

Pre-Treatment of Flowers Extract of *Abelmoschus manihot* Medicus on Ischemia/Reperfusion Renal Injury in Rats

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ABSTRACT

Background and Aim: The purpose of this study is to provide a basic data with the use of flowers extract of *Abelmoschus manihot* (Linnaeus) Medicus (Malvaceae) (AM) as a herbal agent against renal oxidative stress. **Methods:** Pre-treatment effect of flowers extract of AM in rat with renal Ischemia/Reperfusion (I/R) injury was investigated. Renal I/R injury in rat were induced by clamping of the left and right renal arteries for 45 min followed by 24 h of reperfusion after administration of flowers extract of AM for 30 days. The effect of flowers extract of AM was evaluated through the measurement of renal function and the relevant parameters of oxidative stress. **Results:** Renal I/R injury led to renal dysfunction as evidenced by higher serum BUN and creatinine along with increase in oxidative stress in renal tissues compared with Sham group. Pre-treatment of flowers extract of AM decreased serum BUN, creatinine, and renal MDA levels, and increased SOD, CAT and GSH-PX activities in the kidney. **Conclusion:** Collectively, these data indicated that flowers extract of AM could be used as a safe and natural antioxidant for the protection of oxidative stress in kidney.

Keywords: *Abelmoschus manihot* (Linnaeus) Medicus (Malvaceae), Ischemia/Reperfusion, Oxidative stress.

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INTRODUCTION

Renal Ischemia/Reperfusion(I/R) injury is the most common cause of Acute Kidney Injury (AKI), which frequent occurrence in critically ill patients. AKI leads to adverse outcomes in hospitalized patients including prolonged length of stay, higher health care costs, and increased mortality.^[1]

Clinically, AKI may occur as a result of several conditions and events that can lead to renal Ischemia/Reperfusion (I/R) injury, such as sepsis, burns, aortic aneurysm, cardiac surgery, contrast agents, and trauma as well as post-renal transplantation, partial nephrectomy, renal artery angioplasty, and other urological conditions.^[2] The mechanisms contributing to the

pathophysiology of renal I/R injury are complicated and include a variety of signaling pathways that are driven by the interplay of inflammatory cytokines/chemokines, oxidative stress, Reactive Oxygen Species (ROS), and apoptosis-related factors.^[3-5]

The production of ROS during the reperfusion period has been suggested to play a key role for uncontrolled oxidative stress, and increased ROS can also drive the inflammatory cascade.^[6] Additionally, cell apoptosis, one of the most severe outcomes of renal I/R injury, determines the level of renal destruction. Plants provide an abundant source of biologically active molecules that have played critical roles in pharmacology. The flowers of *Abelmoschus manihot* (Linnaeus) Medicus (Malvaceae) (AM) have been used in DPR Korea for a long time as a traditional Koryo medicine for the treatment of many kinds of diseases including kidney disease as well as in China and Southeast Asia. AM, also known as Aibika, belongs to the family of Malvaceae.^[7] In many countries various functional foods have been developed from roots, stems, and leaves of this plant^[8,9] and the flowers



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are an important herbal medicine for the treatment of chronic renal disease,^[10,11] diabetic nephropathy,^[12] oral ulcers^[13] and burns. However, the medical benefits of flowers of AM for the cure of several diseases is well known, but its effect to inhibit the oxidative stress in kidney induced by I/R mechanism has not yet been investigated in experimental studies.

MATERIALS AND METHODS

Preparation of Flowers Extract of AM

Flowers samples of AM collected from Sunan District, the suburban area of Pyongyang, in the spring season (April to May) were authenticated by Institute of Botany, State Academy of Sciences in DPR Korea. The extract used in this study was prepared using the traditional ethanolic method. Briefly, 3 kg of dry flowers including pollen were immersed in 3 L of 90% ethanol with intermittent shaking for 24 h, and then refluxed for 3 h by heating. The filtrate was evaporated below 45°C under reduced pressure. The residue (yield: 4.7%) was designated as an alcoholic extract. The extract was quantified by a HPLC assay to contain main components: total flavonoid at 5.4%.

