties of resveratrol may supply a promising chemopreventative approach in AP prevention<sup>[71]</sup>, which coincides with the core belief of TCM as a preventive treatment.

### **Artemisinin**

Artemisinin is a sesquiterpene that is isolated from the traditional Chinese herb sweet wormwood. Artemisinin is a specific antimalarial that also has antileukaemic and immunoregulation properties. Researchers have studied the effect of artemisinin on AP rats and found that artemisinin reduced trypsinogen excretion, inhibited the activation of neutrophilic granulocytes,

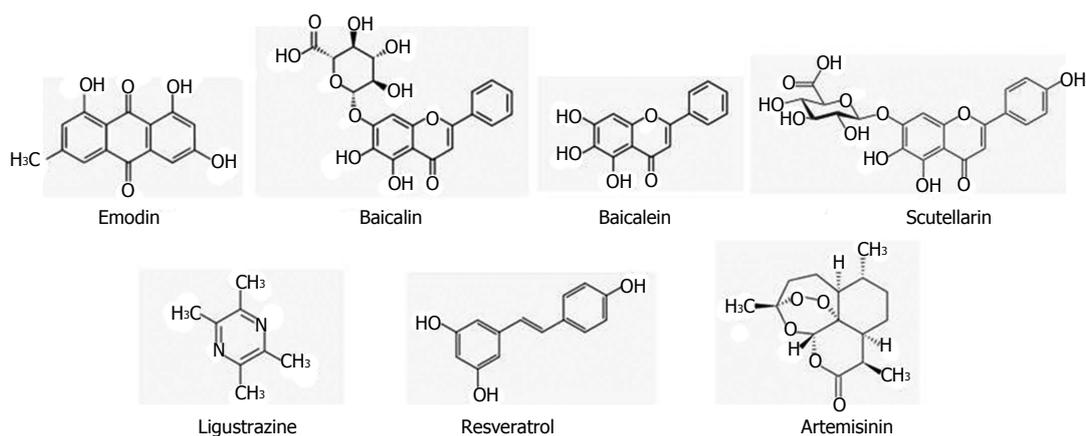


Figure 1 Chemical structures of Traditional Chinese medicine monomers.

