JCHR (2025) 15(2), 351-362

Journal of Chemical Health Risks

sanad.iau.ir/journal/jchr

ORIGINAL ARTICLE

Antihyperuricemic Effects of Turmeric, Ginger, and Black Pepper in Rats

Radwa Donia[*1], Mona Hanfy M.[2], Doaa Elsabakhawi[3], Ghada Soliman [4]

[1]*Ph.D in Biochemistry, National Nutrition Institute of Nutrition, Cairo, Egypt*

[2]*Lecturer Analytical Chemistry, National Nutrition Institute, Cairo, Egypt*

[3]*Assistant Professor of Nutrition, National Nutrition Institute Cairo, Egypt*

[4]*Professor of Biochemistry, National Nutrition Institute Cairo, Egypt*

(Received: 22 December 2024 Accepted: 18 May 2025)

KEYWORDS

Hyperuricemia;
Spices,
Uric acid level;
Lipid profile;
Functional foods

ABSTRACT: Hyperuricemia, characterized by high uric acid levels in blood, can lead to gout and other health issues like type 2 diabetes and hypertension. This study aims to assess the Antihyperuricemic effects of turmeric, ginger, and black pepper powdered spices, individually and in combination, on rats with induced hyperuricemia. The study involved analyzing ginger, turmeric, and black pepper for microbiological safety, aflatoxins, nutritional content, and phytochemical compounds before including them in the rats' diet. Rats were adapted and then divided into six groups, with groups 2-6 induced with hyperuricemia and treated with different combinations of spices or allopurinol as medication for hyperuricemia. The experiment was conducted over a period of 8 weeks, during which body weight and dietary intake were monitored weekly. After the experiment, blood samples were analyzed. Results showed a significant reduction in uric acid, creatinine, and urea levels in the treated group, measuring 3.11 ± 0.29, 1.69 ± 0.11, and 30.51 ± 3.46, respectively, compared to the untreated group, which recorded 5.73 ± 0.27, 3.16 ± 0.19, and 43.81 ± 3.7.Additionally, the lipid profile parameters in the treated group, including total cholesterol, triglycerides, and low-density lipoprotein (LDL), were 87.33 ± 4.1, 102.74 ± 5.0, and 33.59 ± 3.5, respectively. These values were significantly lower than those in the untreated group, which recorded 142.29 ± 6.78, 140.8 ± 4.61, and 85.53 ± 7.9, respectively. Overall, the findings support the use of turmeric, ginger, and black pepper as functional foods in addressing hyperuricemia and associated comorbidities.

INTRODUCTION

Hyperuricemia is a medical condition defined by an increased concentration of uric acid in the bloodstream. Uric acid is a metabolic byproduct formed during the breakdown of purines, which are naturally present in the body and certain foods. When uric acid levels become too high, it can form sharp crystals in your joints, leading to gout, a type of inflammatory arthritis that causes sudden and severe attacks of pain, swelling, redness, and tenderness in one or more joints [1]. Comorbidities associated with hyperuricemia increase the risk of developing type 2 diabetes mellitus, hypertension, obesity, hypertriglyceridemia, and hypercholesterolemia [2]. Dietary modifications play a crucial role in managing hyperuricemia (gout). Functional foods are dietary components that may offer health benefits beyond basic nutrition. While not a replacement for conventional therapy, some functional foods may be helpful alongside medications and dietary modifications

*Corresponding author: radwadonia86@gmail.com; radwadonia_p@sci.asu.edu.eg (R. Donia)
DOI: 10.60829/jchr.2025.1194129

for managing hyperuricemia and gout [3].

Ginger (Zingiber officinale) is a flowering plant belonging to the Zingiberoside family, known for its pungent, aromatic rhizome (underground stem) widely used as a spice and folk medicine. Ginger and compounds are isolated therefrom enhance immune support, cancer cell defense, anti-inflammatory, cell protective, blood sugar regulation, cholesterol control, and anti-nausea effects [4].

Ginger (Zingiber officinale) supplementation may be beneficial for reducing blood uric acid levels. A 2019 study published in Nutrients found that 2 grams of ginger per day for 12 weeks significantly lowered serum uric acid in patients with hyperuricemia [5].

