

The Effect of Green Silver Nanoparticles Synthesized from Two Plant Extracts on the Body Weight of Albino Rats

Wurood Hasan Hadi*, Saleh H. Abud**, Ali Hassan Abood*

* Biology Department, Faculty of Science, University of Kufa, Iraq

** Department of Radiological Techniques, College of Medical and Health Technologies, University of Alkafel, Iraq

(Presented by Academy Member Ramaz Khetsuriani)

Abstract. The effect on body weight and weight gain were investigated in the present study using green-synthesized silver nanoparticles (AgNPs) prepared from *Coffea arabica* seed and *Rosa damascena* extracts. To ensure a comprehensive assessment, AgNPs were administered at doses of 100, 200, 300, and 400 ppm/day for 30 days across six groups of rats (n = 5 per group). UV-Vis spectra revealed irregular AgNPs larger than 30 nm, with size variations influenced by the extract type and concentration. Notably, the relative weight of vital organs increased at higher doses (300 and 400 ppm). Compared to previous studies, no lethal effects were observed; instead, daily monitoring throughout the experimental period confirmed a stable clinical response. © 2026 Bull. Georg. Natl. Acad. Sci.

Keywords: silver nanoparticles, green synthesis, *Coffea arabica*, *Rosa damascena*

Introduction

Driven by the rapid advancement of nanoscience and nanotechnology (NST), plants play a focal role in providing small molecules for drug fabrication and related discovery programs (Chaachouay & Zidane, 2024). These natural compounds have evolved to address a variety of biological targets and complement key pharmaceutical agents (Nasim et al., 2022). Consequently, there is a growing demand for plant-derived natural products alongside existing synthetic pharmaceuticals (Liu et al., 2023). Green biology offers novel approaches to enhance these biological properties and synthesize nanoscale materials for potential new drug candidates.

Materials and Methods

AgNPs synthesis. Silver nitrate (AgNO_3 , 1.69 g, 1 mM) was dissolved in 1000 mL of deionized water. Separately, 4 g of *Rosa damascena* and *Coffea arabica* extracts were stirred and heated at 45-60°C in 400 mL of deionized water for 10-15 minutes. After filtration, the AgNO_3 solution was added dropwise using a dropper to the plant extract to prepare four target concentrations (100, 200, 300, and 400 ppm). The mixture was incubated at 60-70°C for 30 minutes until a visible color change confirmed, indicating the formation of AgNPs (Rai & Ingle, 2012). Finally, a UV-Vis spectrophotometer (model: Mega 2100) was used to ensure that AgNPs were synthesized.

Laboratory animals. Thirty male white rats (180-220 g), were divided into six groups. Nanoparticles were administered orally once daily for 30 days. Clinical parameters, including locomotor activity, appetite, and body weight, were evaluated daily. The percentage of body weight gain was calculated as follows (Durán et al., 2016):

$$\text{body weight gain (\%)} = \frac{\text{final weight} - \text{initial weight}}{\text{initial weight}} \times 100$$

The animals were deeply anesthetized via an intraperitoneal injection of a ketamine/xylazine mixture (9:1 mg/kg peritoneally) prior to sacrifice. Using standard surgical instruments, the testes, liver, and kidneys were dissected and immediately weighed on an analytical balance. The harvested organs were then fixed in 10% formalin (Husain et al., 2023). The relative organ weight was calculated using the following formula:

$$\text{relative organ weight} = \frac{\text{absolute organ weight}}{\text{final body weight}} \times 100$$

Results and Discussion

Optical characterization. Since nanoparticles exhibit unique optical properties, UV-Vis spectroscopy provides essential information regarding nanoparticle shape, size, and synthesis verification through