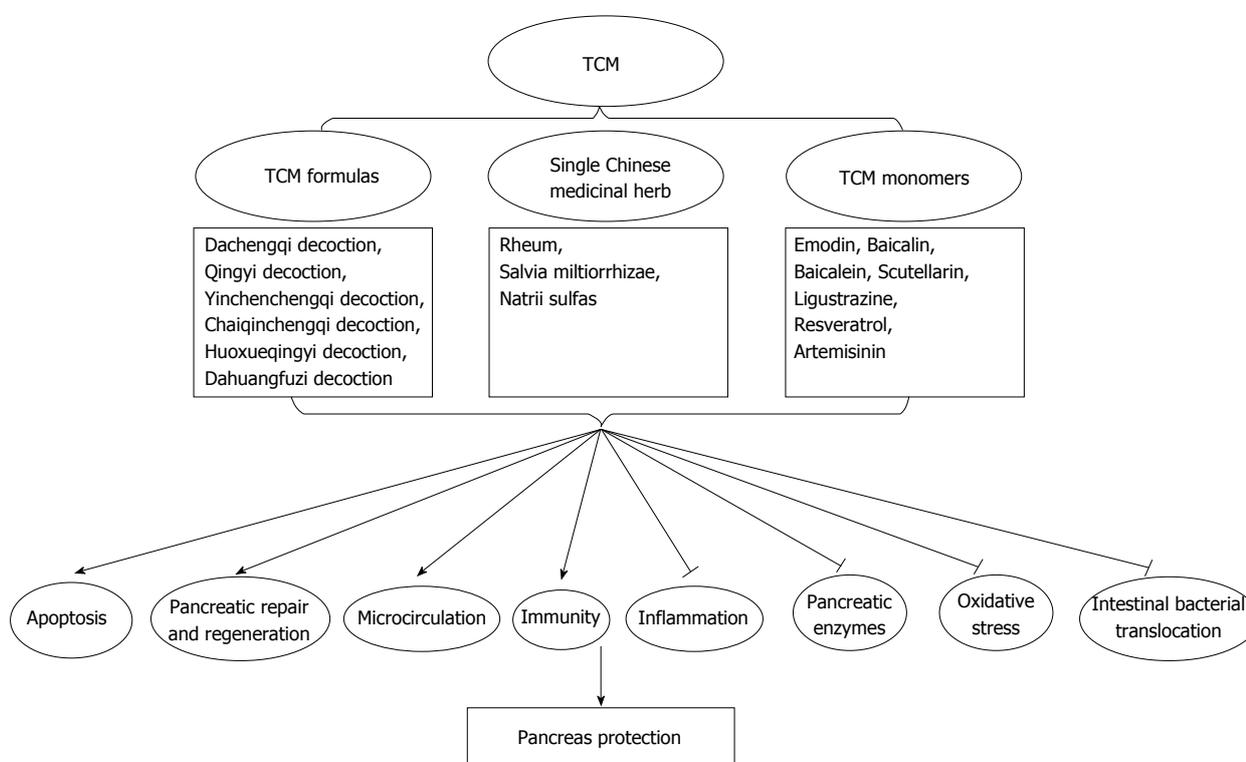


Figure 2 Diagram showing proposed mechanisms of Traditional Chinese medicine for acute pancreatitis treatment. Traditional Chinese medicine (TCM) induces apoptosis, accelerates pancreatic repair and regeneration, improves pancreas microcirculation and strengthens the immunity function and results in the pancreas protection. In addition, TCM mediates inhibition of inflammatory reaction, pancreatic enzymes, oxidative stress and intestinal bacterial translocation, which may contributes to the pancreas protection in AP treatment.

and induced pancreatic acinar cell apoptosis. These results suggest that artemisinin alleviated the severity of AP through the caspase-3 signalling pathway and by inducing intrinsic apoptosis<sup>[72]</sup>.

The chemical structures of TCM monomers mentioned above are presented in Figure 1.

## CONCLUSION

Presently, TCM exhibits good curative effects in AP treatment (Table 1 and Figure 2). However, the ambiguity of the mechanism is an obstacle to the

internationalization and generalization of TCM. Better designed trials are needed to make significant advances in the management of AP. Both pre-clinical and clinical studies have shown promising uses for TCM as a complementary and alternative therapeutic strategy for the treatment of AP that can even supplement conventional treatments, but TCM remains an alternative therapy in AP treatment. The inconvenience of the decoctions has limited the application of TCM. In most formulas, the essential compounds have not been identified. The main obstacle to the internationalization of TCM is the difficulty of standardizing the large

Table 1 Commonly used traditional Chinese medicine for AP treatment and their action targets/mechanisms

TCM	Targets/mechanisms	Ref.
Dachengqi decoction	Induce apoptosis, protect from pancreas injury, recover intestinal mucosal permeability	[16-24]
Qingyi decoction	Anti-inflammation, inhibit pancreatic enzymes, inhibit intestinal bacterial translocation, protect from organ injury	[25-28]
Yinchenchengqi decoction	Induce apoptosis	[29]
Chaiqinchengqi decoction	Inhibit pancreatic enzymes, anti-inflammation	[10]
Huoxueqingyi decoction	Shorten hospital stay, reduce hospitalization cost, decrease duration of SIRS, alleviate hyperamylasemia	[31]
Dahuangfuzi decoction	Anti-inflammatory, protect from organ injury	[32]
Rheum	Anti-inflammation, inhibiting intestinal bacterial translocation, protect from organ injury, accelerating pancreatic repair and regeneration	[33-35]
Salvia miltiorrhizae	Anti-inflammation, induce apoptosis, improve microcirculation, clean reactive oxygen species, protect from organ injury, strengthen the immunity function	[36-38]
Natrii sulfas	Relieve symptoms, inhibit pancreatic enzymes, reduce APACHE II score	[39]
Emodin	Anti-inflammation, inhibit endoplasmic reticulum stress, protect from organ injury, induce apoptosis, improve pancreas microcirculation, accelerate pancreatic repair and regeneration	[40-54]
Baicalin	Anti-inflammation	[54, 56-57]
Baicalein	Induce apoptosis	[58-59]
Scutellarin	Inhibit pancreatic enzymes, protect from organ injury	[60-63]
Ligustrazine	Induce apoptosis, anti-inflammation, inhibit pancreatic enzymes, protect from organ injury	[64-67]
Resveratrol	Induce apoptosis, anti-inflammation, inhibit pancreatic enzymes, antioxidant, immunoregulation	[68-71]
Artemisinin	Induce apoptosis, anti-inflammation, inhibit pancreatic enzymes	[72]

TCM: Traditional Chinese medicine.

number of herbs in one decoction. Along with the further exploration of the precise mechanisms of TCM action, it is hoped that a thorough understanding of the use of TCM in AP treatment strategies and its ability to target various aspects of the pathogenesis of AP will reveal the profound therapeutic benefits of TCM in the future.

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