Turmeric, scientifically known as Curcuma longa, is a perennial herbaceous plant from the Zingiberaceae family. Research indicates that C. longa and its bioactive constituents exhibit a wide array of pharmacological activities. These include antioxidant properties, hepatoprotective effects, anti-osteoarthritis benefits, anti-inflammatory actions, anticancer potential, anti-arthritic activity, neuroprotective effects, antidiabetic properties, relief from diarrhea, antimicrobial effects, prevention of atherosclerosis, antidepressant qualities, anti-aging properties, wound healing capabilities, and enhancement of memory. The utilization of Turmeric in traditional medicine is justified by the presence of more than 300 biologically active compounds, such as polyphenols, sesquiterpenes, diterpenes, triterpenoids, sterols, and alkaloids [6].

Bisacumol, campesterol, and stigmasterol, identified within turmeric, are vital compounds for treating gout and hyperuricemia as they potentially influence protein processing within the endoplasmic reticulum. Their involvement suggests a significant role in the management of gout [7].

Piper nigrum L., known as black pepper, is one of the earliest and most widely used spices. It is available as black and white pepper, depending on harvest time and processing. Black pepper has a long history of use in herbal medicine. It serves various purposes, including functioning as a preservative and a biocontrol agent. The essential oil or extract of black pepper which contains piperine demonstrates a range of biological activities, such as antioxidants, anti-fungal, anti-amoebic, anti-asthmatic, anti-diabetic, and immunomodulatory effects. These properties make black pepper a valuable component not only in food but also in various therapeutic and preservation applications [8].

Spices are considered functional foods because they provide health benefits that go beyond basic nutritional needs, positively affecting specific bodily functions. This study aims to evaluate the hyperuricemia effects of three natural compounds—turmeric, ginger, and black pepper—either individually or in combination, on rats with induced hyperuricemia. The study seeks to determine the efficacy of these treatments in reducing uric acid levels and improving overall health markers associated with hyperuricemia, potentially offering insights into novel treatment strategies for such conditions in humans.

MATERIALS AND METHODS

Materials

The chemicals used for chemical and microbial analysis were obtained from Sigma-Aldrich, Germany, unless otherwise specified in the text. The used spices (turmeric, ginger, and black pepper) were sourced from the Egyptian market .In this experimental study, adult male Sprague-Dawley rats, weighing 100-120 grams (n=60), were acquired from the Helwan University Animal House. The starch, casein, vitamins, and minerals used in the rats' diet were purchased from El Nasr Pharm. Chem. Co., Egypt. The kit used for cholesterol, HDL-cholesterol, and triglyceride determination was purchased from Analyticon Biotechnologies AG, Germany, while the kit used for uric acid, urea, and creatinine determination was purchased from Biosystem, Spain. Monosodium urate and sodium pentobarbital were obtained from Sigma Chemical Company, USA (Egyptian center).

Analysis of Ginger (Zingiber officinale), turmeric, and black pepper:

Ginger (*Zingiber officinale*), turmeric, and black pepper were subjected to microbiological analysis following ICMSF [9] guidelines and aflatoxin assessment based on protocols from Anonymous [10-12] before inclusion in the rats' diet. Chemical analysis was conducted to

determine their nutritional composition, including macronutrients (protein, fat, ash, moisture, and dietary fiber), minerals (Sodium (Na), Potassium (K), Calcium (Ca), Magnesium (Mg), Phosphorus (P), Iron (Fe), Zinc (Zn), Copper (Cu), Manganese (Mn), Chromium (Cr)), and vitamins (vitamin C, vitamin E, vitamin B1, vitamin B2, and vitamin B3), in accordance with AOAC [13-15]standards.

Phytochemical screening and determination of phenols and flavonoids

They were submitted to qualitative chemical screening to identify the various primary classes of active chemical ingredients such as phenols, flavonoids, glycosides, phytosterols, saponins, tannins, and alkaloids using established analytical protocols [16, 17]. Total phenolic compounds were measured using a colorimetric method using the Folin-Ciocalteu reagent [18] and represented as milligrams (mg) of garlic acid equivalents (GAE)g^{-1} of dry weight extract (DW) (mg GAE g^{-1} DW). The total flavonoid compounds were determined using a colorimetric method [19] and expressed as quercetin equivalents (mg QEg^{-1}). All analyses were conducted in duplicate.

