

A Case Report of Diabetic Foot Ulcer Treated by Herbal Food Homology Therapy

Lufei Wang¹, Wei Jiang², Hui Li^{3*}

¹State Key Laboratory of Genetic Engineering, School of Life Sciences, Fudan University, Shanghai, China

²Changhai Hospital, Naval Medical University, Shanghai, China

³MOE Key Laboratory of Contemporary Anthropology, School of Life Sciences, Fudan University, Shanghai, China

Email: *LHCA@fudan.edu.cn

How to cite this paper: Wang, L.F., Jiang, W. and Li, H. (2023) A Case Report of Diabetic Foot Ulcer Treated by Herbal Food Homology Therapy. *Case Reports in Clinical Medicine*, 12, 189-195.
<https://doi.org/10.4236/crcm.2023.126026>

Received: May 16, 2023

Accepted: June 24, 2023

Published: June 27, 2023

Copyright © 2023 by author(s) and Scientific Research Publishing Inc.

This work is licensed under the Creative Commons Attribution International License (CC BY 4.0).

<http://creativecommons.org/licenses/by/4.0/>



Open Access

Abstract

Diabetic foot ulcer (DFU) is a common and severe complication among patients with diabetes. There are hundreds of natural products derived from herbs that have been identified and proven to be effective for glucose-lowering and wound-healing effects, such as flavones. In this case study, we reported that a 76-year-old male patient with severe traumatic DFU was cured after drinking yellow tea (dehydrogenated *Camellia sinensis*) as a postprandial auxiliary treatment for six months. Previously, the patient was required to be hospitalized, but the wound deteriorated after five months. The patient drank yellow tea at approximately 12:30 pm (the active time of heart meridian) after lunch every day. Five grams of yellow tea were boiled in one liter of water and covered above 70°C for approximately 30 minutes. He experienced profuse sweating on his back after drinking yellow tea, with no other adverse effects. His lifestyle and healthcare remained constant except for replacing green tea with yellow tea. After six months, the ulcer had completely healed, and after one year of follow-up, no new abnormalities or side effects were found. This self-controlled case study indicates that flavone-enriched yellow tea or other herbs may be an auxiliary therapy for diabetes and its complications.

Keywords

Diabetic Foot Ulcer, Auxiliary Treatment, Yellow Tea, Flavones

1. Introduction

Diabetic foot ulcer (DFU) is a serious complication among patients with diabetes, causing significant morbidity and mortality. A total of 21% - 30% of patients with diabetes develop peripheral neuropathy or lose sensation in their feet [1]. It was reported that the rate of amputations increased by 50% in the U.S.

population between 2009 and 2015 [2]. The treatment approaches of DFU include controlling blood glucose, debridement, and dressing application [1]. Patients with DFU require frequent health care, including daily wound care, antimicrobial therapy, and surgical procedures [3]. Importantly, controlling glucose plays a critical role in DFU. To date, no effective and feasible therapy might be applied in the treatment of DFU except lower-extremity amputation for patients with severe DFU.

World Health Organization (WHO) recognized the need of focusing on the quality of life when existing healthcare services are not possible, encouraging every country to explore conventional traditional medicine [4]. Among traditional medicines, traditional Chinese medicine (TCM) was first involved in the International Classification of Disease published by WHO. The medical practice in TCM, including acupuncture and herbal remedies, has been proven to be effective [5]. Increasing bioactive compounds derived from herbs have been identified to be effective, such as artemisinin [6]. However, people tend to apply auxiliary treatment using over-the-counter (OTC) herbal teas, *i.e.*, Chinese wolfberry, chrysanthemum, and traditional tea (*Camellia sinensis*). Tea is widely consumed in the world. In the English tradition, there is a binary classification dividing tea into non-fermented tea (green tea) and fermented tea (black tea). Here black tea may include all five kinds of fermented tea but mainly refers to red tea in the scientific six-category classification (green tea, cyan tea, red tea, yellow tea, black tea, and white tea) based on different manufacturing procedures [7]. Each type of tea has distinct medical functions because of different compounds. For example, yellow tea has anti-hyperglycemic and kidney-protective effects [8]. Previous comparative studies evaluated the efficacy and safety of different tea types in high-fat diet-induced diabetic mice [9]. Among them, the rare yellow tea exhibited a unique feature of higher safety and better efficacy, which is consistent with folklore. Yellow tea was first made in the Tang Dynasty (AD 618 to AD 907) and was once lost. Later recovered yellow tea is more similar to green tea due to an insufficient degree of yellowing fermentation (*Menhuang*). According to ancient literature records and field investigations, Golden Buns (*Fan Jim Ji*), one of the most famous yellow tea, was manufactured in Fanjing Mountain, Guizhou. The manufacturing procedures and meridian tropism of Golden Buns with a wolfberry flavor are similar to Goishi Tea from Kochi of Japan. The yellow tea, in this case report, is Golden Buns from Bud-Chem Tea Co. Ltd. (Jiangkou, Guizhou, China). Here, we report an auxiliary therapy of OTC yellow tea for a patient with DFU who was determined the amputation. The wound had healed completely through drinking yellow tea.

