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# Using Some Plants to Alleviate the Side Effects of Fibromyalgia Caused by the Drug Reserpine in Rats

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## ABSTRACT

The present study aimed to investigate the nutritional value of red radish roots, red cabbage leaves, and turnip roots and their therapeutic effect in alleviating some side effects in rats with fibromyalgia. Chemical composition, mineral, and vitamin contents were determined. The biological experiment proceeded on forty rats divided into eight groups (5 rats each), the first group was fed a basal diet only, and the remaining seven groups were injected with reserpine to induce fibromyalgia; one of them continued feeding on the basal diet (positive control). Three injured groups received the powder of red radish roots, red cabbage leaves, and turnip roots in the diet, while the other three groups received their ethanolic extracts orally. At the end of the experiment, blood samples were collected for analysis. The results revealed that the treated groups with red radish roots, red cabbage leaves, and turnip root extracts revealed significant decreases in their blood TC, TG, and LDL-c levels as well as ALT and AST levels and an increase in serum HDL-c and albumin levels significantly compared to the positive control. Significant reduction in serum creatinine, urea, and blood sugar levels was observed in the treated groups compared to the positive control group. However, the ethanolic extract of red radish roots, red cabbage leaves, and turnip roots was more effective than the powder in reducing the side effects of reserpine-induced fibromyalgia in rats. Thus, these plants are recommended for patients with fibromyalgia.

***Keywords:*** Fibromyalgia, Reserpine, Red radish roots, Red cabbage leaves, Turnip roots, Rats.

## INTRODUCTION

Fibromyalgia (FM) is a chronic pain condition that is complicated and frequently misinterpreted. Widespread physical discomfort, exhaustion, and increased sensitivity are its hallmarks, and over time, diagnostic standards and knowledge have changed. After first being viewed with suspicion, fibromyalgia is today acknowledged as a worldwide health issue that impacts millions of individuals and has a prevalence that cuts across demographic lines. Sleep disruptions and cognitive difficulties are among the symptoms that go beyond pain and are included in the clinical features and diagnosis of fibromyalgia (Al sharie *et al*., 2024). The symptoms of FM include fatigue, morning stiffness, decreased sleep quality, psychological problems like anxiety and sadness, and widespread persistent muscle pain of unexplained cause. The most significant and defining symptom of FM is persistent, all-encompassing musculoskeletal pain. Although pain and other symptoms are constant, they vary in intensity throughout the day and from day to day (Yentur and El basti, 2024).

Fibromyalgia is more common in women compared to men, having a prevalence of 2.9% to 4.7% in the general population. FM are not completely understood, the diagnosis is based on the clinical criteria described by the American College of Rheumatology and revised in 2016, including 2 items: Widespread Pain Index (WPI), and Symptoms (Tarsitano *et al*., 2024). A complex illness known as fibromyalgia is characterized by chronic pain, joint stiffness, exhaustion, disturbed sleep, cerebral dysfunction, and depression. Infections, diabetes, rheumatic diseases, mental or neurological disorders, and other particular ailments can also be linked to FM. FM is a condition of central sensitivity.

Reserpine is an indole alkaloid obtained from the roots of the plant *Rauwolfia serpentina* that belongs to the Rauwolfia alkaloids class and is used as an alternative medication to treat and manage hypertension, or elevated blood pressure, certain neuropsychiatric disorders, circulatory disease, anxiety condition, as a sedative and stimulates the central of peripheral nervous system by inhibiting adrenergic absorption (Salimikia and Heidari, 2023). Reserpine can change the amount of serotonin in the small intestine, and there is a link between this effect and the observable reduction of mental disorders. Reserpine is a highly effective medication that depletes biogenic amines (Hedgecock *et al*., 2019). Reserpine releases norepinephrine, dopamine, and serotonin from tissue stores. Nerve cells use these chemicals to communicate with each other, which is known as Neurotransmitters One of the first few naturally occurring substances to have been used in clinical settings was reserpine, which was frequently used to treat hypertension and mental illnesses (Khan, 2022).

Brassica plants including turnips, cabbage, broccoli, and cauliflower are abundant in glucosinolate compounds (GSLs), which are sulfur-containing chemicals. These substances play a part in plant defense against pests and diseases and are water-soluble. One of the substances that contribute to the taste qualities of brassica vegetables is GSLs. The bitter taste has been linked to specific GSLs, including sinigrin, gluconaptin, progoitrin, and neoglucobrassicin (Nor *et al*., 2020). The bitterness and cancer-fighting properties of cruciferous vegetables result from the breakdown products of glucosinolates. Numerous organic acids and phytochemicals as phenolic and malic acids, which have strong antioxidant properties, in addition to several aromatic compounds, which strengthen the immune system in humans, are

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also known to be present in the Brassica family (Haliloglu *et al*., 2012). The supplementing with Brassica had a positive effect on the blood lipid profile, resulting in a considerable reduction in oxidized LDL, total cholesterol, and LDL-cholesterol (Bacchetti *et al., 2*014).

Radish has many vitamins, amino acids, fiber, antioxidants, and minerals as phosphorus, calcium, iron, zinc, manganese, magnesium and copper. Vegetables are vital for enhancing general health and preventing sickness in humans (Khattak, 2011). Radish is regarded as a significant vegetable with promise for both domestic and foreign markets because of its saponin, flavonoid, polyphenol, glycoside, essential oils, vitamin A, and vitamin C content, Also it has the potential to be antibacterial, anti-inflammatory, and antioxidant (Eveline and pasau, 2019). Also, Banihani (2017) found that Radish root seems to be highly advantageous in diabetic circumstances and may have antidiabetic properties. These anti-diabetic effects may result from its ability to strengthen the antioxidant defense system, reduce oxidative stress and lipid peroxidation, enhance hormonally driven glucose homeostasis, promote glucose uptake and energy utilization, and decrease intestinal glucose absorption.