Animals

Male adult Wistar rats (11-12-week-old, 250~300g) were provided by Experimental Animal Department of Pyongyang University of Medical Sciences and adapted in a lab environment before experiments for a week. 50 rats were randomly chosen and during the experiment feed and water were available to rats at any time. The temperature was maintained at 20±2°C and the humidity was 55%. The study was approved by the Ethics Committee for Animal Experimentation, Faculty of Basic Medicine, Pyongyang University of Medical Sciences.

Pre-treatment of Flowers Extract of AM through Diet

After 2 weeks of acclimation, the rats were randomly divided into 5 groups (n=10):

Sham-operated Group (SG): rats fed the control diet only.

Model Group (MG): rats fed the control diet only.

Extract Group-1(EG-1): rats fed a diet containing 30 mg/kg extract.

Extract Group-2(EG-2): rats fed a diet containing 60 mg/kg extract.

Extract Group-3(EG-3): rats fed a diet containing 90 mg/kg extract.

The animals in each group were fed their experimental diets daily for 30 days. Next day rats were operated upon for I/R, except Sham-animals.

I/R Renal Injury Model

Rats were submitted to I/R renal injury model surgery as previously described.^[14] Briefly, rats were anesthetized with Ketamine. A midline incision was made and both left and right renal pedicles were cross-clamped. After 45 min of bilateral renal ischemia, the occlusion clips were removed, and the abdominal wall was closed in two layers, and the animals were placed in single cages, warmed by indirect light, until complete recovery from anesthesia. The same procedure was performed in the sham-operated group without the bilateral clamping process.

Antioxidant Enzyme Activity Estimation in Renal Tissue

The left and right kidneys were removed under fully maintained anesthesia. After removal, the kidneys were homogenized (10000 rpm, 20 s) with a Teflon glass tissue homogenizer (Remi, India) in cold normal saline. The homogenate (10%) was centrifuged at 3000rpm for 20 min at 4°C, and total supernatant was used for assays. Renal tissue Superoxide Dismutase (SOD) activity, Glutathione Peroxidase (GSH-Px) activity, Catalase (CAT) activity, Glutathione (GSH) and Malondialdehyde (MDA) contents were determined with the following methods.

Superoxide Dismutase (SOD) activity

SOD was assayed according to the previous method.^[15] To 0.5 mL of tissue homogenate supernatant, 0.5 mL of 0.6 mM EDTA solution and 1 mL of 0.1 M carbonate-bicarbonate (pH-10.2) buffer were added. The reaction was initiated by the addition of 0.5 mL of 1.8 mM epinephrine (freshly prepared) and the increase in absorbance at 480nm was measured.

Glutathione Peroxidase (GSH-Px) activity

GSH-Px was assayed by the previous method with slight modification.^[16] The reaction mixture consisted of 0.2 mL of 0.8 mM EDTA, 0.1 mL of 10 mM sodium azide, 0.1 mL of 2.5 mM H₂O₂, 0.2 mL of GSH, 0.4 mL of 0.4 M phosphate buffer pH 7.0, and 0.2 mL of tissue homogenate supernatant and was incubated at 37.8°C for 10 min. The reaction was arrested by the addition of 0.5 mL of 10% Trichloroacetic Acid (TCA) and the tubes were centrifuged at 2000rpm. To the supernatant, 3.0 mL of 0.3mM disodium hydrogen phosphate and 1.0mL of 0.04% Dithionitrobenzoic Acid (DTNB) were added and the colour developed was read at 420 nm immediately. The activity of GSH-Px was expressed as μ moles of glutathione oxidized/min per mg of protein.

Catalase (CAT) activity

CAT was assayed by the following method. To 1.2 mL of 50 mM phosphate buffer pH 7.0, 0.2 mL of tissue homogenate supernatant was added and reaction was started by the addition of 1.0 mL of 30 mM H₂O₂ solution. The decrease in absorbance was measured at 240 nm at 30 s intervals for 3 min. The enzyme blank was run

simultaneously with 1.0 mL of distilled water instead of hydrogen peroxide.