2. Case Report

A 76-year-old male with hyperglycemia and hypertension had been hospitalized for around five months due to DFU. Previously, the patient was required hospitalization because of a digestive disorder and fever caused by diabetes. The diabetes history of the patient lasted 10 years with hypertension history. However,

the patient was rarely able to control glucose, which contributed to severe complication. Moreover, he required hospitalization for five months, whereas the wound had no improvement but deteriorated.

Physical examination showed a 4.5×3.5 cm swelling and deteriorative ulcer located above the right-foot cuboid bone, with significant pain, rancidness, serosanguineous drainage, and a necrotic area exposed muscle and tendon (**Figure 1**). Coagulating yellow pus, apparent ischemic black margin, and infection induced gangrene were observed. According to Wagner's classification of DFU, the wound was identified as grade IV (deep ulcer with osteomyelitis or abscess). Routine test indicated the body temperature of the patient was 37.0°C with a heart rate of 70 min^{-1} . Blood glucose and blood pressure were unstable, which was difficult to obtain stable data of blood routine. Meanwhile, the patient presented irritability and demanded to go home to recuperate when he was required for amputation.

Although the orthopedist and diabetic doctor advised amputation, the patient rejected that and volunteered to drink yellow tea when knowing the theoretical anti-hyperuricemia effect of yellow tea. Yellow tea is believed for a long time to have the effect of lowering blood glucose [10]. Key manufacturing procedure of standard yellow tea is similar to Goishi Tea from Kochi of Japan and Lactate tea of *Deang* people from Yunnan in China. First, fresh tea leaves are heated to inactivate the endogenous enzyme. Then, after the leaf cells are broken, tea leaves are wrapped and kept under the hygrothermal circumstance to dehydrogenate, which is the key manufacturing procedure. Finally, the leaves are dried to fix the flavones. To brew the tea, dry yellow tea weighed 5 g was boiled in 1 L water using a metallic electric kettle and kept above 70°C for approximately 30 minutes. Infused leaves of yellow tea could be repeatedly brewed. Yellow tea infusion exhibits a dark orange color with a strong aroma similar to red Chinese Wolfberry. The patient drank yellow tea at approximately twelve thirty after lunch every day. He felt profuse sweating at the back after drinking yellow tea and has no other adverse effects. Abdominal distension and sick caused by indigestion were gradually relieved. The patient felt active and efficient. Before this treatment, he drank green tea frequently instead of yellow tea. During the treatment, his lifestyle and health care remained constant except for replacing green tea with



Figure 1. Injury surface of DFU before and after yellow tea therapy.

yellow tea. For example, regular disinfection of the wound was conducted every day. Surprisingly, the swelling and pain disappeared and the ulcer almost healed after six months (**Figure 1**). Subsequently, his ulcer completely healed during a one-year follow-up. Nowadays, the patient still drinks yellow tea every day and is able to walk normally. He would walk every day and carry a cup of yellow tea in an insulation cup. Meanwhile, no abnormality has ever been found in blood glucose and blood pressure. He is even better than ever before.