Purple cabbage (Brassica oleracea L.) is one of the most significant vegetables produced worldwide. It is known for its high levels of beneficial compounds, including total phenolic content (TPC), total flavonoid content (TFC), and total anthocyanin content (TAC) with values of 10.57 mg GAE/g, 7.01 mg RE/g, and 6.54 C-3-G mg E/g, respectively (Yue *et al*., 2021). Fresh cabbage contains glucosinolates, polyphenols, carotenoids, and vitamins, among other antioxidants. All of them shield the human body from free radicals and lower the chance of developing many chronic illnesses (Hallmann *et al*., 2017). Ascorbic acid, isothiocyanates, hydroxycinnamic residues, B. carotenes, and flavonoids are a few of the health-promoting substances that are abundant in cabbage (Ashfaq *et al*., 2019). Several research has established the positive effects of anthocyanins on health, including their antioxidant, anticancer, antiulcer, antitumor, antimutagenic, cardioprotective, vision-improving, anti-diabetic, anti-neurodegenerative, anti-bacterial, and ophthalmic properties. Red cabbage's purple color is a result of anthocyanin pigments (Demirbas, 2016). Yossef *et al*. (2012) stated that red cabbage treated the diabetes mellitus symptoms. Additionally, diabetic rats' liver and kidney function was enhanced by dried red cabbage.

Turnip roots are a valuable vegetable crop with many culinary and nutritional applications. They are an excellent source of potassium, vitamin C, and vitamin K, among other vitamins and minerals. They are also high in fibre and low in calories. In addition, turnips are known to have anti-inflammatory, anti-cancer, and anti-oxidant qualities. They also aid in preserving normal blood pressure (Sheikh *et al*., 2018; Kumar *et al.*, 2023). Turnips are used as a traditional remedy for gonorrhoea, syphilis, rheumatism, chest problems, headaches, and modems (Paul *et al.,* 20l8). Studies on the bioactivity of turnip have shown that it has nephroprotective, anticancer, antimicrobial, anti-hypoxia, and anti-diabetic properties (Gao *et al.*, 2021). This work aimed to evaluate the importance of three plants; red radish roots, red cabbage leaves and turnip roots which are rich in phytochemicals to alleviate the symptoms of fibromyalgia syndrome in experimental rats.

## MATERIALS AND METHODS

**Materials**

**Plants:** Fresh red radish (*Raphanus Raphanistrum Subsp Sativus L)*, red cabbage (*Brassica oleracea var. capitata*) and turnip (*Brassica rapa subsp subsp rapa*) were purchased from a local market in Mansoura city, Egypt.

**Chemicals:**

All chemicals and kits were purchased from Al Gomhorya Company for trading pharmaceuticals, chemicals, and medical equipment.

**Reserpine**:

Reserpine (methyl ester 2$\alpha$,11-dimethoxy-3-(3,4,5-trimethoxybenzoyloxy)-yohimban-1-carboxylic acid) was obtained from Sigma Aldrich Chemical Company, Cairo, Egypt.

**Experimental animals:**

Forty healthy adult Albino male rats weighing 145 ± 10 g of Sprague–Dawley strain were purchased from the Agricultural Research Center, Giza, Egypt.

**Ethics approval:** The protocol of this study was approved by the research ethics committee of the Faculty of Specific Education, Mansoura University (No N34 -2022)

**The basal diet:** The basal diet was prepared according to the Nutrient Requirements of Laboratory Animals of the National Research Centre (NRC, 1995)

**Methods:**

**Preparation of red radish, red cabbage and turnip powders:**

The fresh radish roots, red cabbage leaves, and turnip roots were cleaned, washed, and sliced into thin pieces about 1-2 mm thick. They were dried in an electric oven at 60° C until reaching a constant weight, then carefully crushed in a Braun blender to produce the powder.

**Preparation of red radish, red cabbage and turnip extracts:**

One hundred grams of each powder was soaked in 1 L ethanol and mixed well, then left overnight and filtered. The filtrate was kept in a dark bottle. Another portion of ethanol was added to the residue, shaken well, left overnight and filtered. The filtrate was added to the previous filtrate. The residue was re-soaked in ethanol overnight and filtered. All the filtrates were collected and the solvent was removed using a rotary evaporator to obtain the extract which was dried in a desiccator to reach a constant weight. The extract was kept in dark bottles in the refrigerator until use (Elbadrawy and Mostafa, 2024).

**Chemical analysis of the investigated plants:**

Moisture, protein, fat, and ash contents were determined according to the methods of AOAC (2000). Total carbohydrate**s** were calculated by difference.

**Minerals**:

Minerals were assessed using an inductivity-coupled plasma apparatus (iCAPTM 7000 Plus Series ICP-OES, Thermo Scientific TM), as mentioned by Khan *et al*. (2014).

**Vitamins, A (retinol), E, D and k:**

were determined using HPLC (Aglient 1100) as described by Gomis *et al*. (2000).

**Biological experiment:**

**Reserpine-induced fibromyalgia:**

One ml of the reserpine solution dissolved in 0.5 % glacial acetic acid was injected into the rats subcutaneously

(in a dose of 1 mg/kg body weight) once a day for three consecutive days (Nagakura *et al*., 2009).

**Experimental design:**

Forty rats were acclimatized for seven days, feeding basal diet and drinking water ad libitum at a constant temperature (25º C) and a 12-hour dark-light cycle. After that, the rats were divided into eight groups, each consisting of five rats. One group remained on the basal diet throughout the 21-day experiment and served as the normal control (Group 1). The remaining groups were injected with a reserpine solution (1 mg/kg body weight) to induce fibromyalgia. One of the injured groups continued on the basal diet until the end of the experiment and served as the positive control (Group 2). The other injured groups received daily treatments that included a powder mixed into their diet and an ethanolic extract administered orally from the three different samples as follows:

**Group 3 (Red radish extract):** The rats received red radish extract daily at a dose of 150 mg/kg b.wt. orally through a stomach tube.

