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Uricosuric effect of dandelion root extract on oxonate-induced hyperuricemia in rats

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Abstract. *This research aimed to investigate the uricosuric effect of dandelion plant extracts in hyperuricemic rats induced by potassium oxonate (PO).*

Methods. Hyperuricemia was induced in rats using PO, and dandelion root extracts were administered to observe their impact on uric acid (UA) levels. The study involved adult male Swiss rats weighing approximately 150–180 grams, randomly divided into five groups ($n = 6$). Group 1 served as the normal control group with no treatment. Group 2 received PO only. Group 3 received oral administration of 50 mg/kg of dandelion extract in 0.5 ml of distilled water (DW) daily. Group 4 was orally administered 100 mg/kg of dandelion powder in 0.5 ml of DW daily. Group 5 was orally treated with allopurinol.

After 12 days, the rats were euthanized using chloroform inhalation, and their sera were collected directly from the heart for biochemical analysis of serum UA, urinary uric acid (UUA), as well as other liver and renal biochemical parameters.

Results. The study revealed that hyperuricemic rats treated with the dandelion solution experienced a significant decrease in blood UA levels and a significant increase in UUA levels. Dandelion treatment also influenced xanthine oxidase activity, with no significant differences observed in liver and kidney functions.

Conclusion. Based on the findings of this study, it can be concluded that dandelion extract significantly reduces UA levels through uricosuric activity and demonstrates significant XO inhibitory effects.

Key words: *dandelion, uric acid, taraxacum, xanthine oxidase, hyperuricemia, uricosuria.*

Conflict of interest. The authors declare no conflict of interest.

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Урикозуричний ефект екстракту кореня кульбаби у щурів з оксонат-індукованою гіперурикемією

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Резюме. Це дослідження мало на меті вивчити урикозуричний ефект рослини кульбаби у щурів з гіперурикемією, індукованою оксонатом калію (ОК).

Методию ОК використовували для індукування гіперурикемії у щурів, а екстракти кореню кульбаби вводили для спостереження за його впливом на рівень сечової кислоти (СК) крові. Досліджуваними тваринами були дорослі самці швейцарських щурів вагою близько 150–180 грамів, які були випадковим чином розділені на п'ять груп ($n = 6$). Група 1 служила контрольною групою без лікування. Група 2 отримувала лише ОК. Групи 3 щоденно вводили внутрішньо 50 мг/кг екстракту кульбаби в 0,5 мл дистильованої води (ДВ). Групи 4 щоденно вводили внутрішньо 100 мг/кг екстракту кульбаби. Групу 5 лікували перорально алопуринолом.

Після 12 днів лікування щури були евтанізовані інгаляцією хлороформу, зразки крові були зібрані безпосередньо з серця. Визначали концентрацію сечової кислоти у крові та сечі, а також інші біохімічні маркери ураження печінки та нирок.

Результати. Щури з гіперурикемією, які отримували екстракт кульбаби, мали достовірне зниження концентрації сечової кислоти крові та підвищення рівня урикозурії. Лікування екстрактом кульбаби також знижувало активність ксантиноксидази; проте, не спостерігалось значних відмінностей у функціях печінки та нирок.

Висновок. На підставі результатів цього дослідження можна зробити висновок, що екстракт кульбаби значно знижує концентрацію сечової кислоти крові завдяки урикозуричній активності та демонструє значний інгібуєчий вплив на ксантиноксидазу.

Ключові слова: кульбаба, сечова кислота, тараксакум, ксантиноксидаза, гіперурикемія, урикозурія.

Introduction. Hyperuricemia (HU) is characterized by elevated uric acid (UA) levels exceeding 6.8 mg/dL [1]. It can be caused by various in vivo and in vitro factors. Prolonged HU can lead to complications such as gout, hypertension, cardiovascular disease, atherosclerosis, metabolic syndrome, lipid disorders, obesity, and chronic kidney disease [2, 3]. Gout, which affects approximately 4% of adults [4], is a pathological condition characterized by painful arthritis and inflammation resulting from the accumulation of sodium urate crystals in the joints, synovia, and other tissues [5].