3. Discussion

DFU is considered as one of the causes of amputation, intensive care, and even death. The patients need to prevent DFU by self-care functions [11]. Controlling blood glucose is essential to improve DFU healing and limit adverse effects on cellular immunity and infection [12]. When the patients are not satisfied with the existing healthcare services, they would predispose to conventional medicines, such as OTC herb therapy in TCM. DFU was recorded in the Yellow Emperor's Canon of Medicine (*Huangdi Neijing*), frame of which might originate in Hongshan culture of 6000 - 5000 before present in northeastern China. Currently, more than 40 Chinese herbs and their derivatives have been used to treat diabetes by regulation of multiple targets, including natural compounds (berberine, ginsenoside, and curcumin) and Chinese prescriptions [13]. A randomized double-blind placebo-controlled study indicated that a six-month treatment of the herbal recipe (Astragali Radix and Radix Rehmanniae) could promote the healing in ulcer areas and significantly decrease serum TNF- α levels compared with a placebo-controlled group [14]. In addition, microarray studies uncovered that herbal recipe treatment could regulate the expression of genes implicated in fibroblast regeneration, angiogenesis, and anti-inflammation. Significantly, flavonoids from the herbs are responsible for anti-hyperglycemic effects through regulation of α -amylase and α -glucosidase activity [15]. Tea is one of the herbal food homological plants with the highest content of flavonoids. Tea was first discovered by *Shennong*, which was recorded in Shennong's Canon of Herbs. Historically, healthy functions of tea were documented in many ancient books, *i.e.*, Luyu's Classic of Tea and Huatuo's Classic of Food. Hence, tea is used as an herbal remedy in daily life to prevent and treat various diseases from time immemorial, especially hypoglycemic effect and emotion improvement. However, numerous epidemiological studies focus on the function of green tea and red tea and even do not distinguish six types of tea [16]. In this case, the patient with severe DFU rejected amputation and then chose to drink yellow tea every day. The patient not only healed completely, but also got back the normal walking ability in daily life. Compared with hospitalization for five months, the patient only changed the consumption of tea types from green tea to yellow tea. Notably, the patient with DFU sweated copiously during drinking yellow tea, demonstrating that the patient was metabolically active, resulting in the reduction of blood glucose. This result reveals that yellow tea might be an auxiliary therapy for daily health care of patients with diabetes.

Tea has been initially used as a traditional Chinese herb with a long history of cultivation and utilization for around 6000 years. In Tang Dynasty, tea drinking was quite popular and gradually shifted to a healthy beverage in daily life. Simultaneously, yellow tea was invented, including *Yonghu* yellow tea from Dongting Lake, *Huxi* yellow tea from Poyang Lake, Goishi Tea from Kochi of Japan, and *Deang* Lactate tea from Yunnan [17]. Unfortunately, the former two yellow teas had been lost after Tang Dynasty. In multiple fieldworks, these two yellow teas were finally restored recently, having a promising function for cardiovascular and kidney-protective effects. A recent study indicated that yellow tea exhibited anti-hyperglycemic effects compared with other types of tea [18]. Untargeted metabolomics of tea indicated that yellow tea was enriched in flavones, not flavan-3-ols within green tea [17]. This might be resulted from the dehydrogenation of flavan-3-ols at C2- and C3-position produced 2-phenyl chromogenone of flavones in yellowing fermentation. Thus, anti-hyperglycemic effect of yellow tea might be associated with flavones compared with green tea. In addition, epigallocatechin-3-gallate, a derivative of flavonoid, ameliorated diabetic wound healing in mice through targeting the Notch signaling pathway [19], alleviating insulin resistance through inhibition of inflammation to reduce the risk of diabetes [20]. According to TCM, green tea is cold (cytoactive inhibiting) with diuretic and brain-refreshing effects, whereas yellow tea is hot (cytoactive enhancing) with cardiovascular-protective effects. Besides, the best drinking time for yellow tea is the active time of heart meridian suggested by TCM, consistent with circadian principle of TCM (Figure 2). Furthermore, copious sweating during drinking yellow tea may result in excreting other chemicals and metabolites from the body [21], which might activate the targeted organs along the heart meridian. Therefore, drinking yellow tea helps in lowering the glucose, promoting fibroblast migration and the formation of new capillaries around the wound.