**Group 4 (Red radish powder):** The rats were fed a diet containing 10% red radish powder.

**Group 5 (Red Cabbage extract):** The rats received red cabbage extract daily at a dose of 150 mg/kg b.wt. orally through a stomach tube.

**Group 6 (Red cabbage powder):** The rats were fed a diet containing 10% red cabbage powder.

**Group 7 (Turnip extract):** The rats received turnip extract daily at a dose of 150 mg/kg b.wt. orally through a stomach tube.

**Group 8 (Turnip powder):**The rats were fed a diet containing 10% turnip powder.

**Biochemical analysis of serum:**

**Lipid profile:**

Total cholesterol, Triglycerides, and HDL-c were determined according to Allain *et al*. (1974); Fasssati and Prencipe (1982) and Lopes *et al*. (1977), respectively.

LDL-c and VLDL-c were calculated according to Friedewald *et al*. (1972) as follows:

$$\text{VLDL-c} = \frac{TG}{5}$$

$$\text{LDL-c} = \text{Total cholesterol} - (\text{HDL-c} + \text{VLDL-c})$$

**Liver function tests**

Serum alanine aminotransferase (ALT), and aspartate aminotransferase (AST) were measured according to the method of Whitakar (1969).

Serum albumin was determined colorimetrically using the method described by Doumas *et al*. (1971).

**Kidney function tests:**

Serum creatinine was determined as described by Young (2001).

Serum urea was determined according to Orsonneau *et al*. (1992)

Enzymatic determination of plasma sugar was carried out colorimetrically according to the method of Tinder (1969)

**Statistical analysis**

The collected data were presented as mean± SD. The statistical analyses were performed using one-way analysis of variance (ANOVA). The means between groups were compared using (LSD) at $P \leq 0.05$ using the computer program according to Gomez and Gomez (1984).

## RESULTS AND DISCUSSION

**Chemical analyses of the powders of red radish roots, red cabbage leaves and turnip roots.**

**Proximate chemical composition**

The data presented in Table (1) show the proximate chemical composition of the powder of red radish roots, red cabbage leaves and turnip roots.

It can be noticed that the roots of red radish powder contain moisture, ash, fat, protein and carbohydrates with values of 18.15 ±0.06, 13.22 ±0.07, 1.93 ±0.04, 26.02 ±0.20 and 40.69±0.36%, while the leaves of red cabbage powder contain 15.66±0.15, 6.11±0.08, 1.89±0.07, 22.28±0.14 and 54.07±0.20 %, respectively. On the other hand, the roots of turnip powder contain 13.61±0.18, 8.89±0.06, 1.89±0.06, 21.01±0.15 and 54.60±0.33%, respectively.

These results revealed that red radish roots are a good source of protein followed by red cabbage leaves and turnip roots. While turnip roots are rich in carbohydrates followed by red radish roots and red cabbage leaves.

Muratkhan *et al*. (2022) mentioned that a 65g serving of fresh raw turnips contains 18 kcal of energy, 92% of it is water, 1g of dietary fiber, 4g of carbohydrates, 1g of protein, 20mg of calcium, 124mg of potassium, 7mg of magnesium, 18mg of phosphorus, and 14mg of vitamin C, 0.1 mg of vitamin B6, and 9 mg of Folate.

However, Goyeneche *et al.* (2015) reported that the fresh red radish roots contained 95.24±0.29 g/100g, 0.57±0.09 g/100g, 0.07±0.01 g/100g, 0.77 ±0.07 g/100g and 3.03 g/100g for moisture, crude protein, lipid content, ash and carbohydrates, respectively. The moisture content of fresh red cabbage was 90.31±0.276% and 1.18 ±0.007%, 0.19 ±0.007 % and 1.52±0.028 % for ash, lipid and crude protein, respectively (Adelanwa and Medugu, 2015).

**Table 1. Chemical composition of the powders of red radish roots, red cabbage leaves and turnip roots:**

| Samples | Moisture % | Ash % | Fat % | Protein % | Carbohydrates% |
|---|---|---|---|---|---|
| Red radish | 18.15$^{a}$±0.06 | 13.22$^{a}$±0.07 | 1.93$^{a}$±0.04 | 26.02$^{a}$±0.20 | 40.69$^{c}$±0.36 |
| Red cabbage | 15.66$^{b}$±0.15 | 6.11$^{c}$±0.08 | 1.89$^{a}$±0.07 | 22.28$^{b}$±0.14 | 54.07$^{b}$±0.20 |
| Turnip | 13.61$^{c}$±0.18 | 8.89$^{b}$±0.06 | 1.89$^{a}$±0.06 | 21.01$^{c}$±0.15 | 54.60$^{a}$±0.33 |

**Each value is the mean of three replicates ± SD**

**Minerals content of red radish roots, red cabbage leaves and turnip roots:**

Minerals content, including calcium (Ca), selenium (Se), magnesium (Mg), zinc (Zn), Sodium (Na), Manganese (Mn), Iron (Fe), and Potassium (K), were determined in the powders of red radish roots, red cabbage leaves and turnip roots. The obtained results are presented in Table (2). Their values in red radish roots were 6310.55±5.20 (Ca), 13.97±0.43 (Se), 2541.43±3.19 (Mg), 66.65±1.11 (Zn), 7536.08±3.46 (Na), 20.66±0.34 (Mn), 447.24±1.12 (Fe), and 47443.67±8.56 (K) in mg\kg. Their values in red cabbage leaves were 5017.12±4.52, 8.09±0.25, 1776.17±3.52, 64.61±11.40, 2090.01±3.20, 27.04±0.31, 122.23±1.09, and 24217.39±9.26 mg/kg, respectively. While their values in turnip roots were 5465.86±2.79, 7.11±0.30, 1810.52±3.13, 43.89±1.88, 6497.32±3.18, 9.06±0.39, 163.16±1.02, and 30783.13±8.63 mg/kg, respectively. The values showed that the three samples

contain high amounts of potassium followed by sodium in red radish and turnip and Ca in red cabbage.