Experimental procedures

All rats were housed individually in wire-mesh cages to facilitate the weighing of the rats and their diet. All the rats were acclimated to the animal facility for ten days, where they were kept under controlled conditions, including a 12-hour light and 12-hour dark cycle, a temperature range of 25°C±2.0, and a humidity level of 40±2%. A standard basal diet was introduced to the rats following Reeves et al. [20], using the AIN-93 M diet designed for adult rats.

The duration of the experiment was eight weeks. And libitum water and rat food were provided. Monosodium urate was injected into groups two through six to induce hyperuricemia. There were ten animals in each of the six groups into which the experimental animals were divided:

Group 1 (Normal Control): Fed a standard diet without treatment.

Group 2 (Positive Control): Hyperuricemic rats with no treatment.

Group 3: Hyperuricemic rats treated with allopurinol (60 $mg \cdot kg^{-1}$ BW).

Group 4: Hyperuricemic rats treated with turmeric (500 $mg \cdot kg^{-1}$ BW).

Group 5: Hyperuricemic rats treated with a black pepper and ginger mixture (500 $mg \cdot kg^{-1}$ BW and 50 $mg \cdot kg^{-1}$ BW, respectively).

Group 6: Hyperuricemic rats treated with a combination of turmeric, ginger, and black pepper (250 $mg \cdot kg^{-1}$ BW, 250 $mg \cdot kg^{-1}$ BW, and 25 $mg \cdot kg^{-1}$ BW, respectively).

Weekly weights and diets of rats were also documented. Body weight increase (BWG) was estimated as the difference between the beginning body weight (IBW) and the final body weight (FBW) (BWG=FBW-IBW).

After the experiment, the rats were fasted overnight, weighed, and sacrificed under anesthesia by Sodium Pentobarbital injection (Sigma, USA). Blood samples were collected from the hepatic portal vein. Fasting blood samples were taken in tubes. The serum was separated by centrifugation at 3,000 rpm (Relative Centrifugal Force (RCF) is approximately 5000 g) for 15 minutes and kept at -20ºC for subsequent biochemical analysis.; urea [21, 22], creatinine [23], uric acid [21,24] , total cholesterol [25] , High density lipoprotein (HDL-C) [26, 27], Low density lipoprotein LDL-C [28] , Very low density lipoprotein VLDL-C {VLDLC= total cholesterol- (HDL-C+LDL-C)}, and triacylglycerol [29] using suitable kits. The organs such as kidneys from various animal types were promptly removed, cleansed with saline, dried, and weighed.

Histological examination

The kidneys were placed in 10% formalin for histological evaluation, then dehydrated, cleaned in zylol, and embedded in parablast. Paraffin slices will be cut serially at 6mm thickness and stained with hematoxylin and eosin (Hx & E), as reported by Drury and Wakkington [30].

Statistical analysis

Data analysis was performed using SPSS software version 21.0 (SPSS, Inc.). Results are presented as mean ± SD. Differences between groups were assessed

using one-way ANOVA, followed by Duncan's New Multiple Range post hoc test. Statistical significance was set at $P < 0.05$ [31].

RESULTS

Table 1 clarifies the detailed nutritional facts for turmeric, ginger, and black pepper. It includes macronutrients (energy, water, protein, fat, carbohydrates, fiber, ash, and dietary fiber), minerals (sodium, potassium, calcium, magnesium, phosphorus, iron, zinc, copper, manganese, and chromium), and vitamins (β-Carotene, vitamin C, vitamin E, and vitamins B1, B2, and B3). From the data, it's clear that all three species are rich in nutrients. Turmeric, for example, is high in energy, fiber, and contains a significant amount of β-Carotene. Ginger, on the other hand, has a good amount of vitamin B3 and a balanced mineral profile. Black pepper is high in energy and dietary fiber and contains a high amount of vitamin C.

Table 1. Macronutrients, minerals, and vitamin content of Ginger, turmeric, and black pepper.