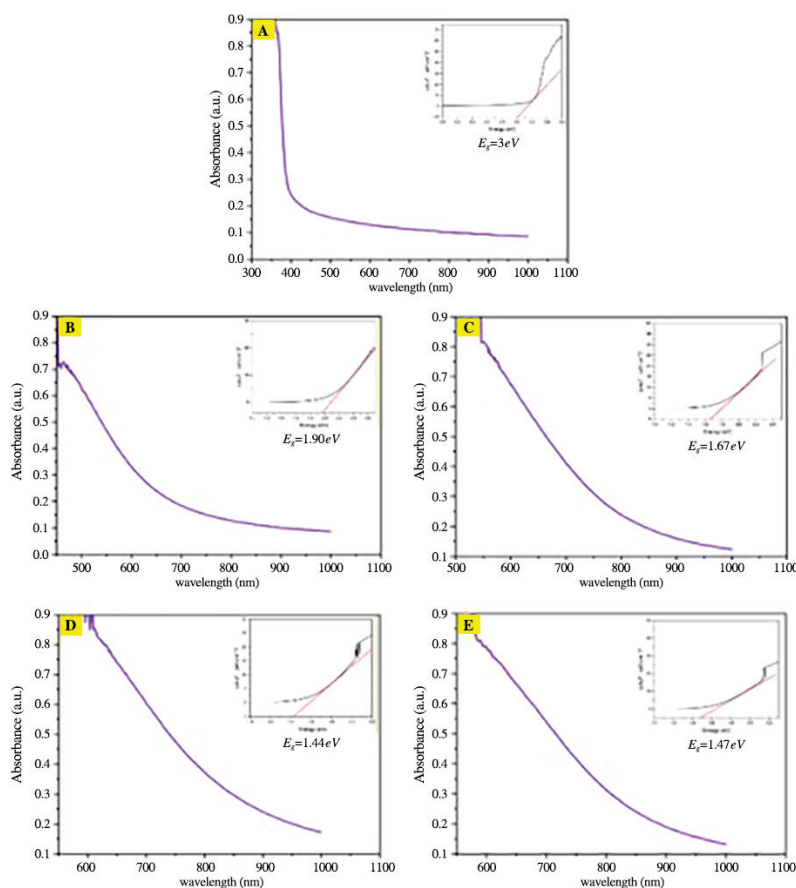


Fig. 1. Absorbance spectra of AgNPs with *Coffea arabica* seeds extract at different concentrations (A) control negative, (B) 100 ppm, (C) 200 ppm, (D) 300 ppm, and (E) 400 ppm.

quantum confinement effects and Surface Plasmon Resonance (SPR) (Gungure et al., 2024). Fig. 1 displays the absorbance spectra of AgNPs synthesized using *Coffea arabica* seed extract at concentrations of 100, 200, 300, and 400 ppm. Relative to the negative control, a distinct red shift in the maximum absorption wavelength occurred as the extract concentration increased. The broadening of the absorbance peak indicates both the successful formation of AgNPs and a polydisperse particle size distribution (Paramelle et al., 2014). The direct energy band gap is shown in the figure insets. A similar trend was observed for *Rosa damascena* extracts, as shown in Fig. 2.