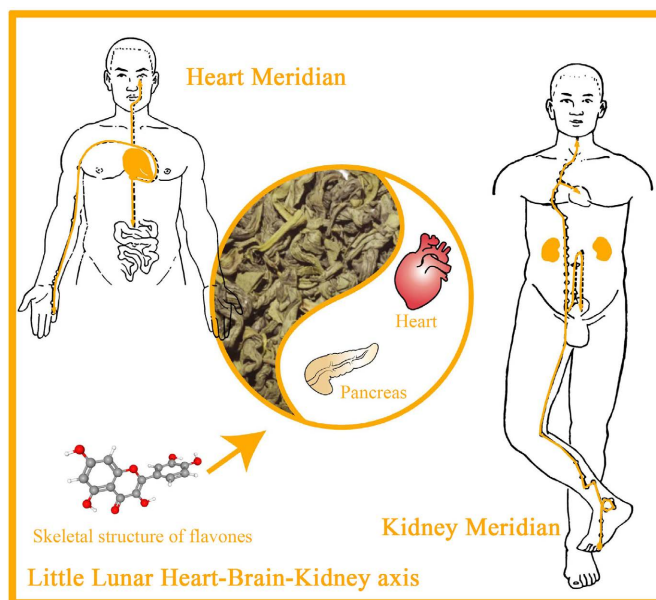


Figure 2. The main target organs of the heart channels.

4. Conclusion

In summary, this case provides a new perspective that flavone-enriched yellow tea or other herbs may be useful as an auxiliary therapy for DFU or other complications caused by diabetes.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

- [1] Brown, S., Nixon, J., Ransom, M., Gilberts, R., Dewhirst, N., McGinnis, E., *et al.* (2020) Multiple Interventions for Diabetic Foot Ulcer Treatment Trial (MIDFUT): Study Protocol for a Randomised Controlled Trial. *BMJ Open*, **10**, e035947. <https://doi.org/10.1136/bmjopen-2019-035947>
- [2] Gregg, E.W., Hora, I. and Benoit, S.R. (2019) Resurgence in Diabetes-Related Complications. *JAMA*, **321**, 1867-1868. <https://doi.org/10.1001/jama.2019.3471>
- [3] Lipsky, B.A., Senneville, É., Abbas, Z.G., Aragón-Sánchez, J., Diggie, M., Embil, J.M., *et al.* (2020) Guidelines on the Diagnosis and Treatment of Foot Infection in Persons with Diabetes (IWGDF 2019 Update). *Diabetes/Metabolism Research and Reviews*, **36**, e3280. <https://doi.org/10.1002/dmrr.3280>
- [4] World Health Organization (2014) WHO Traditional Medicine Strategy: 2014-2023. WHO Press, Geneva.
- [5] Zhao, L., Li, D., Zheng, H., Chang, X., Cui, J., Wang, R., *et al.* (2019) Acupuncture as Adjunctive Therapy for Chronic Stable Angina: A Randomized Clinical Trial. *JAMA Internal Medicine*, **179**, 1388-1397. <https://doi.org/10.1001/jamainternmed.2019.2407>
- [6] Tu, Y.Y. (2011) The Discovery of Artemisinin (Qinghaosu) and Gifts from Chinese Medicine. *Nature Medicine*, **17**, 1217-1220. <https://doi.org/10.1038/nm.2471>
- [7] Jin, W.L., Tao, Y.C., Wang, C., Wang, L.F., Ao, X., Su, M.J., *et al.* (2023) Infrared Imageries of Human Body Activated by Tea Match the Hypothesis of Meridian System. *Phenomics*. <https://doi.org/10.1007/s43657-022-00090-x>
- [8] Sang, S.Y., Wang, L.F., Liang, T.T., Su, M.J. and Li, H. (2022) Potential Role of Tea Drinking in Preventing Hyperuricaemia in Rats: Biochemical and Molecular Evidence. *Chinese Medicine*, **17**, Article No. 108. <https://doi.org/10.1186/s13020-022-00664-x>
- [9] Han, M.M., Zhao, G.S., Wang, Y.J., Wang, D.X., Sun, F., Ning, J.M., *et al.* (2016) Safety and Anti-Hyperglycemic Efficacy of Various Tea Types in Mice. *Scientific Reports*, **6**, Article No. 31703. <https://doi.org/10.1038/srep31703>
- [10] Xu, J., Wang, M., Zhao, J., Wang, Y.H., Tang, Q. and Khan, I.A. (2018) Yellow Tea (*Camellia sinensis* L.), a Promising Chinese Tea: Processing, Chemical Constituents and Health Benefits. *Food Research International*, **107**, 567-577. <https://doi.org/10.1016/j.foodres.2018.01.063>
- [11] Jalilian, M., Ahmadi Sarbarzeh, P. and Oubari, S. (2020) Factors Related to Severity of Diabetic Foot Ulcer: A Systematic Review. *Diabetes, Metabolic Syndrome and Obesity*, **13**, 1835-1842. <https://doi.org/10.2147/DMSO.S256243>
- [12] Everett, E. and Mathioudakis, N. (2018) Update on Management of Diabetic Foot