Macronutrients g $100g^{-1}$ (Mean ±SD)				Minerals mg $100g^{-1}$ (Mean ±SD)				Vitamins mg $100g^{-1}$ (Mean ±SD)			
Item	**Turmeric**	**Ginger**	**Black pepper**	**Item**	**Turmeric**	**Ginger**	**Black pepper**	**Item**	**Turmeric**	**Ginger**	**Black pepper**
Energy (cal)	355.5±32.5	353.3±22.3	402.7±42.3	Na	ND*	50±5.6	11.11±3.8	βCarotene	ND*	92.9±16.2	0.16±0.05
Water (g)	9.48±2.1	8.92±1.6	9.02±2.3	K	2104±107	1200.2±235	1210.2±189	vit. C	27.58±6.3	10.55±3.2	30.2±2.7
Protein (g)	10.2±1.2	9.01±2.3	10.25±2.9	Ca	175.4±23.1	100.3±17.8	410.2±32.5	Vit. E	2.91±0.4	ND	1.1±0.12
Fat (g)	3.41±0.08	3.4±0.15	10.9±0.9	Mg	212.5±33.9	200±28.9	244.2±32.6	vit. B1	0.84±0.11	0.042±0.01	0.79±0.06
Carbohydrates (g)	71.01±10.3	71.67±12.3	65.92±16.2	P	250.7±26.2	190.2±27.6	156.٧±31.3	vit. B2	0.24±0.03	0.15±0.02	0.51±0.07
Fiber (g)	11.25±2.5	6.3±1.6	11.23±2.6	Fe	49.2±11.4	9.21±1.9	18.12±2.9	vit. B3	0.16±0.01	9.11±1.7	0.72±0.09
Ash (g)	5.9±0.6	7.0±1.3	3.91±0.78	Zn	4.41±0.9	3.21±0.2	1.62±0.08				
Dietary fibre(g)	22.7±5.6	12.35±1.9	24.1±2.4	Cu	0.65±0.02	4.21±0.6	0.93±0.05				
				Mn	752.25±104	30.45±4.8	22.23±3.1				
				Cr	40.23±11.5	80.02±10.5	30.25±7.5				

*ND

The Data in Table 2 provides a comparative analysis of phytochemical constituents, and total phenolic, and flavonoid content of turmeric, ginger, and black pepper. Turmeric and ginger exhibit similar profiles across various phytoconstituents including alkaloids, flavonoids, saponins, tannins, phytosterol, glycosides, phenols, and sterols, while black pepper shares most of these constituents except for lactones, diterpenes, and triterpenoids. Turmeric shows the highest total phenolic content (110.56 mg GAE g^{-1}) followed by ginger (155.25 mg GAE g^{-1}) and black pepper (44.23 mg GAE g^{-1}). Similarly, turmeric exhibits the highest total flavonoid content (11.1 mg g^{-1} DW) compared to ginger (7.69 mg g^{-1} DW) and black pepper (7.1 mg g^{-1} DW). The diphenyl – picrylhydrazyl (DPPH) radical scavenging activity assay values are comparable among the three spices, indicating relatively similar antioxidant potential. Additionally, black pepper contains the highest amount of piperine (3.35 mg g^{-1}), a bioactive compound known for its various health benefits. Overall, the table highlights the rich phytochemical profiles of turmeric, ginger, and black pepper, which contribute to their potential health-promoting properties.

Table 2. Phytochemical analysis, Total phenolic and flavonoid content of Turmeric, Ginger and Black pepper.

Parameter		Turmeric	Ginger	Black pepper
Phytoconstituents*	Alkaloids	+	+	+
	Flavonoids	+	+	+
	Saponins	+	+	+
	Tannins	+	+	+
	Phytosterol	+	+	+
	Diterpenes	-	-	-
	Triterpenoids	-	-	-
	Glycosides	+	+	+
	Anthraquinones	-	-	+
	Phenols	+	+	+
	Sterols	+	+	+
	Lactones	+	-	-
Total phenolic as gallic acid (mg g^{-1})		110.56±6.1	155.25±12.5	44.23±8.6
Total flavonoid (mg g^{-1})		11.1±1.7	7.69±0.3	7.1 ±1.2
DPPH radical scavenging activity (100 µg mL^{-1})**		36.91±8.6	39.01±2.3	38.91±5.3
Piperine (mg g^{-1})				3.35±0.41