Red radish contains calcium, iron, magnesium, zinc, phosphorous, sodium and potassium with values of 25.0, 0.34, 10.0, 0.28, 20.0, 39.0 and 233 mg/100g wet weight (USDA, 2020). Radishes contain significant concentrations of minerals such as calcium, potassium, magnesium, copper, and iron (Dhahir and Al-Naely, 2022).

Goyeneche *et al.* (2015) stated that red radish roots had minerals such as Fe, Mn, Zn, Ca, Mg, Na and K with values 0.15±0.01 mg/100g, 0.07±0.01 mg/100g, 0.24±0.00 mg/100g, 147.87±1.31 mg/100g, 14.89±0.02 mg/100g, 104.95±0.18 mg/100g and 380.11±0.87 mg/100g, respectively. Red cabbage contained minerals as Ca, Mg, Na, Fe, Zn and Mn with values 20.56±1.11 mg/100g, 20.61±0.99 mg/100g, 12.33±0.55 mg/100g, 1.11±0.04 mg/100g, 0.29±0.01 mg/100g and 0.18±0.01 mg/100g, respectively (Ashfaq *et al.*, 2018). While turnip contained 50 mg/100g Ca, 50 mg/100g Fe, 8 mg/100g Mg and 18 mg/100g Na (Javed *et al*., 2019).

Some research has identified a significant correlation between calcium scores, age, and lipid profile parameters, including cholesterol, LDL, HDL, and triglycerides (TG). Therefore, calcium scoring can serve as a valuable tool for identifying individuals at high risk of developing cardiovascular disease (Nammour *et al*., 2023). In addition to lowering serum cholesterol, triglyceride, FFA, and hepatic enzyme levels, calcium supplementation markedly improved anthropometric measures. Supplementing with calcium dramatically reduced oxidative stress, hepatic fat accumulation, PPAR-g-mediated FAS activity, and antioxidant enzyme activity, further preventing the pro-inflammatory response from being stimulated (Das and Choudhuri, 2020).

**Table 2. Minerals content of the powders of red radish roots, red cabbage leaves and turnip roots (mg/kg):**

| Samples | Ca | Se | Mg | Zn | Na | Mn | Fe | K |
|---|---|---|---|---|---|---|---|---|
| Red radish | 6310.55$^{a}$±5.20 | 13.97$^{a}$±0.43 | 2541.43$^{a}$±3.19 | 66.65$^{a}$±1.11 | 7536.08$^{a}$±3.46 | 20.66$^{b}$±0.34 | 447.24$^{a}$±1.12 | 47443.67$^{a}$±8.56 |
| Red cabbage | 5017.12$^{c}$±4.52 | 8.09$^{b}$±0.25 | 1776.17$^{c}$±3.52 | 64.61$^{b}$±11.40 | 2090.01±3.20 | 27.04$^{a}$±0.31 | 122.23$^{c}$±1.09 | 24217.39$^{c}$±9.26 |
| Turnip | 5465.86$^{b}$±2.79 | 7.11$^{c}$±0.30 | 1810.52$^{b}$±3.13 | 43.89$^{c}$±1.88 | 6497.32$^{b}$±3.18 | 9.06±0.39 | 163.16$^{b}$±1.02 | 30783.13$^{b}$±8.63 |

**Each value is the mean of three replicates ± SD**

**Vitamin content of the powders of red radish roots, red cabbage leaves and turnip roots:**

Vitamin A (retinol), Vit. D, Vit. K and Vit. E (tocopherols) content of the powders of red radish roots, red cabbage leaves and turnip roots were determined and recorded in Table 3.

It was noticed that red radish roots have 10.55±0.35 mg/100 g tocopherols, 2.14±0.15 mg/100g vitamin D, 4.10±0.22 mg/100g vitamin K and 1.19±0.13 mg/100g retinol. While, red cabbage leaves recorded 6.20±0.33 mg/100g for tocopherols, 7.11±0.21 mg/100 g for Vit.D, 5.41±0.23 mg/100g for Vit. K and 10.45±0.22 mg/100 g for retinol. Turnip roots recorded 10.63±0.29 mg/100 g for Tocopherols, 1.26±0.16 mg/100 g for Vit.D, 11.78±0.24 mg/100g for Vit. K and 8.46±0.25 mg/100 g for retinol. The red radish and turnip have high levels of tocopherols while red cabbage has high levels of vitamin D and retinol. The results also showed that the turnip roots are rich in Vitamin K and retinol.

Vitamin D is necessary for healthy bones. It is necessary to provide strong bones by controlling the flow of calcium and phosphorus into and out of the skeleton and absorbing them into the body. Rickets and other bone abnormalities can result from a vitamin D deficiency (Cowbrough, 2015).

Vitamin A is a vital vitamin that humans need in trace levels for a variety of metabolic processes throughout their lives. It is essential for healthy growth and development, immune system maintenance, epithelial cell integrity, proper vision, reproduction, and fat metabolism. Vitamin A is also an important antioxidant (WHO/FAO, 2004).

Both vitamin K1 (phylloquinone, PK) and vitamin K2 (menaquinones, MKs) are naturally occurring forms of vitamin K, an essential fat-soluble vitamin. Because it is essential for the liver's synthesis of blood-clotting proteins, vitamin K is required for blood clotting. Vitamin K insufficiency seldom happens. However, getting enough vitamin K might be challenging for some populations, such as the elderly and those with intestinal absorption deficiency.