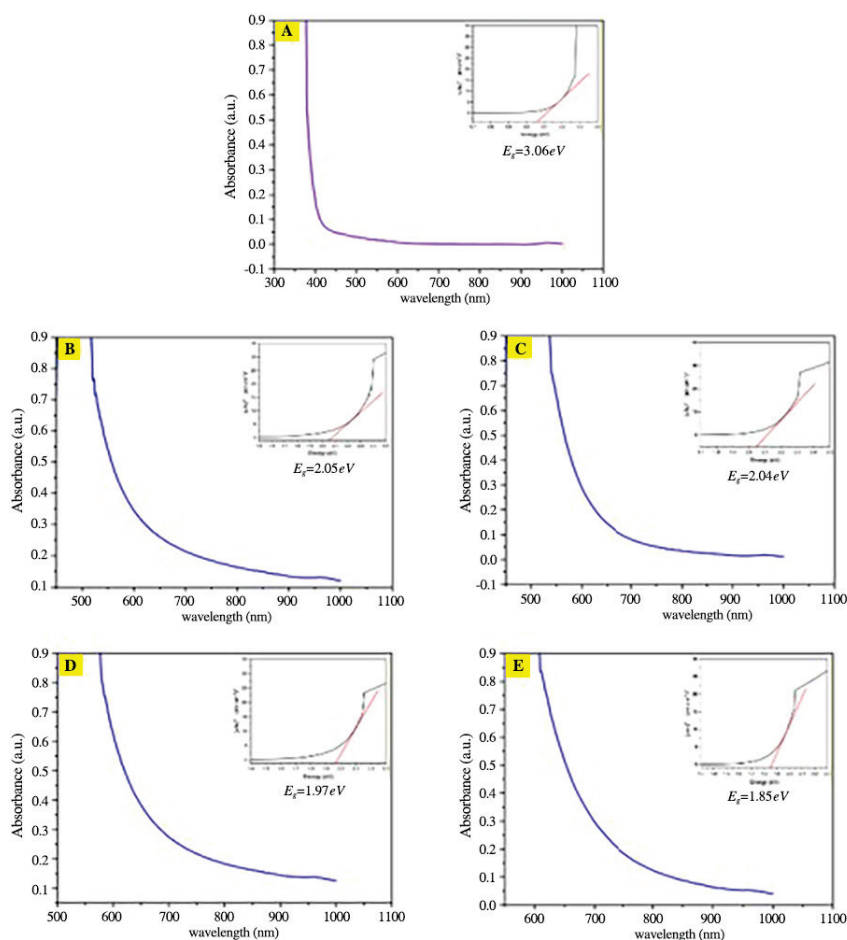


Fig. 2. Absorbance spectra of AgNPs with *Rosa damascene* extract at different concentrations (A) control negative, (B) 100 ppm, (C) 200 ppm, (D) 300 ppm, and (E) 400 ppm.

Body weight. Daily oral administration of AgNPs synthesized using *Coffea arabica* seed extract (100, 200, 300 and 400 ppm/day) led to a significant increase ($p < 0.05$) in the final body weight of male rats (Fig. 3A). A similar pattern was observed for AgNPs synthesized with *Rosa damascena* extract (Fig. 3B). All body weight parameters are summarized in Table 1.

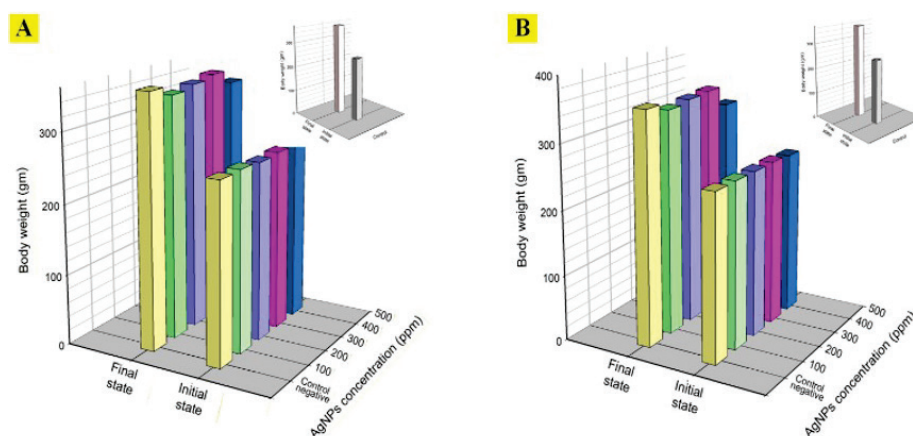


Fig. 3. Effect of daily oral administration of green-synthesized AgNPs at various concentrations (100-400 ppm/day) on body weight in male rats using (A) *Coffea arabica* seed extract and (B) *Rosa damascena* extract.

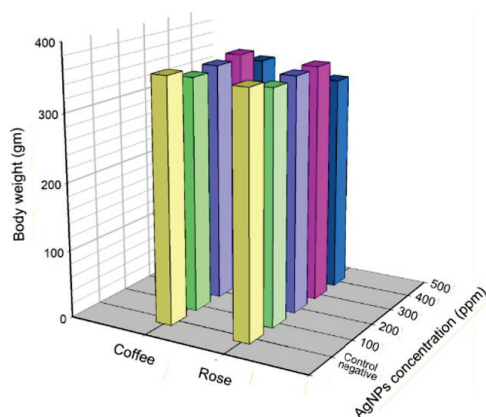


Fig. 4. Final body weights of rats with *Coffea arabica* seeds and *Rosa damascene* extracts.