The end product of purine breakdown in humans and great apes is UA, which exhibits antioxidant properties and contributes to 50% of the total antioxidant capacity in human bodily fluids [6]. Elevated blood levels of UA can result from decreased UA secretion or increased UA production. The development of this condition is associated with factors such as age, ethnicity, sex, and lifestyle, primarily affecting middle-aged males [7].

The progression of HU can be hindered by certain medications, such as xanthine oxidase (XO) inhibitors (e.g., allopurinol), which impede the body's natural UA synthesis. Other medications, such as probenecid and benzbromarone, known as uricosuric drugs, facilitate

UA elimination and benefit patients with under-excretion of UA. However, these medications are associated with side effects, including hypersensitivity and toxicity in the renal and gastrointestinal systems [8, 9].

For example, allopurinol, the preferred medication, can cause gastrointestinal discomfort, hypersensitivity syndromes, bone marrow suppression, hepatitis, and decreased renal function, and only 5% of patients can tolerate it. Patients allergic to allopurinol or who have normal renal function without a history of urolithiasis are treated with uricosuric medications. However, uricosuric drugs, such as benzbromarone, have their drawbacks. Benzbromarone was withdrawn from the market by Sanofi-Synth labo in 2003 due to reports of severe hepatotoxicity. Similar reports of nephrotoxicity have been associated with probenecid and sulfipyrazone when administered to treat HU in patients with mild chronic renal deficiency. Urate oxidase enzyme treatment is only used for severe cases of HU and is not widely employed [8, 9].

Due to their significant side effects, these medications have limited scientific use. Therefore, exploring alternative anti-hyperuricemic medicines with better toxicity profiles, especially those derived from natural sources, is crucial.

Dandelion, scientifically known as *Taraxacum officinale* Weber, belongs to the genus *Taraxacum* and is a member of the Asteraceae family. It naturally thrives in the humid and warm climates of the northern hemisphere [10]. The various parts of the dandelion plant, including its roots, leaves, and flowers, possess thera-

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peutic properties. The chemical composition of these plant materials is significantly influenced by factors such as environmental conditions, time of day, harvesting methods, and drying techniques. Dandelion is rich in beneficial phytochemicals, including flavonoids, phenolic acids, terpenes, and polyphenolic compounds [11].

The health benefits of dandelion are attributed to its phytochemical properties, which contribute to its strong antioxidant and anti-inflammatory effects. Studies have demonstrated that administering an herbal blend containing dandelion to mice reduced lipid peroxidation in the blood and tissues, increased the activity of antioxidant defense enzymes such as superoxide dismutase (SOD) peroxidase, and decreased levels of glutathione [12].

Moreover, *in vitro* studies have revealed that dandelion leaves can suppress the production of interleukin-1, thereby inhibiting the production of tumor necrosis factor [13].

Recent studies have highlighted the potential antitumor effects of dandelion root extract on aggressive and resistant chronic myelomonocytic leukemia cells, positioning it as a promising candidate for cancer treatment [14]. Despite its extensive use in traditional herbal medicine, limited scientific research has been dedicated to exploring the plant's pharmacological properties [15]. However, dandelion's antioxidant and anti-inflammatory properties form the basis of its cardiovascular benefits. Treatment with various dandelion extracts has been shown to reduce the severity of atherosclerosis, total cholesterol, and triglyceride levels while increasing high-density lipoprotein (HDL) levels [16, 17]. Additionally, dandelion root has recently gained attention as a potential treatment for obesity [10].

In 2022, Yao et al. and others [18-25] conducted studies demonstrating that dandelion can modify pH values, acid contents, polyphenols, sugar contents, flavonoids, phenolic acids, chicoric acids, and various other bioactive ingredients. These modifications increased the antioxidant activity levels against xanthine oxidase (XOD) and azulene. However, the results did not reveal any significant effects on UA production inhibition, limiting their utility for future research. Moreover, dandelion did not exhibit significant effects on the inhibition characteristics of UA. It is essential to increase the amount of dandelion used to enhance bioactive components, contents, and inhibitory activities against XOD in practical applications.