GSH estimation

GSH content in the supernatant was measured by reaction with DTNB. To 0.1 mL of tissue homogenate supernatant, 2.0 mL of 0.6 mM DTNB and 0.2M phosphate buffer (pH 8.0) were added to make up to a final volume of 4.0 mL. The absorbance was read at 412 nm against a blank containing TCA instead of sample. A series of standards treated in a similar was also were run to determine the glutathione content. 5-Sulphosalicylic acid was used to prevent oxidation of glutathione. The amount of glutathione was expressed as $\mu\text{mol/mg}$ of tissue.

MDA estimation

MDA was determined by the Thiobarbituric Acid (TBA) method, based on its reaction with TBA to form Thiobarbituric Acid-Reactive Substances (TBARS). Determination of TBARS in renal tissue was measured as described previously with slight modification. To 0.2 mL of tissue homogenate supernatant, 0.2 mL of 8.1% sodium lauryl sulphate and 1.5 mL of 20% acetic acid solution (pH adjusted to 3.5 with sodium hydroxide) were added. Then 1.5 mL of 0.8% aqueous solution of TBA was added. The mixture was made up to 40 mL with distilled water and heated in a water bath at 95°C for 60 min. In cooling water 1.0 mL of

distilled water and 5.0 mL mixture of n-butanol and pyridine (15:1 v/v) were added. After centrifugation at 4000 rpm for 10 min. Absorbance of the organic layer was read at 532 nm. The level of MDA was expressed as nmol/mg of tissue. Protein concentration of renal tissue was measured using the method of Lowry and others,^[17] using bovine serum albumin as standard.

Assessment of Renal Function

Serum supernatants were stored at -80°C until laboratory analysis. Samples were thawed before the study. Serum BUN and creatinine analyses were performed with autoanalyzers.

Statistical Analysis of Data

Quantitative data are reported as Mean $\pm$ standard error of the mean. Statistical differences in basal characteristics between the groups were calculated by one-way analysis of variance and t-test for continuous variables. $p<0.05$ or $p<0.01$ was considered statistically significant. All statistical analyses were performed using the SPSS 16.0 software.

RESULTS

As shown in Table 1, the activities of SOD, GSH-Px and CAT in renal tissue of MG rats significantly decreased compared to SG rats ($p<0.01$, $p<0.01$ and $p<0.01$, respectively). Pre-treatment

Table 1: Changes of antioxidant enzyme activity in renal tissue.

Groups	SOD (U/mg protein)	GSH-Px (U/mg protein)	CAT (U/mg protein)
SG	3.3 $\pm$ 0.4	2.7 $\pm$ 0.3	10.3 $\pm$ 0.7
MG	1.6 $\pm$ 0.2 $\Delta\Delta$	1.1 $\pm$ 0.1 $\Delta\Delta$	4.4 $\pm$ 0.3 $\Delta\Delta$
EG-1	2.1 $\pm$ 0.2	1.8 $\pm$ 0.3*	5.1 $\pm$ 0.5
EG-2	2.8 $\pm$ 0.4*	2.3 $\pm$ 0.3**	8.2 $\pm$ 0.3**
EG-3	2.9 $\pm$ 0.3*	2.3 $\pm$ 0.2**	8.5 $\pm$ 0.5**

Each value represents the mean $\pm$ SEM of 10 rats per group. * $p<0.05$, ** $p<0.01$ as compared with MG (Model group). $\Delta\Delta p<0.05$ as compared with SG (Sham-operated group). SG: Sham-operated group; MD: Model group; EG: Extract group.

Table 2: Changes of GSH and MDA level in renal tissue.