**Table 3. Vitamin content of the powders of red radish roots, red cabbage leaves and turnip roots (mg/100g):**

| Samples | Tocopherols | Vit.D | Vit.K | Retinol |
|---|---|---|---|---|
| Red radish | 10.55±0.35 | 2.14±0.15 | 4.10±0.22 | 1.19±0.13 |
| Red cabbage | 6.20±0.33 | 7.11±0.21 | 5.41±0.23 | 10.45±0.22 |
| Turnip | 10.63±0.29 | 1.26±0.16 | 11.78±0.24 | 8.46±0.25 |

**Each value is the mean of three replicates ± SD**

**Biological assay**

**Effect of red radish roots, red cabbage leaves and turnip roots on lipid profile in rats with fibromyalgia**

The results in Table (4) indicate significant increases in total cholesterol (TC), triglycerides (TG), and low-density lipoprotein cholesterol (LDL-c), while the level of high-density lipoprotein cholesterol (HDL-c) decreased significantly in the reserpine control group (positive control) compared to the normal control group.

The treated groups with red radish roots, red cabbage leaves and turnip roots powders and extracts revealed significant decreases in serum TC, TG, LDL-c and VLDL-c levels and non-significant effects in serum HDL-c compared to the positive control. However, the red radish root powder and extract was the best among the treated groups followed by red cabbage leaves and finally turnip roots in improving lipid profile in rats with fibromyalgia. The effects of these plants can be attributed to their content of phytochemicals, including phenolic compounds and flavonoids, as well as their fiber content. Additionally, they are rich in antioxidants like vitamins A, C, and E, along with essential minerals such as zinc (Zn), selenium (Se), and manganese (Mn). In addition to phytosterol, *Raphanus sativus* includes important fatty acids such as oleic, linoleic, and γ-linolenic acids that contribute to hypolipidemic action. Because polyunsaturated fatty acids have been shown to facilitate lipid transportation and metabolism, *Raphanus sativus* decreased blood lipid profiles, which leads to a low risk of cardiovascular disease (Abdel hamed and Bashandy, 2022).

Red radish improves dieresis, controls bile production, activates enzymes, lowers high blood pressure and cholesterol, lessens hyperglycemia and sexual dysfunction, moisturizes and softens skin, strengthens and increases bone density, drives out intestinal worms, and enhances general health (El-Beltagi *et al.*, 2022). The dried red radish roots significantly decreased blood and urine glucose levels, lipid profile, hepatic lipid and atherogenic. Red radish roots are a source of anti-oxidant compounds that have a hypoglycemic effect, improve lipid metabolism and prevent cardiovascular diseases. The antioxidant activity of red radish roots was accompanied by a good concentration of bioactive substances such as flavonoids, anthocyanins and phenolic compounds (Khedr and El sheikh, 2016). Red radish root extract contains phenolic compounds such as ferulic, sinapic, catechin, and coumaric acids, which play an important role as hypoglycemic and hypocholesterolemic agents (Abdel Magied *et al*., 2008).

Red cabbage has been shown to contain a higher concentration of phenolic and flavonoid compounds in its aqueous extract, with anthocyanins being the primary pigments that are present in significant amounts. The antioxidants found in red cabbage have a distinct impact on the lipid profile in the blood. Specifically, anthocyanins can increase HDL (high-density lipoprotein) levels while reducing LDL (low-density lipoprotein) levels by inhibiting cholesteryl ester transfer protein and enhancing reverse cholesterol transport activity (Andari *et al*., 2023).

Turnips have a high concentration of glucosinolates, isothiocyanates, and phenolic compounds, which have a variety of biological actions, including anti-oxidant, anti-tumour, anti-diabetic, anti-inflammatory, antimicrobial, hypolipidemic, cardioprotective, hepatoprotective, nephroprotective, and analgesic qualities (Paul *et al*., 2019).

**Table 4. Effect of red radish roots, red cabbage leaves and turnip roots on lipid profile in rats with fibromyalgia:**

| Groups | TC (mg/dl) | TG (mg/dl) | HDL (mg/dl) | LDL-c (mg/dl) | VLDL-c (mg/dl) |
|---|---|---|---|---|---|
| G1: Normal control (-ve) | $61.33^{d}$±6.51 | $64.33^{f}$±7.57 | $46.33^{ab}$±3.21 | $2.13^{e}$±3.75 | $12.87^{f}$±1.51 |
| G2: Positive control (+ve) | $123.33^{a}$±4.73 | $128.67^{a}$±6.51 | $41.67^{b}$±4.73 | $55.93^{a}$±3.56 | $25.73^{a}$±1.30 |
| G3: Red radish Ex | $71.00^{cd}$±6.56 | $77.67^{e}$±5.69 | $47.33^{ab}$±4.51 | $8.13^{de}$±2.30 | $15.53^{e}$±1.14 |
| G4: Red radish Po | $68.00^{cd}$±6.56 | $76.33^{ef}$±6.51 | $48.67^{ab}$±5.86 | $4.07^{de}$±2.55 | $15.27^{ef}$±1.30 |
| G5: Red cabbage Ex | $79.00^{c}$±9.17 | $86.00^{de}$±7.21 | $51.33^{a}$±3.21 | $10.47^{d}$±5.02 | $17.20^{de}$±1.44 |
| G6: Red cabbage Po | 100.33±9.07 | $103.33^{bc}$±7.77 | $49.67^{ab}$±6.03 | $30.00^{c}$±1.97 | $20.67^{bc}$±1.55 |
| G7: Turnip Ex | $95.33^{b}$±7.02 | $96.67^{cd}$±6.51 | $51.67^{a}$±4.04 | $24.33^{c}$±2.30 | $19.33^{cd}$±1.30 |
| G8: Turnip Po | $105.67^{b}$±9.50 | $114.00^{b}$±6.00 | $46.00^{ab}$±3.00 | $36.87^{b}$±5.95 | $22.80^{b}$±1.20 |
| LSD at 0.05 | 13.83 | 12.54 | 8.16 | 6.69 | 2.50 |

**Each value is the mean ±SD**

**Mean values in each column with different superscript letters are significantly different at P<0.05.**

**G = group, Po = powder & Ex = extract.**

**Effect of red radish roots, red cabbage leaves and turnip roots on liver function in rats with fibromyalgia**

Table (5) shows the effects of extracts and powders from red radish roots, red cabbage leaves, and turnip roots on liver function parameters in rats with fibromyalgia.