- Ulcers. *Annals of the New York Academy of Sciences*, **1411**, 153-165. <https://doi.org/10.1111/nyas.13569>
- [13] Gao, Z.Z., Li, Q.W., Wu, X.M., Zhao, X.M., Zhao, L.H. and Tong, X.L. (2017) New Insights into the Mechanisms of Chinese Herbal Products on Diabetes: A Focus on the “Bacteria-Mucosal Immunity-Inflammation-Diabetes” Axis. *Journal of Immunology Research*, **2017**, Article ID: 1813086. <https://doi.org/10.1155/2017/1813086>
- [14] Ko, C.H., Yi, S., Ozaki, R., Cochrane, H., Chung, H., Lau, W., et al. (2014) Healing Effect of a Two-Herb Recipe (NF3) on Foot Ulcers in Chinese Patients with Diabetes: A Randomized Double-Blind Placebo-Controlled Study. *Journal of Diabetes*, **6**, 323-334. <https://doi.org/10.1111/1753-0407.12117>
- [15] Proença, C., Ribeiro, D., Freitas, M. and Fernandes, E. (2022) Flavonoids as Potential Agents in the Management of Type 2 Diabetes through the Modulation of α -Amylase and α -Glucosidase Activity: A Review. *Critical Reviews in Food Science and Nutrition*, **62**, 3137-3207. <https://doi.org/10.1080/10408398.2020.1862755>
- [16] Ma, L., Hu, Y., Alperet, D.J., Liu, G., Malik, V., Manson, J.E., et al. (2023) Beverage Consumption and Mortality among Adults with Type 2 Diabetes: Prospective Cohort Study. *BMJ*, **381**, e073406. <https://doi.org/10.1136/bmj-2022-073406>
- [17] Wang, L. (2022) The Observation of Meridian Phenotype Activated by Tea and Molecular Mechanism of Meridian Tropism. Master’s Thesis, Fudan University, Shanghai.
- [18] Wang, C., Liu, J.X., Sang, S.Y., Ao, X., Su, M.J., Hu, B.W., et al. (2022) Effects of Tea Treatments against High-Fat Diet-Induced Disorder by Regulating Lipid Metabolism and the Gut Microbiota. *Computational and Mathematical Methods in Medicine*, **2022**, Article ID: 9336080. <https://doi.org/10.1155/2022/9336080>
- [19] Huang, Y.W., Zhu, Q.Q., Yang, X.Y., Xu, H.H., Sun, B., Wang, X.J., et al. (2018) Wound Healing Can Be Improved by (–)-Epigallocatechin Gallate through Targeting Notch in Streptozotocin-Induced Diabetic Mice. *The FASEB Journal*, **33**, 953-964. <https://doi.org/10.1096/fj.201800337R>
- [20] Ren, N., Kim, E., Li, B., Pan, H., Tong, T., Yang, C.S., et al. (2019) Flavonoids Alleviating Insulin Resistance through Inhibition of Inflammatory Signaling. *Journal of Agricultural and Food Chemistry*, **67**, 5361-5373. <https://doi.org/10.1021/acs.jafc.8b05348>
- [21] Yang, D.S., Ghaffari, R. and Rogers, J.A. (2023) Sweat as a Diagnostic Biofluid. *Science*, **379**, 760-761. <https://doi.org/10.1126/science.abq5916>