Ma and colleagues conducted a study using *Lactobacillus acidophilus* fermented dandelion to alleviate HU. Their findings indicated that dandelion could address HU through various mechanisms, including reducing XOD levels and UA synthesis, improving liver and kidney functions, promoting UA excretion, enhancing flora diversity, and maintaining intestinal homeostasis. Their results concluded that dandelion holds promise as a potential therapeutic agent for the treatment of HU [26].

This study aimed to examine the anti-hyperuricemic activity of dandelion root and investigate its urate-lowering effect by promoting UA excretion (uricosuric effect) in rats. Additionally, the study aimed to evaluate the impact of dandelion root on liver enzymes and renal function, including UA, creatinine (Cr), aspartate aminotransferase (AST), urea, alanine transaminase (ALT), antioxidant enzymes, and alkaline phosphatase (ALP) levels. Moreover, the study aimed to explore whether the mechanism of action of DA root extends beyond its uricosuric and xanthine oxidase (XOD) inhibitory effects.

Materials and methods. Ethical approval. The study was approved by the College of Pharmacy, University of Basrah (No. #4 of 3/5/293 on 21/10/2021).

Animals. Thirty adult male Swiss rats weighing about 150–180 grams, provided by the animal house of the College of Pharmacy, University of Basrah were included in this study. Before acclimation, the animals were divided into five groups ($n = 6$) and housed in isolated cages for one week. The animals were kept in a room with controlled environmental conditions, including a temperature of 22 ± 2 °C, $30 \pm 14\%$ humidity, and a 12-h dark/12-h light cycle. They had unrestricted access to normal feed and water throughout the experiment. All the animals handling procedures described in this paper were approved by the Basrah University Animal Ethics Committee (No. 2013/32, amended to 2023/32A). The sample size was calculated by using the formula: $n = N / (1 + N(e)^2)$, (n : sample, N : population, e : error (0.05)).

Experiment. The study was conducted between January and February 2022 at the University of Basrah, Iraq. The effect of dandelion on UA levels and urinary creatinine, as well as on UA, XO, and antioxidant enzyme levels in blood, was demonstrated using a modified PO-induced HU in rats [20]. Before medication administration, the animals underwent a 2-hour fasting period without access to food or water.

The rats were divided into five groups. During the 12 days, PO was administered intraperitoneally (i.p.) to groups 2, 3, 4, and 5 every 2 days [18]. Oral treatments were then administered once daily, 1 h after the administration of PO.

The study groups.

- Group 1: Control Group. The animals received only food and water.
- Group 2: Negative Control Group. Rats in this group were intraperitoneally injected with PO for one month.
- Group 3: Dandelion Group 1. Rats were orally administered dandelion at a daily dose of 50 mg/kg for thirty days.
- Group 4: Dandelion Group 2. Rats received oral administration of dandelion at a daily dose of 100 mg/kg for thirty days.
- Group 5: Allopurinol Group. Rats were given the standard drug allopurinol (5 mg/kg) orally every day for 30 days.

Drug and plant administration. PO was administered intraperitoneally (i.p.) at a dosage of 0.25 g/kg, dissolved in a warm normal saline solution [18]. Allopurinol was given orally via gastric intubation at a dosage of 5 mg/kg, dissolved in 5 ml distilled water (DW), while dandelion roots were also administered orally at dosages of 100 and 50 mg/kg, dissolved in 0.5 ml of DW [19]. Dandelion root was obtained from NOW FOODS at 395 S. Glen Ellyn Rd., Bloomingdale, IL 60108, USA. All solutions were freshly prepared before the testing.