The serum levels of ALT and AST increased significantly in the positive control group with values of 263.67±23.01U/L and 55.33±5.86 U/L, respectively compared to the normal control while serum level of albumin decreased significantly (3.23±0.17 g/dl) compared to the normal control group (4.71±0.17 g/dl).

The results revealed that the rats with fibromyalgia treated with the extracts and powders of red radish roots, red cabbage leaves and turnip roots showed significant decreases in ALT and AST enzymes and an increase in serum albumin levels compared to the positive control group. However, the extracts were more effective than the powder in this respect. The reduction percentage in serum ALT level was 48.8, 45.8, and 34.9% for the extracts of red cabbage, red radish and turnip, respectively. On the other hand, the reduction percentages in serum AST with the same sequence of extracts were 57.3, 54.1, and 42%, while the increase percentages in serum albumin levels were 41.8, 37.1, and 31.3%, respectively, compared to the positive control.

The results revealed that the groups that were fed the powder of red cabbage, red radish, and turnip had a reduction percentage in their serum ALT level of 22.9, 20.5, and 18.07%, while the reduction percentage in their serum AST level was 29.8, 27.8, and 24.02%, respectively. In contrast, their serum albumin levels increased by 20.4, 17.02, and 14.24%, respectively, compared to the positive control.

Radish roots contain various chemical compounds, including coumarins, phenols glucosinolates and antioxidants which act as hepatoprotective, platelet aggregation and immunity boosters and can be used in households for the improvement of chronic diseases (Noreen *et al*., 2023). Red radish contains several natural compounds that have antioxidant potent such as phenolic compounds (ferulic, sinapic, catechin, caffeic, gallic, syringic, rutin and gentistic acid) and pigments that might lower oxidative stress and hepatic protective (Sadeek *et al*, 2018). Radishes may help with the decline in enzyme levels that indicate liver damage (Shelke *et al.*, 2023).

Red cabbage (*Brassica oleracea* L) extract reverses lipid oxidative stress in rats. It has been connected to a lower risk of developing chronic illnesses, such as heart problems. They provided evidence about the usage of red cabbage not only as a hypolipidemic agent but also as an organ protector against oxidative damage, mainly the brain (Veber *et al.*, 2020). It contains glutathione which has been shown to have many health benefits, including antioxidant activity. LPVs contain essential pigments including carotenoids, anthocyanins and phenolic compounds that can function as natural antioxidants (Al–Temimi *et al*., 2023). Turnips have a beneficial effect on the liver damage brought on by diabetes, have significant antioxidant activity, and play a hepatoprotective role (Javed *et al*., 2019; Daryoush *et al.*, 2011). The treatment with a 5% mixture of powdered turnip roots and leaves enhanced the lipid profile (HDL) and liver function in hypercholesterolemic rats (Sobh and Shalan, 2022).

**Table 5. Effect of red radish roots, red cabbage leaves and turnip roots on liver function in rats with fibromyalgia:**

| Groups | ALT (U/L) | | AST (U/L) | | Albumin (g/dl) | |
|---|---|---|---|---|---|---|
| | Mean±SD | Decrease % * | Mean±SD | Decrease % * | Mean±SD | Increase % * |
| G1: Normal control (-ve) | $23.00^{e}$±3.61 | | $92.67^{e}$±20.74 | | $4.71^{a}$±0.17 | |
| G2: Positive control (+ve) | $55.33^{a}$±5.86 | | $263.67^{a}$±23.01 | | $3.23^{e}$±0.172 | |
| G3: Red radish EX | $30.00^{de}$±5.57 | 45.8 | $121.00^{de}$±22.61 | 54.1 | $4.43^{ab}$±0.183 | 37.1 |
| G4: Red radish Po | $44.00^{bc}$±4.58 | 20.5 | $190.33^{bc}$±19.04 | 27.8 | $3.78^{d}$±0.250 | 17.02 |
| G5: Red cabbage Ex | $28.33^{de}$±6.03 | 48.8 | $112.67^{e}$±22.25 | 57.3 | $4.58^{ab}$±0.170 | 41.8 |
| G6: Red cabbage Po | $42.67^{bc}$±5.51 | 22.9 | $185.00^{bc}$±17.52 | 29.8 | $3.89^{cd}$±0.271 | 20.4 |
| G7: Turnip Ex | $36.00^{cd}$±5.57 | 34.9 | $153.00^{cd}$±22.87 | 42 | $4.24^{bc}$±0.260 | 31.3 |
| G8: Turnip Po | $45.33^{b}$±4.04 | 18.07 | $200.33^{b}$±21.83 | 24.02 | $3.69^{d}$±0.215 | 14.24 |
| LSD at 0.05 | 9.25 | | 38.40 | | 0.39 | |

**Each value is the mean ±SD**
**Mean values in each column with different superscript letters are significantly different at P<0.05.**
*** Change % is related to the positive control.**
**G = group, Po = powder & Ex = extract.**

### Effect of red radish roots, red cabbage leaves and turnip roots on kidney function tests in rats with fibromyalgia

Data in Table (6) reveals the effects of extract and powder of red radish roots, red cabbage leaves and turnip roots on the serum creatinine and urea levels as main indicators of kidney function parameters in rats with fibromyalgia.