- *** Phytoconstituents: (+) the compound is present, (–) the compound is absent**
- ****DPPH activity indicates antioxidant potential.**
- The mean in same column with different superscripted letters was significantly different (***p<0.05***)

The data provided in Table 3 appears to be from a study investigating the effects of various treatments on uricemic rats. The treatments significantly influenced the rats' body weight gain (BWG), relative BWG; daily feed intake, and kidney weight. Group VI, which received a mixture of turmeric, ginger, and black pepper, showed the highest BWG and relative BWG, suggesting this combination might be the most effective in promoting weight gain in uricemic rats. However, the kidney weight, an important indicator of renal health, was highest in the control group (Group I) and lowest in the negative control group (Group II). This suggests that while the treatments may promote weight gain, their effects on kidney health vary. Further studies are needed to fully understand these effects and their implications for treating conditions related to high uric acid levels.

Table 3. Internal body weight, Final body weight, Body weight gain, Relative body weight gain Feed efficiency ratio, kidney weight, and relative kidney weight in the different experimental groups.

Groups \ Parameter		IBW (g)	FBW(g)	BWG(g)	RBWG	feed/rat/day	Kid Wt(g)	R Kid Wt(g)
G I	Mean	176.70	232.80	56.10	31.87	15.00	7.22	3.10
	± SD	9.65 ^{a}	11.71 ^{a}	8.66 ^{b}	5.45 ^{b}	1.49 ^{a}	0.62 ^{a}	0.17 ^{a}
G II	Mean	172.10	209.50	37.40	21.75	10.60	5.18	2.47
	± SD	5.63 ^{a}	5.97 ^{c}	2.12 ^{d}	1.45 ^{d}	0.97 ^{d}	0.24 ^{c}	0.11 ^{b}
G III	Mean	171.40	227.80	56.40	32.87	14.19 ^{b}	7.01	3.08
	± SD	6.36 ^{a}	11.97 ^{b}	7.21 ^{b}	3.64 ^{b}	1.51	0.23 ^{a}	0.14 ^{a}
G IV	Mean	174.50	224.50	50.00	28.67	12.27	6.49	2.90
	± SD	6.74 ^{a}	8.11 ^{b}	2.83 ^{c}	1.64 ^{c}	1.29 ^{c}	0.35 ^{b}	0.25 ^{a}
G V	Mean	172.40	222.70	50.30	29.25	12.07	6.25	2.81
	± SD	6.83 ^{a}	5.95 ^{b}	2.67 ^{c}	2.38 ^{c}	1.26 ^{c}	0.23 ^{b}	0.08 ^{a}
G VI	Mean	171.70	234.70	63.00	36.70	14.43	6.95	2.97
	± SD	7.42 ^{a}	11.37 ^{a}	6.32 ^{a}	3.46 ^{a}	1.40 ^{a,b}	0.19 ^{a}	0.12 ^{a}

The mean in same column with different superscripted letters was significantly different (p<0.05)

Table 4 compares the effects of various treatments on uricemia in rats, measured by Urea, Creatinine, and Uric Acid levels. The control group (Group I) had the lowest levels, while the untreated uricemic group (Group II) had the highest. Treatments with allopurinol (Group III), turmeric (Group IV), a ginger and black pepper mixture (Group V), and a mixture of turmeric, ginger, and black pepper (Group VI) all resulted in reduced levels, indicating their potential effectiveness in managing uricemia. The significant differences between groups suggest that these treatments could have different levels of effectiveness.

Table 4. Kidney functions in different experimental groups

Groups \ Parameter		Urea	Creatinine	Uric acid
G I	Mean	26.49	1.07	2.96
	± SD	2.58 ^{d}	0.13 ^{f}	0.23 ^{d}
G II	Mean	43.81	3.16	5.73
	± SD	3.70 ^{a}	0.19 ^{a}	0.27 ^{a}
G III	Mean	29.85	1.33	3.08
	± SD	3.54 ^{c}	0.09 ^{e}	0.24 ^{c}
G IV	Mean	34.05	1.92	3.79
	± SD	1.62 ^{b}	0.09 ^{b}	0.16 ^{b}
G V	Mean	32.49	1.81	3.68
	± SD	2.58 ^{b}	0.04 ^{c}	0.24 ^{b}
G VI	Mean	30.51	1.69	3.11
	± SD	3.46 ^{c}	0.11 ^{d}	0.29 ^{c}