Fig. 4 demonstrates a statistically significant increase in final body weight, with greater weight gain observed in rats treated with *Coffea arabica* seed extract compared to those receiving *Rosa damascene* extract and the control group.

Table 1. Oral administration of different concentrations of AgNPs of rose and coffee-mediated synthesis with initial, final body weight, and weight gain

Oral drench mg/kg/day	Initial body weight (g) (mean±S.E)	Final body weight (g) (mean±S.E)	Weight gain (%) (mean±S.E)	Gain (+) or loss (-)
Control negative (n=5)	230.0 ± 0.5	367.6 ± 0.5	59.83±1.5	+
Control positive (<i>Rosa damascene</i>) (n=5)	255.6 ± 0.5	356.6 ± 0.5	39.51±2.8	+
Control positive (<i>Coffea arabica</i>) (n=5)	256.6± 0.7	359.2 ± 0.7	39.98±1.6	+
Ag/R/1% (n=5)	255.6 ± 0.5	344.6± 0.5	34.82±1.5	+
Ag/R/2% (n=5)	255.2± 0.5	349.6± 0.5	36.98±1.9	+
Ag/R/3% (n=5)	255.8± 0.3	352.16 ±0.7	37.67±2.1	+
Ag/R/4% (n=5)	255.4± 0.5	320.2 ±1.9	25.37±2.2	+
Ag/C/1% (n=5)	256.8± 0.5	345.6± 0.5	34.58±1.3	+
Ag/C/2% (n=5)	255.4± 0.3	351.74 ± 0.7	37.71±1.2	+
Ag/C/3% (n=5)	257.8 ± 0.3	357.8 ± 0.7	38.79±2.6	+
Ag/C/4% (n=5)	256.0 ± 0.5	338.2± 0.5	32.11±1.4	+
LSD $P \leq 0.05 = 4.10$				

The interactive effects of administration duration and green-synthesized AgNPs (rose- and coffee-mediated) on the final body weight and body weight gain of male rats are presented in Table 2. After 30 days of daily gavage, a significant increase ($p < 0.05$) in final body weight was observed for both rose- and coffee-synthesized AgNPs compared to their respective initial body weights. Regarding weight gain, rats receiving rose-mediated AgNPs demonstrated a significantly higher increase ($p < 0.05$) after 30 days than those treated with coffee-mediated AgNPs.

Table 2. Oral administration of different concentrations of AgNPs of rose and coffee-mediated synthesis with body weight and percentage and weight gain (%)

Oral drench mg/kg/day	Initial body weight (g) (mean± S.E)	Final body weight (g) (mean± S.E)	Weight gain (%) (mean± S.E)	Gain (+) or loss (-)
Ag/ <i>Rosa damascene</i> (n=25)	255.08±0.7	241.6±3.5	34.78± 1.2	+
Ag/ <i>Coffea arabica</i> (n=25)	256.5±0.5	234.3±3.06	38.6± 1.2	+
LSD $P \leq 0.05 = 3.85$				

Weight of organs. The different concentrations of AgNPs of rose and coffee-mediated synthesis that taken up orally impact on the relative weight of liver, kidney, and testes in male rats was shown in Fig. 5(A, B, C). There is a significant increase ($p < 0.05$) for all organs after oral administration with 100, 200, 300, and 400 ppm/day. As a comparison to the control group (see insets in Fig. 5), there is also an increase in the relative weight for all organs after oral administration with 100, 200, 300, and 400 ppm/day as follows: (3.47 ± 0.5 , 3.6 ± 0.5 , 3.7 ± 0.7), (0.35 ± 0.5 , 0.36 ± 0.5 , 0.31 ± 0.7), and (0.65 ± 1.5 , 0.66 ± 2.8 , 0.69 ± 1.6) g/100 gm respectively. The results were tabulated in Table 3.