The results show that the serum creatinine and urea levels of the positive control rats elevated to 1.10±0.064 and 70.33±8.737 mg/dl significantly which are higher than the normal control (0.52±0.057 and 17.67±5.508 mg/dl), respectively.

The rats with fibromyalgia treated with the extracts and powders of red radish roots, red cabbage leaves and turnip roots showed significant decreases in the serum creatinine and urea levels compared to the positive control group. However, the extracts were more effective than the powder in this regard. The reduction percentage in the serum creatinine level was 47.27, 44.54, and 37.27% for the extracts of red cabbage, red radish and turnip, respectively. On the other, the reduction percentages in the serum urea level caused by the same sequence of extracts were 67.76, 67.76 and 51.91% compared to the positive control.

Regarding the groups that were fed on the powder of red cabbage, red radish and turnip, the results revealed that the reduction percentage in their serum creatinine level was 27.27, 23.64 and 21.82%, while the reduction percentage in their serum urea level was 32.22, 28.91 and 25.11%, respectively compared to the positive control.

Radish extract has been shown to reduce and prevent the formation of urinary stones. This effect is linked to its diuretic properties, which help lower urinary concentrations and, as a result, deter the formation of these stones. Additionally, radish may have a preventive role against lipid peroxides that can cause kidney damage. Furthermore, the chemical components found in radish leaves play a significant role in protecting the kidneys and exhibit antioxidant activity.(Dhahir and Al-Naely, 2022; Aziz and Hassan, 2020).

P. Hydroxy benzoic acid and other phenolic acids have been reported in cabbage leaves of Portuguese and Spanish samples. Ferulic acid and flavonoids such as kaempferol and quercetin showed antioxidant, anti-inflammatory and anti-arthritic activities in animal models. Phenolic acids increase glucose uptake and glycogen synthesis which improve glucose and lipid profiles in certain diseases (Mehmood *et al.,* 2023).

Turnip leaf water extracts can be used in chemotherapy and therapeutic activities. Whereas; it is rich in flavonoids which have the role of glomerulonephritis and chemically-induced kidney insufficiency (Salem *et al.,* 2018). The extract of turnip roots and leaves supplemented diet significantly lowered the plasma level of kidney functional markers including creatine, urea and uric acid (Sobh and Shalan, 2018).

**Table 6. Effect of red radish roots, red cabbage leaves and turnip roots on kidney function tests in rats with fibromyalgia**

| Groups | Creatinine (mg/dl) | | Urea (mg/dl) | |
|---|---|---|---|---|
| | Mean ±SD | Decrease %* | Mean ±SD | Decrease %* |
| G1: Normal control (-ve) | $0.52^{e}$±0.057 | | | |
| G2: Positive control (+ve) | $1.10^{a}$±0.064 | | $70.33^{a}$±8.737 | |
| G3: Red radish Ex | $0.61^{de}$±0.060 | 44.54 | $22.67^{cd}$±6.506 | 67.76 |
| G4: Red radish Po | $0.84^{b}$±0.079 | 23.64 | $50.00^{b}$±7.000 | 28.91 |
| G5: Red cabbage Ex | $0.58^{de}$±0.057 | 47.27 | $22.67^{cd}$±6.506 | 67.76 |
| G6: Red cabbage Po | $0.80^{bc}$±0.095 | 27.27 | $47.67^{b}$±6.110 | 32.22 |
| G7: Turnip Ex | $0.69^{cd}$±0.095 | 37.27 | $34.33^{c}$±9.018 | 51.91 |
| G8: Turnip Po | $0.86^{b}$±0.070 | 21.82 | $52.67^{b}$±8.622 | 25.11 |
| LSD at 0.05 | 0.14 | | 12.80 | |

**Each value is the mean ±SD**
**Mean values in each column with different superscript letters are significantly different at P<0.05.**
*** Decrease % is related to the positive control.**
**G = group, Po = powder & Ex = extract.**

### Effect of red radish roots, red cabbage leaves and turnip roots on blood sugar in rats with fibromyalgia

Data in Table (7) indicated the effect of the extract and powder of red radish roots, red cabbage leaves and turnip roots on blood sugar in rats with fibromyalgia. The serum sugar increased significantly in the positive control group (138.00±6.56 mg/dl) compared to the normal control group (74.33±6.11 mg/dl).

The results revealed that the rats with fibromyalgia treated with the extracts and powders of red radish roots, red cabbage leaves and turnip roots showed significant decreases in serum sugar levels compared to the positive control group. However, the extracts were more effective than the powder in this respect. The reduction percentage in serum sugar level was 39.37, 36.96, and 29.22% for the extracts of red cabbage, red radish and turnip, respectively. On the other, the reduction percentages in serum blood sugar caused by the same plant powder sequences were 19.08, 16.67 and 14.01%, compared to the positive control.

Anthocyanins are food compounds which belong to polyphenols and can mainly be found in vegetables (e.g., red cabbage, and radish). The results of large research have shown that these compounds play an important role in the prevention of Type 2 diabetes (T2D), it was observed that anthocyanins regulated the carbohydrate metabolism in the body due to the upregulation of GLUT 4 (insulin-regulated glucose transporter) translocation, increased activation of PPARY (Peroxisome proliferator-activated receptor. Y) in adipose tissue and skeletal muscles as well as increased secretion of adiponectin and leptin. Moreover, these compounds reduce the inflammation status in the body. Anthocyanin also decreases insulin resistance (Rozanska and Regulska–llow, 2016).