The meaning in same column with different superscripted letters was significantly different ($p<0.05$)

The Data in Table 5 presents the effects of various treatments on cholesterol and lipid profiles in uricemic rats. Group I, the control group, had the lowest levels of cholesterol, HDL-C, LDL-C, VLDL-C, and TG. Group II, the untreated uricemic rats, had the highest levels, indicating the impact of uricemia on these parameters. Groups III to VI, which were uricemic rats treated with allopurinol, turmeric, a mixture of ginger and black pepper, and a mixture of turmeric, ginger, and black pepper respectively, all showed reduced levels compared to Group II. This suggests that these treatments were effective in managing uricemia and improving lipid profiles.

Table 5. Lipid profile in the different experimental groups.

Groups \ Parameters		Cholesterol	HDL-C	LDL-C	VLDL-C	TG
G I	Mean	80.11	37.29	20.90	21.91	112.13
	± SD	4.90 ^{c}	4.07 ^{a}	7.80 ^{d}	1.26 ^{c}	6.88 ^{c}
G II	Mean	142.29	28.84	85.53	27.93	140.80
	± SD	6.78 ^{a}	2.30 ^{d}	7.95 ^{a}	1.31 ^{a}	4.61 ^{a}
G III	Mean	88.90	33.83	34.34	20.72	104.18
	± SD	4.92 ^{c}	2.04 ^{b}	4.27 ^{c}	1.67 ^{c}	5.87 ^{d,e}
G IV	Mean	106.50	31.42	49.14	25.94	122.21
	± SD	3.92 ^{b}	1.77 ^{c}	4.65 ^{b}	1.96 ^{b}	9.15 ^{b}
G V	Mean	101.49	32.11	48.51	20.87	108.49
	± SD	4.06 ^{b}	1.30 ^{c}	3.80 ^{b}	2.83 ^{c}	6.74 ^{d}
G VI	Mean	87.33	33.56	33.59	20.18	102.74
	± SD	4.15 ^{c}	2.04 ^{b}	3.51 ^{c}	1.90 ^{c}	5.01 ^{e}

The mean in the same column with different superscripted letters was significantly different (***p<0.05***)

Figure 1 shows the renal cortex of Control Group 1, which appeared normal and serves as the baseline for comparison. Figure 2 presents kidney sections from Group 2 (uricemic rats), displaying severe vascular congestion in the renal cortex. In Figure 3, the renal cortex of uricemic rats treated with allopurinol appears normal. Figure 4, which shows the photomicrograph of uricemic rats treated with turmeric, reveals congestion in the renal cortex. Similarly, Figure 5 demonstrates that uricemic rats treated with a mixture of ginger and black pepper also exhibited renal cortical congestion. In contrast, Figure 6 presents a photomicrograph of Group 6, showing a normal renal cortex.

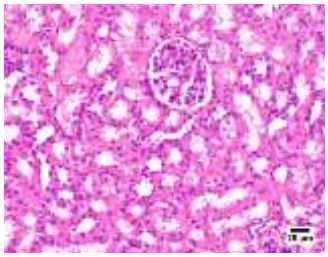

Figure 1. Photomicrograph of kidney, control group 1 showing normal renal cortex (H&E).

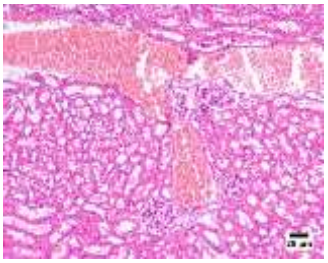

Figure 2. Photomicrograph of kidney, group 2 showing severe vascular congestion in the renal cortex (H&E).

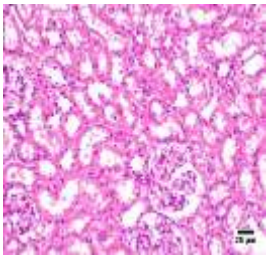

Figure 3. Photomicrograph of kidney, G 3 showing normal renal cortex (H&E).