The effects of oral administration of rose- and coffee-synthesized AgNPs on the relative weights of the liver, kidneys, and testes in male rats are shown in Fig. 5 (A, B, C). A statistically significant increase ($p < 0.05$) in relative organ weights was observed across all organs following oral administration at 100, 200, 300, and 400 ppm/day. Compared to the control group (Fig. 5 insets), relative organ weights increased across doses as follows: liver (3.47 ± 0.5 , 3.6 ± 0.5 , and 3.7 ± 0.7 g/100 g), kidneys (0.35 ± 0.5 , 0.36 ± 0.5 , and 0.31 ± 0.7 g/100 g), and testes (0.65 ± 1.5 , 0.66 ± 2.8 , and 0.69 ± 1.6 g/100 g). Detailed values are tabulated in Table 3.

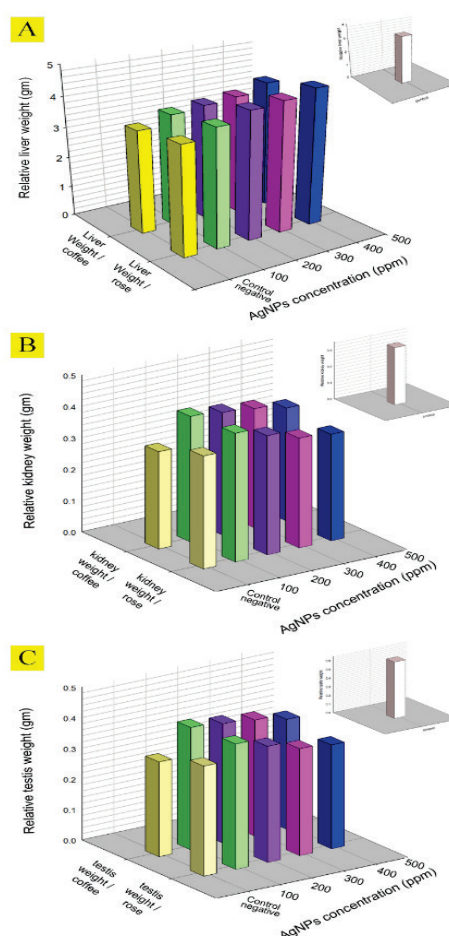


Fig. 5. Effect of daily oral administration of green-synthesized AgNPs on the relative organ weights of male rats compared to the control group: (A) liver, (B) kidneys, and (C) testes.

Table 3. Effect of daily oral administration of various concentrations of rose- and coffee-synthesized AgNPs on relative liver, kidney, and testis weights (g/100g of body weight) in male rats

Oral drench mg/kg/day	Relative organs weight (g/100gm)		
	Liver (mean±S.E)	Kidney (mean±S.E)	Testes (mean±S.E)
Control negative(n=5)	3.47±0.5	0.35±0.5	0.65±1.5
Control positive (<i>Rosa damascena</i>) (n=5)	3.6±0.5	0.36±0.5	0.66±2.8
Control positive (<i>Coffea arabica</i>) (n=5)	3.7±0.7	0.31±0.7	0.69±1.6
Ag/R/1%(n=5)	3.9±0.5	0.41±0.5	0.71±1.5
Ag/R/2%(n=5)	4.2±0.5	0.38±0.5	0.72±1.9
Ag/R/3%(n=5)	4.3±0.3	0.35±0.7	0.73±2.1
Ag/R/4%(n=5)	4.5±0.5	0.34±1.9	0.74±2.2
Ag/C/1%(n=5)	3.7±0.5	0.4±0.5	0.75±1.3
Ag/C/2%(n=5)	3.8±0.3	0.39±0.7	0.8±1.2
Ag/C/3%(n=5)	3.89±0.3	0.37±0.7	0.83±2.6
Ag/C/4%(n=5)	4.16±0.5	0.36±0.5	0.85±1.4
	LSD $p < 0.05 = 0.361$	LSD $p < 0.05 = 0.042$	LSD $p < 0.05 = 0.064$

A comparison of relative organ weights following oral administration of AgNPs synthesized using *Rosa damascena* versus *Coffea arabica* extracts is presented in Table 4.