Urate-lowering impact therapy. The UA value indicating the need for urate-lowering therapy (ULT) was defined as < 6.0 mg/dl ($360 \mu\text{mol/L}$) for both sexes according to the ACR guidelines [27]. In 2012, the ACR guidelines defined the indications for initiating ULT therapy in adults with gout to include cases with tophi (tophaceous gout), acute gouty arthritis (≥ 2 attacks/year), CKD (stages 2–5), and a history of urolithiasis [27, 28]. ULT the treatment of gout is approached in two ways: first, by educating patients about dietary changes, lifestyle modifications, management of comorbidities, and targeted treatment as a non-pharmacological approach ULT; second, by using XO inhibitors such as allopurinol and febuxostat as a first-line pharmacological approach [27]. In this study, allopurinol (Zyloric)[®] was used for ULT and was administered orally at a dosage of 5 mg/kg, dissolved in 0.5 ml DW PO was dissolved in warm normal saline to achieve a dosage of 0.25 g/kg for intraperitoneal injection.

Dandelion was administered orally at a dosage of 50 and 100 mg/kg, dissolved in 1 ml DW.

Blood sampling. After one month of treatment, the rats were fasted overnight and anesthetized by inhalation of chloroform. Blood samples were obtained directly from the rats' hearts. Approximately 3 mL of

the collected blood was transferred into gel tubes and allowed to clot at room temperature for 30 min. The serum was then separated by centrifugation (at 4000 rpm) for 10 min and stored at -20°C until further analysis of biochemical characteristics.

Collection of urine. The 24-hour urine was collected on days 0, 7, 14, 21, and 28. The collected urine samples were centrifuged at 2,000 rpm to obtain the supernatant for urine creatinine and UA analyses.

Biochemical parameter assays. The following reagents were utilized in this study: serum levels of UA (Catalog No.: 3P39, Abbott Laboratories/USA), Cr (Catalog No.: 3L81, Abbott GmbH & Co. KG/Germany), AST (Catalog No.: 7D81, Abbott Laboratories/USA), urea (Catalog No.: 7D75, Abbott Laboratories/USA), ALT (Catalog No.: 7D56, Abbott Laboratories/USA); rat XO (Catalog No.: E1263Ra, Bioassay Technology Laboratory/China), rat SOD (Catalog No.: E0168Ra, Bioassay Technology Laboratory/China), rat glutathione peroxidase (Catalog No.: E1242Ra, Bioassay Technology Laboratory/China), rat catalase (Catalog No.: E0869Ra, Bioassay Technology Laboratory/China), and ALP (Catalog No.: 7D55, Abbott Laboratories/USA).

All measurements were conducted using enzymatic-colorimetric methods (Biolaboratory, France) and ELISA kits.

Statistical analysis. Results are expressed as mean (M) and standard deviations (SD). Data analysis was performed using the one-way analysis of variance (ANOVA) followed by Dunnett's test. Statistical significance was defined as a p -value < 0.05 .

Results. As presented in Table 1, the serum level of XO in group 1 was within the normal range.

Table 1

Biochemical parameters of the studied groups

Group	Xanthine oxidase (IU/L)	UA (mg/dL)	ALT (IU/L)	AST (IU/L)	Alkaline Phosphatase (IU/L)	Urea (mg/dL)	Creatinine (mg/dL)
1	22.3 ± 1.5	2.45 ± 0.9	42.25 ± 3.8	128 ± 8.5	125 ± 9.6	27.5 ± 3.1	0.41 ± 0.1
2	30.25 ± 3.3*	4.87 ± 1.2*	54.11 ± 5.8*	139 ± 9.4*	152 ± 8.6*	39.1 ± 4.5*	0.5 ± 0.2*
3	22.57 ± 3.2*	0.98 ± 0.8*	44.28 ± 4.2*	133 ± 7.3*	134 ± 6.3*	23.6 ± 2.9*	0.37 ± 0.2*
4	21.98 ± 3.4*	1.54 ± 0.3*	49.51 ± 4.8*	125 ± 8.6*	138 ± 6.7*	25.7 ± 3.8*	0.4 ± 0.1*
5	14.54 ± 2.4*	0.65 ± 0.2*	52.45 ± 5.2	134 ± 9.3*	132 ± 7.9*	29.2 ± 3.8*	0.45 ± 0.1*

Values are expressed as mean ± SD, * Significant at $p < 0.05$ by ANOVA

However, there was a significant increase in XO level in group 2 ($p < 0.01$), resulting in increased production of UA compared to group 1. Each blood sample from group 2 had higher UA levels.

