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• Research Article

Hypolipidemic activity of *Tamarix articulata* Vahl. in diabetic rats

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ABSTRACT

OBJECTIVE: *Tamarix articulata* Vahl. (Tamaricaceae) is a medicinal plant commonly used in Morocco for the treatment of diabetes mellitus and cardiovascular diseases. The objective of this study was to evaluate the hypolipidemic activity of aqueous extract of *T. articulata* in normal and streptozotocin (STZ)-induced diabetic rats. Phytochemical analysis as well as determination of polyphenol and flavonoid contents in the aqueous extract of *T. articulata* was performed.

METHODS: The effects of oral administration of aqueous extract of *T. articulata* (5 mg/kg) on the plasma total cholesterol, triglyceride and high-density lipoprotein cholesterol (HDL-c) concentrations were measured in both normal and STZ-induced diabetic rats. Total phenolic content of the aqueous extract was determined by Folin-Ciocalteu method. In addition, determination of flavonoid content was performed using colorimetric $AlCl_3$ method.

RESULTS: A single oral administration in diabetic rats induced a significant increase in the HDL-c concentration after 6 h of treatment with *T. articulata* (5 mg/kg). The results also demonstrated that the aqueous extract of *T. articulata* produced a significant decrease of serum total cholesterol after repeated oral administration in diabetic rats ($P < 0.01$). The total polyphenol and flavonoid contents of *T. articulata* aqueous extract were equal to 102.50 mg of gallic acid equivalent per gram of extract and 54.83 mg of quercetin equivalent per gram of extract, respectively.

CONCLUSION: According to preliminary phytochemical screening of the aerial part of *T. articulata*, several classes of chemicals have been found, such as polyphenols, flavonoids, tannins, cyanidins (flavones, catechols), mucilage, sesquiterpenes, terpenoids and carbohydrates. In conclusion, *T. articulata* exhibits a hypolipidemic effect in diabetic rats and its beneficial role as hypolipidemic agent should be evaluated in clinical studies.

Keywords: hypolipidemic; streptozotocin; total cholesterol; triglycerides; flavonoids

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1 Introduction

Diabetes mellitus is related to lipid metabolic abnormality. This chronic pathology is characterized mainly by high plasma total cholesterol (TC), triglyceride (TG), low-density lipoprotein (LDL) and high-density lipoprotein (HDL) levels.[1] Hyperlipidemia is a major cause of atherosclerosis and atherosclerosis-associated conditions, such as coronary heart disease, ischemic cerebrovascular disease and peripheral vascular disease.[2] The modern lifestyle, with a high-fat diet and less physical activity, contributes to the development of hypercholesterolemia and cardiovascular diseases.[3,4] Therefore, developing novel classes of hypolipidemic agents with high efficacy and safety is still an important aspect of the treatment of dyslipidemia.[5] Medicinal plants contain a wide array of active components, such as flavonoids, polyphenols, tannins and alkaloids, which could be involved in their hypolipidemic activity.[6–9]

Tamarix articulata Vahl. (Tamaricaceae), locally known as "*El aadba*," is a common forest tree in the arid zone, widely distributed throughout the south-eastern region of Morocco (Tafilalet). This plant is traditionally used by the Tafilalet population for the treatment of hypertension and cardiac disease,[10] ulcer and gastrointestinal disorders, skin diseases, hair loss and dandruff.[11] Herbal healers from Tafilalet region also recommended this plant for the management of type 2 diabetics. In addition, scientific evidence has shown the curative effects of *T. articulata* in epilepsy[12] and hair care.[13] Furthermore, phytochemical investigations have indicated that the plant contains several bioactive compounds, isolated from different parts of the plant, such as flavonoid glycosides,[14] brevifolin, carboxylic acid,[15] myricadiol, isomyricardiol[16] and aphyllin.[17] In addition, ellagitannins, phenolic acid and sugars were found in galls formed on the plant.[18]

The aim of this study was to evaluate the hypolipidemic effect of the aqueous extract of *T. articulata*. Present investigation was undertaken to examine the total phenolic and total flavonoid contents of the aqueous extract of *T. articulata*. The preliminary phytochemical screening was also evaluated.

2 Material and methods

2.1 Plant material

Specimens of *T. articulata* were collected from the Tafilalet region, a semi-arid area of Morocco, from March to April, 2015, and air-dried at 40 °C. The plant was taxonomically identified and a voucher specimen (ME 64) was deposited at the herbarium of the Faculty of Sciences and Techniques, Errachidia, Morocco.

2.2 Preparation of the aqueous extract

Plant material was prepared according to the traditional method used in Morocco (decoction): 1 g of powdered aerial parts was mixed with 100 mL distilled water, boiled for 10 min and cooled for 15 min. Thereafter, the aqueous extract was filtered (Millipore 0.2 mm, St Quentin en Yvelines, France) to remove particulate matter. The dose administered was 5 mg of lyophilized aqueous extract per kilogram of body weight.

2.3 Preliminary phytochemical screening of *T. articulata*

The phytochemical analysis of the aerial parts of aqueous extract of *T. articulata* was performed and the presence of various bioactive pharmaceutical constituents such as alkaloids, polyphenols, flavonoids, cyanidins, tannins, glucosides, saponins, quinones, anthraquinones, mucilage, sterols, sesquiterpenes, reducing sugars, carbohydrates and terpenoids was tested. These analyses were carried out according to standard methods.[19–26]

2.4 Total polyphenol content

Total polyphenol content in the aqueous extract of *T. articulata* was determined with the Folin-Ciocalteu reagent, using gallic acid as a standard phenolic compound.[27] One milliliter of aqueous extract solution, at 1 mg/mL, was introduced into test tubes, followed by the addition of 1 mL of the Folin-Ciocalteu reagent. After 3 min, 3 mL of 2% sodium carbonate were added, the tubes were shaken immediately and kept in the dark for 3 h at room temperature. The absorbance of each solution was measured at 760 nm using an ultraviolet-visible (UV-VIS) spectrophotometer. The results were expressed in milligrams of gallic acid equivalent per gram (mg EAG/g) of extract.[28]

2.5 Total flavonoid content

The $AlCl_3$ method was used to determine the total flavonoid content in the aqueous extract of *T. articulata*.[29] The aqueous extract was placed in methanol at a ratio of 1 mg/mL of solvent. Two milliliters of each sample were added to 2 mL of the $AlCl_3$ solution (2% in ethanol), and the mixture was vigorously stirred. After 10 min of incubation, the absorbance was measured at 430 nm. For the quantification of flavonoids, a calibration curve ($y = ax + b$) was established using quercetin (0–40 μg/mL). The flavonoid content was expressed in milligrams of quercetin equivalent per gram (mg EQ/g) of extract.

2.6 Experimental animals

Healthy adult male Wistar rats, weighing approximately 140 g, were purchased from the Experimental Animal Center of Missour. All animals were allowed to acclimate for at least 1 week before the experiment, and were kept in individual polyethylene cages and maintained in standard conditions ((23 ± 1) ºC , with 55% ± 5% humidity and a 12 h/12 h light/dark cycle). The animals were fed *ad libitum* with a standard pellet diet. The experiment was performed