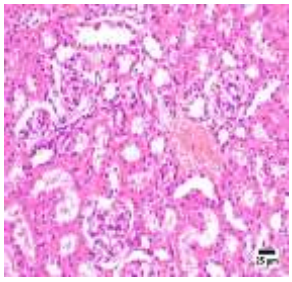

Figure4. Photomicrograph of kidney, G 4 showing congestion of the renal cortex (H&E).

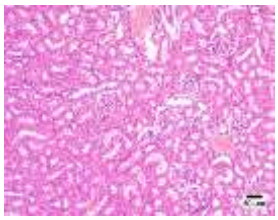

Figure 5. Photomicrograph of kidney, G 5 showing congestion of the renal cortex (H&E).

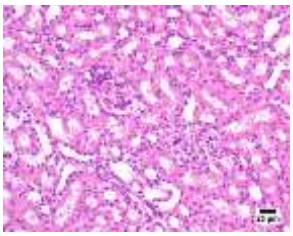

Figure 6. Photomicrograph of kidney, G 6 showing normal renal cortex (H&E).

DISCUSSION

Turmeric, ginger, and black pepper are spices that, apart from adding flavor to our dishes, also contribute to our daily nutritional intake. The data in Table 1 you provided outlines the nutritional composition of turmeric, ginger, and black pepper. These spices are rich in macronutrients, minerals, and vitamins, which contribute to their health benefits. According to a systematic review by Vázquez-Fresno et al. [32], culinary herbs and spices have been used for centuries due to their known and presumptive health benefits, including antioxidant, anti-microbial, and anti-inflammatory effects, as well as potential protection against cardiovascular disease, neurodegeneration, type 2 diabetes, and cancer. In the context of the data, you provided, turmeric, for instance, is high in energy, fiber, and contains a significant amount of β-Carotene. Ginger has a good amount of vitamin B3 and a balanced mineral profile. Black pepper is high in energy and dietary fiber, and contains a good amount of vitamin C. However, a meta-analysis by Wang et al., [33] suggests that while spicy food intake may have a beneficial effect on hypertension, it could adversely affect overweight/obesity and blood lipid levels[2]. These

benefits, their consumption should be balanced with other dietary components. The phytochemical analysis presented in Table 2 reveals valuable insights into the composition of turmeric, ginger, and black pepper. Turmeric (*Curcuma longa*) and ginger (*Zingiber officinale*) are renowned for their rich phytochemical profiles, containing alkaloids, flavonoids, saponins, tannins, and phenols, among others [34, 35]. These compounds have been extensively studied for their antioxidants, anti-inflammatory, and anticancer properties [36, 37]. The notably high total phenolic content in turmeric and ginger, as indicated in the table, corroborates findings from previous research highlighting their potent antioxidant activity [38]. Additionally, black pepper (*Piper nigrum*) exhibits a similar phytochemical profile to turmeric and ginger, albeit with some differences such as the absence of lactones and the presence of piperine [39] Piperine, the major alkaloid in black pepper, has been shown to possess various pharmacological properties, including antioxidant, anti-inflammatory, and anticancer effects [40]. The antioxidant potential of black pepper, demonstrated in the DPPH radical scavenging activity assay, further underscores its therapeutic significance [40]. The data in Table 3 provided information about a study investigating the effects of various treatments on uricemic rats. The treatments significantly influenced the rats' body weight gain (BWG), relative BWG; daily feed intake, and kidney weight. Group VI, which received a mixture of turmeric, ginger, and black pepper, showed the highest BWG and relative BWG. This is consistent with studies indicating that the combination of turmeric, ginger, and black pepper can enhance absorption and provide health benefits [42]. H‧owever, the kidney weight, an important indicator of renal health, was highest in the control group (Group I) and lowest in the negative control group (Group II). This suggests that while the treatments may promote weight gain, their effects on kidney health vary. Allopurinol, used in Group III, is known to have uricosuric and hypouricemic activity [43]. It has been shown to improve kidney injury in rats [44]. The data presented in Table (4) shows the effects of different treatments on uricemia in rats, as indicated by the levels of Urea, Creatinine (Creat), and Uric Acid (Uric). The results indicated that Allopurinol is a well-known urate-lowering drug. It has been shown to decrease serum and urine uric acid levels, which aligns with the observed reduction in the levels of these substances in Group [45]. Also, Turmeric contains curcumin, a compound with anti-inflammatory properties [46]. While there's no direct evidence of turmeric's effect on uricemia, its anti-inflammatory properties could potentially contribute to the management of uricemia. Both ginger and black pepper have been shown to have health benefits, including anti-inflammatory properties [47]. However, specific studies on their effects on uricemia are lacking. However, the combination of turmeric, ginger, and black pepper has been suggested to have enhanced anti-inflammatory effects [48]. This could potentially explain the observed reduction in the levels of Urea, Creat, and Uric in Group VI. Table 5 showed that uricemic rats with no treatment in Gp II, their cholesterol and triglyceride levels were significantly higher than in the control group, indicating the effect of uricemia on these parameters. This is consistent with studies showing that uricemia can lead to dyslipidemia [49]. The cholesterol and triglyceride levels in the Allopurinol treatment group are closer to the control group than the Negative control group, suggesting that allopurinol has a positive effect. Allopurinol is known to lower uric acid levels and can potentially improve lipid profile [50]. Group IV (Turmeric treatment) The cholesterol and triglyceride levels in this group are higher than the control group but lower than the Negative control group, suggesting that turmeric also has a positive effect, but not as strong as allopurinol. Turmeric has been reported to have hypolipidemic effects as it contains bisacurone which has the potential to reduce serum lipid levels [52]. The cholesterol and triglyceride levels in the group of rats treated with ginger and black pepper were similar to those in the turmeric-treated group, suggesting a comparable effect. Both ginger and black pepper have been reported to have hypolipidemic effects [53, 54]. The rats received a combination of Turmeric, Ginger, and Black Pepper treatments. The cholesterol and triglyceride levels in this group are the closest to the normal control group, suggesting that the combination of treatments has the most positive effect. This could be due to the synergistic effect of the three ingredients, although more research is needed to confirm this. Uricemic rat sections