Administration of allopurinol, the standard XO inhibitor, resulted in a highly significant decrease

($p < 0.001$) in XO levels in group 5 compared to group 2. When administered at a dose of 100 mg/Kg, dandelion significantly decreased XO enzyme activity ($p < 0.05$). However, when administered at a dose of 50 mg/Kg, dandelion inhibited XO enzyme activity even more significantly ($p < 0.01$) than in group 2.

Moreover, the increase in XO activity by PO-induction resulted in a significant increase ($p < 0.01$) in UA levels in group 2 compared to group 1. However, in group 5, UA levels decreased significantly ($p < 0.001$) compared to group 2. In addition, oral administration of dandelion at a dose of 50 mg/kg in Group 3 and 100 mg/kg in Group 4 resulted in a significant decrease ($p < 0.001$) in UA levels compared to Group 2, primarily due to significant inhibition of XO enzyme activity.

In addition, both the standard and treatment groups showed no significant changes in liver function

markers, including AST, ALP, and ALT, and renal markers, such as urea and Cr, compared with group 1 animals (see Table 1). However, there was a significant increase ($p < 0.001$) in the levels of AST, ALP, and urea in group 2 and a significant increase ($p < 0.01$) in the serum levels of ALT and Cr in the same group.

Analysis of urine markers showed a significant decrease in UUA levels ($p < 0.05$) after 3 days and an even more significant decrease ($p < 0.01$) after 6, 9, and 12 days compared to group 2 and group 1, as shown in Table 2.

Table 2

Urinary uric acid (mg/dl) at different time points in the studied rats

Group	Cr (mg/dl)				
	Day 0	Day 3	Day 6	Day 9	Day 12
1	68.24 ± 5.1	70.21 ± 4.3	66.47 ± 3.8	67.52 ± 4.5	73.39 ± 3.5
2	67.35 ± 5.1	58.36 ± 3.4*	49.72 ± 3.3*	40.65 ± 2.7*	34.93 ± 2.2*
3	69.24 ± 4.1	75.11 ± 3.8*	79.51 ± 4.6*	86.23 ± 5.1*	90.28 ± 5.2*
4	70.65 ± 3.8	74.81 ± 4.7*	75.43 ± 5.2*	80.94 ± 6.2*	83.91 ± 5.2*
5	69.35 ± 4.8	62.35 ± 4.4*	59.46 ± 5.4*	56.35 ± 4.6*	54.24 ± 5.1*

Values are expressed as mean ± SD, * Significant at $p < 0.05$ by ANOVA

In Group 3, sequential administration of 50 mg/kg dandelion to rats increased UA excretion ($p < 0.01$) at 3 and 6 days and even more significantly ($p < 0.001$) at 9 and 12 days. In contrast, administration of 100 mg dandelion in group 4 resulted in a significant ($p < 0.05$) increase in UA excretion at 3 days, an even more significant ($p < 0.01$) increase at 6 and 9 days, and a highly

significant ($p < 0.001$) increase at 12 days compared to rats in group 2. In addition, UA level decreased significantly ($p < 0.05$) after 3, 6, 9, and 12 days in group 5 compared to group 2.

As shown in Table 3, there was a significant decrease in Cr level after 3 days in comparison between group 2 and group 1 ($p < 0.01$).

Table 3

Urinary creatinine (mg/dl) at different time points in the studied rats

Group	UUA (mg/dl) at different time points				
	Day 0	Day 3	Day 6	Day 9	Day 12
1	15.22 ± 2.2	14.85 ± 2.5	15.46 ± 1.9	15.66 ± 1.8	14.92 ± 1.3
2	14.91 ± 1.5	9.52 ± 1.2*	7.41 ± 0.6*	6.85 ± 0.7*	6.31 ± 0.8*
3	14.05 ± 3.5	17.82 ± 1.8*	19.93 ± 2.2*	22.25 ± 3.1*	25.66 ± 3.4*
4	15.28 ± 2.8	16.12 ± 1.3*	17.44 ± 1.7*	19.47 ± 2.9*	21.36 ± 3.3*
5	14.69 ± 1.1	12.52 ± 1.2*	11.61 ± 0.9*	10.32 ± 1.0*	10.75 ± 1.2*

Values are expressed as mean ± SD, * Significant at $p < 0.05$ by ANOVA

This decrease was highly significant after 6, 9, and 12 days, respectively ($p < 0.001$). In addition, there was a highly significant ($p < 0.001$) increase in urinary creatinine levels in groups 3 and 4 compared to group 2 after 3, 6, 9, and 12 days, respectively.