Table 4. Comparative effects of daily oral administration of rose- and coffee-synthesized AgNPs at various concentrations on relative liver, kidney, and testis weights (g/100g of body weight) in male rats

Oral drench mg/kg/day	Relative organs weight (%)		
	Liver (mean±S.E)	Kidney (mean±S.E)	Testes (mean±S.E)
Ag/ <i>Rosa damascena</i> (n=25)	4.24 ± 0.077	0.37± 0.008	0.70 ± 0.007
Ag/ <i>Coffea arabica</i> (n=25)	3.90 ± 0.071	0.38± 0.005	0.70 ± 0.01
	LSD $p<0.05$ = 0.233	LSD $p<0.05$ = 0.022	LSD $p<0.05$ = 0.034

Body weight. The study results revealed a significant decrease ($p \leq 0.05$) in the final body weight of male rats following daily oral administration of 100, 200, 300 and 400 ppm/day AgNPs compared to their initial body weight. Furthermore, animals treated with rose-synthesized AgNPs exhibited a significantly greater reduction in final body weight than those receiving coffee-synthesized AgNPs. Consequently, oral administration of AgNPs synthesized from both plant sources significantly reduced ($p \leq 0.05$) the percentage of body weight gain relative to the control group. Because changes in body weight reflect the metabolic rate of visceral organs, fat storage, and muscle mass (Alattar & Al-tememe, 2024), dosage-dependent weight fluctuations in rats serve as an indicator of overall biological activity and toxicity, aiding in the selection of the safest green synthesis route for medical applications (Hadi et al., 2025). The data presented in Figs. 1 and 2 and Tables 1 and 2 demonstrate a progressive decline in mean body weight over time across all AgNP-treated groups compared to controls. These findings suggest a potential dose- and plant-dependent relationship governing AgNP toxicity in vivo. Notably, previous research confirmed an increase in serum magnesium levels in animals administered silver nanoparticles that were prepared from coffee using the green method (Hadi, 2025).

Calcium influx across plasma membrane channels and release from intracellular stores are tightly regulated to drive cellular signaling. Following signal transduction, intracellular calcium must be actively extruded or sequestered to prevent intracellular accumulation, which can induce toxic hyperexcitability, calcification, cellular dysfunction, cell death, and secondary metabolic elevation (Hadi et al., 2025). In *Rosa damascena*, specific phenolic compounds and flavonoids enhance mineral absorption (e.g., iron, (Fe) by suppressing intestinal oxidative stress. Additionally, essential minerals like zinc (Zn) and magnesium (Mg) maintain metabolic homeostasis during oxidative stress or inflammation, thereby mitigating fat accumulation and tissue degradation (Rasheed et al., 2023). These mechanisms help explain the distinct biological actions of silver nanoparticles based on their synthesis source (Hamed et al., 2022). Specifically, variations in phytochemical profiles differentially alter circulating levels of Zn, Mg, Ca, K and Fe in animals treated with coffee-synthesized AgNPs compared to rose-synthesized AgNPs (Kant et al., 2023).

Furthermore, AgNPs significantly modulate lipogenesis, thermogenesis, mitochondrial activity, and ATP production in beige adipocytes (Skóra et al., 2023). Beige adipocytes are specialized, inducible thermogenic fat cells interspersed within white adipose tissue (WAT). Upon exposure to cold or sympathetic stimulation, these cells upregulate uncoupling protein 1 (UCP1) and accumulate multilocular lipid droplets and dense mitochondria (Akl et al., 2025). Activating beige fat – a process termed “browning” – increases energy expenditure, making it a key therapeutic target for obesity and metabolic disorders (Hadi & Abood, 2022). In diet-induced obesity rat models, subcutaneous administration of AgNPs to regions enriched with beige fat induced metabolic disruptions, including altered energy expenditure dependent on fat mass and impaired glucose/lipid homeostasis (Hadi & Abood, 2023). Although previous studies demonstrated that a 13-week oral administration of low-dose AgNPs (mg/kg) produced no overt toxicity in

rats, detailed metabolic parameters were not thoroughly evaluated (Staszak et al., 2022). The dosage evaluated in our study (400 ppm) exceeds the threshold previously reported as safe by Akl et al. (2025).