Radish (*Raphanus raphanistrum Subsp. Sativus*) extract showed an advantage in the hypoglycemic response. It was suggested that water-soluble extract contains insulin-like components such as polyphenolic substances or glycosidase-inhibiting components. Radish could significantly reduce the starch-induced- postprandial glycemic load (Woolim *et al*., 2019). The phytochemical content of radish makes it a good alternative treatment for various health problems such as hyperlipidemia, coronary heart disease and cancer as well as diabetes (Mohamed *et al.* , 2019).

Red cabbage has been demonstrated to possess anti-diabetic activity such as lowering blood glucose levels, stimulating insulin secretion and alleviating diabetic complications (An sari *et al.*, 2023). It stands out as a superfood with a myriad of health benefits. From its potent anti-ageing properties and immune system support to its efficiency in managing diabetes and enhancing heart and health bone (Banerjee, 2022).

Nutritionists also suggested incorporating turnips in the diets of those with diabetes and obesity. Utilizing turnips as a food fortifier will offer products with nutritional and biological values and give them medicinal and preventative properties (Anosova *et al*., 2020). Turnip has received significant attention because of its bioactive components and biological function such as glucosinolates, isothiocyanate, phenolic compounds, flavonoids and organic acids. Studies on turnip revealed its anticancer, antimicrobial, anti-hypoxia, anti-diabetic, anti-oxidation and nephroprotective activity (Cao *et al.*, 2021).

**Table 7. Effect of red radish roots, red cabbage leaves and turnip roots on blood sugar in rats with fibromyalgia**

| Groups | FBS (mg/dl) | |
|---|---|---|
| | Mean ± SD | Decrease % * |
| G1: Normal control (-ve) | $74.33^{e}$±6.11 | |
| G2: Positive control (+ve) | $138.00^{a}$±6.56 | |
| G3: Red radish Ext | $87.00^{de}$±8.54 | 36.96 |
| G4: Red radish Po | $115.00^{b}$±9.54 | 16.67 |
| G5: Red cabbage Ex | $83.67^{de}$±8.02 | 39.37 |
| G6: Red cabbage Po | $111.67^{bc}$±8.08 | 19.08 |
| G7: Turnip Ex | $97.67^{cd}$±7.02 | 29.22 |
| G8: Turnip Po | $118.67^{b}$±8.02 | 14.01 |
| LSD at 0.05 | 14.32 | |

**Each value is the mean ±SD**

**Mean values in each column with different superscript letters are significantly different at P<0.05.**

*** Decrease % is related to the positive group.**

## CONCLUSION

It can be concluded that red radish roots, red cabbage leaves, and turnip roots have nutritional value. They contain high amounts of protein, carbohydrates, Na, K, Mg, Ca, Fe, Zn, Mn, and Se. They also contain moderate amounts of tocopherols, vitamin D, vitamin K, and retinol. The effect of these three plant samples was studied on rats with fibromyalgia induced by the reserpine drug. The powder of the three tested plants and their extracts showed significant improvements in serum lipid profile, liver functions, Kidney functions and blood sugar levels compared to the positive control. However, almost all the samples' extracts were more effective than their powder. So, it is recommended to Consume red radish roots, red cabbage Leaves, and turnip roots or their extracts to alleviate the side effects of neurological disorders such as fibromyalgia, Multiple sclerosis, Parkinson's disease, and generally all the causes of dementia.

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# استخدام بعض النباتات لتخفيف الآثار الجانبية لمرض الألم العضلي الليفي الناتج عن عقار ريزيربين في الفئران

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## الملخص

تهدف الدراسة الحالية إلى معرفة القيمة الغذائية لجذور الفجل الأحمر وأوراق الكرنب الأحمر وجذور اللفت وتأثيرها العلاجي في تخفيف بعض الأعراض الجانبية لدى الفئران المصابة بالألم العضلي الليفي وتم تقدير التركيب الكيميائي ومحتوى المعادن والفيتامينات. وأجريت التجربة البيولوجية على أربعين فأرًا مقسمة إلى ثماني مجموعات (٥ فئران لكل منها)، حيث تم تغذية المجموعة الأولى على نظام غذائي أساسي فقط (الكنترول السالب) وتم حقن المجموعات السبع المتبقية بالريزربين لإحداث الألم العضلي الليفي؛ واستمرت إحدى المجموعات في التغذية على النظام الغذائي الأساسي (الكنترول الموجب). وتناولت ثلاث مجموعات مصابة مسحوق جذور الفجل الأحمر وأوراق الكرنب الأحمر وجذور اللفت في النظام الغذائي، بينما تلقت المجموعات الثلاث الأخرى مستخلصاتها الإيثانولية عن طريق الفم. وفي نهاية التجربة تم جمع عينات الدم للتحليل. وأوضحت النتائج أن المجموعات المعالجة بمستخلصات جذور الفجل الأحمر وأوراق الكرنب الأحمر وجذور اللفت أظهرت انخفاضًا كبيرًا في مستويات TC وTG وLDL-c في الدم وكذلك مستويات ALT وAST وزيادة في مستويات HDL-c والألبومين في المصل بشكل ملحوظ مقارنة بالمجموعة الضابطة الإيجابية. كما لوحظ انخفاض كبير في مستويات الكرياتينين ,واليوريا والسكر في الدم في المجموعات المعالجة مقارنة بالمجموعة الضابطة الإيجابية. ومع ذلك، كان المستخلص الإيثانولي لجذور الفجل الأحمر وأوراق الكرنب الاحمر وجذور اللفت أكثر فعالية من المسحوق في تقليل الآثار الجانبية لمرض الألم العضلي الليفي الناجم عن الريزربين في الفئران. وبالتالي، يوصى بهذه النباتات لمرضى الألم العضلي الليفي.

***الكلمات الدالة:*** الألم العضلي الليفي، ريزيربين، جذور الفجل الأحمر، أوراق الكرنب الأحمر، جذور اللفت، الفئران