As indicated in Table 4, there was a highly significant decrease ($p < 0.001$) in serum antioxidant enzyme levels, including SOD and glutathione peroxidase, and a highly significant increase ($p < 0.001$) in catalase levels in group 2 compared with group 1.

Table 4

Serum antioxidant enzyme levels in the studied groups

Groups	Glutathione Peroxidase (GPx) (U/ml)	Superoxide Dismutase (SOD) (U/ml)	Catalase (CAT) (U/ml)
1	95.14±6.23	0.65±0.12	1.35±0.82
2	59.23±4.92 *	0.33±0.08 *	8.36±1.12 *
3	91.22 ± 5.25 *	0.45 ± 0.07 *	1.65 ± 0.25 *
4	96.36 ± 6.85 *	0.74 ± 0.09 *	1.52 ± 0.63 *
5	81.4 ± 6.30 *	0.51 ± 0.14 *	1.59 ± 2.50 *

Values are expressed as mean ± SD, * Significant at $p < 0.05$ by ANOVA

Treatment with dandelion resulted in a dose-dependent increase ($p < 0.001$) in the activities of SOD, catalase and GPx. When comparing group 5 with group 2, there was a significant increase ($p < 0.01$) in the blood levels of the antioxidants SOD and glutathione peroxidase, while catalase showed a highly significant decrease ($p < 0.001$).

Discussion. The findings showed that the serum level of XO in group 1 was within the normal range. However, there was a significant increase in XO level in group 2 ($p < 0.01$), resulting in increased production of UA compared to group 1. Furthermore, the administration of allopurinol resulted in a highly significant decrease ($p < 0.001$) in XO levels in group 5. Whereas when administered at a dose of 100 mg/Kg, dandelion significantly decreased XO enzyme activity ($p < 0.05$). These are similar to the suggestion of a previous study, that concluded that high XO activity leads to an excessive generation of UA because xanthine and hypoxanthine are converted into UA [21].

Based on previous research [21-23], the serum level of the parameter in group 1 was considered normal, as indicated in Table 1. In vivo studies have demonstrated that both dosages of DA powder (50 and 100 mg/kg) significantly inhibit XO. Dandelion's phenolic and flavonoid components may play a crucial role in XO inhibition [25]. Therefore, it is worth exploring a new alternative that is free of side effects and offers improved health benefits while suppressing the production of UA.

In this study, the rise in XO activity by PO induction resulted in a significant increase ($p < 0.01$) in UA levels in group 2. However, in groups 3, 4, and 5, UA levels decreased significantly ($p < 0.001$) due to significant inhibition of XO enzyme activity. These could be explained by the PO caused an increase in UA synthesis and a decrease in UA excretion by inhibiting hepatic uricase and reducing renal urine excretion. As a result, there was an accumulation of UA and a subsequent elevation in UA levels, as observed in group 2 [9, 29]. Allopurinol has been shown in previous studies to decrease UA production, as observed in group 5 [30]. In both doses of dandelion, the main components are

chlorogenic acid and flavonoids, which are known to have physiological activity. These phytochemicals have been shown in previous studies to possess UA-reducing properties, leading to the inhibition of SUA [25].

Stimulating HU in rats resulted in a significant decrease in urine production and a notable increase in blood UA levels. These results demonstrate the model's effectiveness in inducing HU, as indicated in a previous study [29]. Additionally, administering a 5 mg/kg dose of allopurinol reduced urate excretion by 35% compared to CG [30, 31].