Weight of organs. This study demonstrated a statistically significant increase ($p < 0.05$) in the relative weights of the liver, kidneys, and testes following 30 days of daily oral administration of rose- and coffee-synthesized AgNPs (100, 200, 300, and 400 ppm/day) compared to the control group. This finding aligns with Akl et al. (2025), who observed that the predominant effect of AgNP compounds on male rat livers was dose-dependent, reversible hepatomegaly. Hepatomegaly in rodents is frequently accompanied by an elevated total hepatic DNA content – indicative of cellular hyperplasia – leading to a marked increase in organ mass (Skóra et al., 2023).

Biogenic green synthesis noticeably mitigates the intrinsic toxicity of silver nanoparticles. A primary mechanism driving nanosilver cytotoxicity is oxidative stress resulting from lipid peroxidation, which triggers cell death via apoptosis or necrosis when ROS generation overwhelms cellular antioxidant defenses. AgNPs induce dose-dependent oxidative injury, as evidenced by elevated hepatic malondialdehyde (MDA) levels and depleted glutathione (GSH) reserves. Although oxidative stress plays a central role in this pathological cascade, phytochemicals present in plant extracts offer substantial antioxidant protection, which helps counter severe cellular injury during organ enlargement (Luaibi & Qassim, 2018).

Conclusion

The findings indicate that green-synthesized AgNPs using *Coffea arabica* and *Rosa damascena* extracts caused concentration-dependent changes in body and relative organ weights, with higher concentrations (300 and 400 ppm) leading to increases in relative organ weights. However, no mortality or severe clinical signs were observed during the 30-day treatment, indicating a stable clinical profile under the experimental conditions.

ბიოფიზიკა

ორი მცენარისგან მიღებული მწვანე ვერცხლის ნანონაწილაკების გავლენა ალბინოსი ვირთაგვების სხეულის წონაზე

ვურუდ ჰასან ჰადი*, სალუჰ ჰ. აბუდი**, ალი ჰასან აბუდი*

* ქუფის უნივერსიტეტი, საბუნებისმეტყველო მეცნიერებათა ფაკულტეტი, ბიოლოგიის დეპარტამენტი, კუფა, ერაყი

** ალ-ქაფილის უნივერსიტეტი, სამედიცინო და ჯანდაცვის ტექნოლოგიების კოლეჯი, რადიოლოგიური ტექნოლოგიების დეპარტამენტი, ერაყი

(წარმოდგენილია აკადემიის წევრის რამაზ ხეცურიანის მიერ)

წარმოდგენილ კვლევაში შეფასდა მწვანე სინთეზით მიღებული ვერცხლის ნანონაწილაკების (AgNPs) კლინიკური რეაქცია და გავლენა სხეულის მასასა და წონის მატებაზე. AgNP-ები მიღებულ იქნა *Coffea arabica*-ს თესლებისა და *Rosa damascena*-ს ექსტრაქტების გამოყენებით. 100, 200, 300 და 400 ppm/დღეში დოზები გამოიყენებოდა 30 დღის განმავლობაში. UV-Vis სპექტრებმა დაადასტურა AgNP-ების წარმოქმნა, რომელთა მახასიათებლები განსხვავდებოდა გამოყენებული ექსტრაქტისა და მისი კონცენტრაციის მიხედვით. მაღალი დოზების (300 და 400 ppm) გამოყენებისას აღინიშნა სასიცოცხლო ორგანოების ფარდობითი მასის ზრდა. ექსპერიმენტის პერიოდში ლეტალური ეფექტები არ დაფიქსირებულა, ხოლო ყოველდღიურმა მონიტორინგმა აჩვენა სტაბილური კლინიკური რეაქცია.

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