Groups	GSH ($\mu\text{mol/mg}$ Protein)	MDA (nmol/mg Protein)
SG	32.5 $\pm$ 3.1	2.5 $\pm$ 0.2
MG	13.4 $\pm$ 1.8 $\Delta\Delta$	6.8 $\pm$ 0.5 $\Delta\Delta$
EG-1	22.2 $\pm$ 2.3**	4.3 $\pm$ 0.1**
EG-2	25.5 $\pm$ 2.7**	3.8 $\pm$ 0.3**
EG-3	28.1 $\pm$ 1.9**	3.5 $\pm$ 0.3**

Each value represents the mean $\pm$ SEM of 10 rats per group. ** $p<0.01$ as compared with MG (Model group). $\Delta\Delta p<0.05$ as compared with SG (Sham-operated group). SG: Sham-operated group; MD: Model group; EG: Extract group.

Table 3: Changes of BUN and Creatinine in serum.

Groups	BUN (mg/dL)	Creatinine (mg/dL)
SG	24.1 $\pm$ 1.7	0.37 $\pm$ 0.02
MG	86.7 $\pm$ 4.3 $\Delta\Delta$	1.48 $\pm$ 0.04 $\Delta\Delta$
EG-1	60.3 $\pm$ 2.5**	0.81 $\pm$ 0.01**
EG-2	57.9 $\pm$ 2.1**	0.66 $\pm$ 0.03**
EG-3	51.6 $\pm$ 2.8**	0.62 $\pm$ 0.01**

Each value represents the mean $\pm$ SEM of 10 rats per group. ** $p<0.01$ as compared with MG (Model group). $\Delta\Delta p<0.05$ as compared with SG (Sham-operated group). SG: Sham-operated group; MD: Model group; EG: Extract group.

of extract increased activities of all enzymes in dose-dependent manners.

In MG rats, there were significant changes in GSH and MDA level compared with SG rats ($p < 0.01$ and $p < 0.01$, respectively). But pre-treatment of extract significantly improved these changes compares with MG. Improved effects were in dose-dependent manners (Table 2).

The serum BUN and creatinine levels were increased in MG rats compared with those in SG rats ($p < 0.01$ and $p < 0.01$, respectively). However, in rats pre-treated with extract, the serum levels of BUN and creatinine were significantly reduced, unlike those in MG rats (Table 3).

DISCUSSION

Recent evidence has indicated that the main causes of renal I/R injury include increased production of renal oxygen-free radicals, overload of intracellular calcium, and abnormal energy and hormone metabolism.^[18] The damaging effect of ROS on renal tissues has been considered crucial in these complex pathophysiological processes.^[19]

Oxygen radicals produced after ischemia/reperfusion can cause lipid peroxidation and destroy cell and organelle membranes, thereby disrupting the tissue structure and function.^[20,21]

In terms of inflammation, hypoxic and anoxic cell injuries occur in the renal tissue after ischemia, leading to the local robust synthesis of inflammatory cytokines. These cytokines can initiate defensive physiological activities to isolate and inhibit tissue damage, or further aggravate organ damage and dysfunction by inducing free radicals to produce and recruit inflammatory cells.^[22]

Therefore, it is important to control oxidative stress and inflammation in the early stage of renal I/R injury. *Abelmoschus manihot* (Linnaeus) Medicus (Malvaceae) (AM), the main medicinal part of this plant, have been used in clinical practice to treat Chronic Kidney Disease (CKD), inflammatory diseases, oral ulcers, and burns for hundreds of years in our country. However, there have been no studies on flowers of AM to treat renal I/R injury. In this study, we attempted to examine the pre-treating effect of flowers extract of AM on renal injury by I/R in rats so as to provide data available in clinical practice. Oxygen radicals cause the peroxidation of polyunsaturated fatty acids in the biofilm, and the decomposition products of lipid hydroperoxide, causing cell damage. As major antioxidant enzymes, SOD, CAT and GSH-Px, and GSH serve a crucial role in scavenging oxygen radicals, the activity of which can reflect the ability of scavenging oxygen free radicals and the ability of the kidney to resist lipid peroxidation. The MDA content can reflect the content of oxygen free radicals, the level of lipid peroxidation, and the degree of damage of oxygen free radicals to the kidney tissue.^[23,24] The present study revealed that the MDA level was decreased, while