of the kidney show severe vascular congestion in the renal cortex. Vascular congestion can occur when the flow of blood through the vessels is impaired, leading to an accumulation of blood. This suggests that uricemia without treatment can lead to significant kidney damage [54]. The photomicrographs of the rats that were treated with allopurinol showed a normal renal cortex, suggesting that allopurinol treatment can effectively mitigate the kidney damage caused by uricemia. This is consistent with the known effects of allopurinol, a medication that decreases high blood uric acid levels [55]. The photomicrograph in Uricemic rats treated with turmeric shows congestion of the renal cortex, indicating some level of impairment or inflammation, but not as severe as in Group 2. This suggests that turmeric has some protective effects against kidney damage, which aligns with research showing the anti-inflammatory properties of turmeric [56]. While kidney sectors in Uricemic rats treated with a mixture of ginger and black pepper showed congestion of the renal cortex, like Group 4. This suggests that the mixture of ginger and black pepper also has some protective effects against kidney damage. Uricemic rats treated with a mixture of turmeric, ginger, and black pepper showed a normal renal cortex, similar Uricemic rats treated with allopurinol, suggesting that the combination of treatments has the most positive effect on mitigating kidney damage caused by uricemia.

CONCLUSIONS

The comprehensive analysis of the data highlights the nutritional composition and potential health benefits of turmeric, ginger, and black pepper. These spices are rich in phytochemicals such as alkaloids, flavonoids, saponins, tannins, and phenols, which contribute to their antioxidant, anti-inflammatory, and anticancer properties. While individual treatments with these spices show promising effects on various physiological parameters in uricemic rats, the combination of turmeric, ginger, and black pepper appears to exert the most significant positive effects, particularly in mitigating kidney damage caused by uricemia. This synergistic effect could be attributed to the complementary mechanisms of action of the bioactive compounds present in each spice. However, further research is warranted to elucidate the underlying mechanisms and optimize the therapeutic potential of these spice combinations. Overall, incorporating turmeric, ginger, and black pepper into the diet may offer promising strategies for promoting health and mitigating the risk of chronic diseases, but their consumption should be balanced with other dietary components to ensure overall health and well-being.

Conflicts of interest

The authors declared that there is no conflict of interest regarding the publication of this paper.

Funding Statement

This study did not receive any funding in any form.

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