Analysis of urine markers in our study showed a significant decrease in UA levels in the subsequent days of the study in untreated groups. While in treated groups an increased UA excretion was seen. The administration of dandelion powder showed a dose-dependent improvement in UA clearance and a reduction in blood UA levels. Interestingly, the 50 mg/kg dosage of dandelion was more effective than the 100 mg/kg dosage in reducing UA in urine. Compared to groups 2 and 5, both dosages of dandelion exhibited a highly significant uricosuric effect [25, 32]. This could be attributed to the stronger diuretic effect of dandelion root compared to other plant-based medicines. Additionally, dandelion has been found to provide protective benefits for the kidneys [33]. Previous studies have shown that over 90% of gout patients have impaired UA excretion [34, 35], making the uricosuric activity of dandelion particularly beneficial in treating gout and related conditions.

Although gout and HU are common conditions, only a limited number of available drugs can effectively lower blood UA levels. Unfortunately, these drugs are often associated with adverse side effects, leading to restrictions on their use. Consequently, there is a need to explore natural substances as potential sources of anti-hyperuricemic drugs [34, 35].

PO administration results in the accumulation of UA, decreased urine volume, and reduced clearance of urea and creatinine, indicative of renal damage, as supported by previous studies [36]. While PO can cause renal toxicity [37], using dandelion therapy has shown the potential to mitigate glomerular damage. Another study demonstrated that dandelion therapy can lead to

an increase in renal antioxidant enzymes and a decrease in the production of renal reactive oxygen species, potentially aiding in the prevention of renal ischemia [38-40]. These effects collectively contribute to increased creatinine excretion.

In this work, all the groups showed no significant changes in liver function markers (AST, ALP, and ALT), and renal function tests (urea and creatinine). However, there was a highly significant increase in all test levels in group 2. The same was seen in previous studies [31, 32]. As a result, we suggested that the standard and treatment groups did not exhibit significant differences in liver and kidney function compared to the normal animals. However, the administration of PO, which induces an increase in UA production and the subsequent elevation of free radicals and oxidative stress, resulted in hepatotoxicity and nephropathy in rats [32].

As indicated in Table 4, there was a highly significant decrease in serum antioxidant enzyme levels (SOD and glutathione peroxidase), whereas there was a highly significant increase in catalase levels in group 2 compared with group 1. Treatment with dandelion resulted in a dose-dependent increase ($p < 0.001$) in the activities of SOD, catalase, and glutathione peroxidase. The authors concluded that essential antioxidant enzymes play a crucial role in evaluating the cellular antioxidant defense system and are closely associated with the production of the lipid peroxidation product malondialdehyde [42].

Our findings are supported by a recent experiment that used a PO-induced HU model in rats [43]. A significant decrease in serum SOD levels was observed following PO injection compared to control rats, indicating an increase in oxidative stress [43]. Previous studies have shown that HU enhances the generation of oxygen-free radicals, leading to oxidative stress [44]. Therefore, extracts from the dandelion root may po-

tentially reduce the production of reactive oxygen-free radicals and enhance the activity of antioxidant enzymes, as demonstrated in previous research [45].

Limitations. This study had certain limitations, including a small sample size, limited availability of certain facilities, and potential selection bias in animal selection.

Conclusions. The dandelion root extract has demonstrated promising uricosuric effects, significantly reducing blood UA levels in PO-induced hyperuricemic rats. These results suggest that dandelion powder's uricosuric and XOD inhibitory properties may be primarily responsible for its antihyperuricemic efficacy. Based on the findings, dandelion exhibited a significant reduction in UA levels through its uricosuric activities and notable XO inhibition.

Data availability. The data supporting the findings of this study are openly available in Zenodo at <https://doi.org/10.5281/zenodo.7904950>.

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The authors' contributions.

Khairullah Mohammed Khallawi: data collection and analysis, writing, preparation of the manuscript for publication, and final editing;

Basim Jasim Hameed: data collection and analysis, writing of the clinical case presentation section, preparation of the manuscript for publication, and final editing;

Nadheerah Falih Neamah: analysis of literary sources, preparation of the manuscript for publication, and final editing.

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