activity of antioxidant enzymes (SOD, GSH-Px and CAT) and GSH level were increased, in the renal tissues in pre-treatment of extract, demonstrating a relatively mild oxidative injury (Tables 1-3). These results imply that the protective role of flowers of AM against bilateral I/R injury may be associated with the inhibition of free radical and oxidant formation. Additionally, pre-treatment of extract significantly improved parameters such as serum BUN and creatinine associated with renal function, as shown in Table 3. In summary, protective effect of flowers of AM against I/R-induced renal injury by inhibiting oxidative stress in rats. A more detailed study is currently under way to explore several mechanisms underlying the protective role of flowers of AM in renal I/R injury.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

ABBREVIATIONS

AKI: Acute Kidney Injury; **AM:** *Abelmoschus manihot* (Linnaeus) Medicus (Malvaceae); **BUN:** Blood Urea Nitrogen; **CAT:** Catalase; **CKD:** Chronic Kidney Disease; **DTNB:** 5,5'-Dithiobis-(2-nitrobenzoic acid); **EG:** Extract Group; **GSH:** Reduced Glutathione; **GSH-Px:** Glutathione Peroxidase; **HPLC:** High-Performance Liquid Chromatography; **I/R:** Ischemia/Reperfusion; **MDA:** Malondialdehyde; **MG:** Model Group; **ROS:** Reactive Oxygen Species; **SG:** Sham Group; **SOD:** Superoxide Dismutase; **TBARS:** Thiobarbituric Acid Reactive Substances; **TBA:** Thiobarbituric Acid; **TCA:** Trichloroacetic Acid.

REFERENCES

- Chertow GM, Burdick E, Honour M, Bonventre JV, Bates DW. Acute kidney injury, mortality, length of stay, and costs in hospitalized patients. *J Am Soc Nephrol.* 2005;16(11):3365-70.
- Kaur A, Kaur T, Singh B, Pathak D, Buttar HS, Singh AP. Curcumin alleviates ischemia reperfusion-induced acute kidney injury through NMDA receptor antagonism in rats. *Ren Fail.* 2016;38(9):1462-7.
- Bagshaw SM, Bellomo R, Devarajan P, Johnson C, Carvellas CJ, Kutsogiannis DJ, et al. Acute kidney injury in critical illness. *Can J Anaesth.* 2010;57(11):985-98.
- El Sabbahy M, Vaidya VS. Ischemic kidney injury and mechanisms of tissue repair. *Wiley Interdiscip Rev Syst Biol Med.* 2011;3(5):606-18.
- Pakula AM, Skinner RA. Acute kidney injury in the critically ill patient: a current review of the literature. *J Intensive Care Med.* 2016;31(5):319-24.
- Wang L, Liu X, Chen H, Chen Z, Weng X, Qiu T, et al. Effect of picoside II on apoptosis induced by renal ischemia/reperfusion injury in rats. *Exp Ther Med.* 2015;9(3):817-22.
- Rubiang-Yalambing L, Arcot J, Greenfield H, Holford P. Aibika (*Abelmoschus manihot* L.): Genetic variation, morphology and relationships to micronutrient composition. *Food Chem.* 2016;193:62-8.
- Du L, Qian D, Jiang S, Guo J, Su S, Duan J. Comparative characterization of amino acids in *Abelmoschus manihot* roots, stems and leaves during different growth periods by UPLC-TQ-MS/MS. *Anal Methods.* 2015;7:10280-90.
- Du L, Qian D, Jiang S, Shang E, Guo J, Liu P, et al. Comparative characterization of nucleotides, nucleosides and nucleobases in *Abelmoschus manihot* during different growth periods by UPLC-TQ-MS/MS. *J Chromatogr B.* 2015;1006:130-7.
- Zhang L, Li P, Xing CY, Zhao JY, He YN, Wang JQ, et al. Efficacy and safety of *Abelmoschus manihot* for primary glomerular disease: a prospective, multicentre randomized controlled clinical trial. *Am J Kidney Dis.* 2014;64(1):57-65.

11. Shen YQ, Liao SH, Sun Y, Jiang YF, He LQ. Clinical research of Huangkui Capsule in treating chronic kidney disease III phase of chronic nephritis in 37 cases. *Chin J Exp Tradit Med Form.* 2014;20:205-9.
12. Mao ZM, Shen SM, Wan YG, Sun W, Chen HL, Huang MM, *et al.* Huangkui capsule attenuates renal fibrosis in diabetic nephropathy rats through regulating oxidative stress and p38MAPK/Akt pathways, compared to α -lipoic acid. *J Ethnopharmacol.* 2015;173:256-65.
13. Zhang HY, Dong LY, Jiang Q, Fang M, Li JP, Chen ZW, *et al.* Effect of anti-infection oral mucosa ulcers of guinea-pig and antibacterial *in vitro* of total flavone of *Abelmoschus manihot* (L.) Medic. *Anhui Med Pharm J.* 2006;10:810-1.
14. Shoskes DA. Nonimmunologic renal allograft injury and delayed graft function: clinical strategies for prevention and treatment. *Transplant Proc.* 2000;32(4):766-8.
15. Paglia DE, Valentine WN. Studies on the quantitative and qualitative characterization of erythrocyte glutathione peroxidase. *J Lab Clin Med.* 1967;70(1):158-69.
16. Takahara S, Hamilton HB, Neel JV, Kobara TY, Ogura Y, Nishimura ET. Hypocatalasemia: a new genetic carrier state. *J Clin Invest.* 1960;39(4):610-9. doi:10.1172/JCI104075.
17. Lowry OH, Rosebrough NJ, Farr AL, Randall RJ. Protein measurement with the Folin phenol reagent. *J Biol Chem.* 1951;193(1):265-75.
18. Granger DN, Kvietys PR. Reperfusion injury and reactive oxygen species: the evolution of a concept. *Redox Biol.* 2015;6:524-51. doi:10.1016/j.redox.2015.08.020.
19. Goswami SK, Maulik N, Das DK. Ischemia-reperfusion and cardioprotection: a delicate balance between reactive oxygen species generation and redox homeostasis. *Ann Med.* 2007;39(4):275-89. doi:10.1080/07853890701374677.
20. Guerra-Mora JR, Perales-Caldera E, Aguilar-León D, Nava-Sanchez C, Díaz-Cruz A, Díaz-Martínez NE, *et al.* Effects of sildenafil and tadalafil on edema and reactive oxygen species production in an experimental model of lung ischemia-reperfusion injury. *Transplant Proc.* 2017;49(6):1461-6. doi:10.1016/j.transproceed.2017.03.089.
21. Tang Y, Tang J, Qian P, Zhang Y, Shen R, Shen X, *et al.* Recombinant human erythropoietin restrains oxidative stress in streptozotocin-induced diabetic rats exposed to renal ischemia reperfusion injury. *Transplant Proc.* 2019;51(6):2076-80. doi:10.1016/j.transproceed.2019.03.023.
22. Hashiguchi H, Morooka H, Miyoshi H, Matsumoto M, Koji T, Sumikawa K. Isoflurane protects renal function against ischemia and reperfusion through inhibition of protein kinases, JNK and ERK. *Anesth Analg.* 2005;101(6):1584-9. doi:10.1213/01.ANE.0000184044.51749.B8.
23. Zhu MM, Wang L, Yang D, Li C, Pang ST, Li XH, *et al.* Wedelolactone alleviates doxorubicin-induced inflammation and oxidative stress damage of podocytes by I κ B/I κ B/NF- κ B pathway. *Biomed Pharmacother.* 2019;117:109088. doi:10.1016/j.biopha.2019.109088.
24. Hu B, Tang J, Zhang Y, Ma Z, Shan Y, Liu J, *et al.* Glycogen synthase kinase-3 β inhibitor attenuates renal damage through regulating antioxidant and anti-inflammation in rat kidney transplant with cold ischemia reperfusion. *Transplant Proc.* 2019;51(6):2066-70. doi:10.1016/j.transproceed.2019.05.010.

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