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Antioxidant activities of aqueous extracts from 12 Chinese edible flowers in vitro and in vivo

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ABSTRACT

Edible flowers' antioxidant properties are gaining attention. Food-borne oxidative damage, including hypoxia-reoxygenation and hyperlipidemia, has not been studied in detail. Aqueous extracts from 12 Chinese edible flowers were tested in four distinct antioxidant models, including total antioxidant capacity (TAC), oxygen radical absorbance capacity (ORAC), scavenging hydroxyl radical capacity (SHRC) and scavenging superoxide anion radical capacity (SARC) (SSARC). When hypoxia-reoxygenation and hyperlipidemia were combined, the possible antioxidant effects on rat cardiac microvascular endothelial cells (rCMEC) were investigated. Lonicera japonica Thunb., Rosa rugosa Thunb., Chrysanthemum indicum L. and Rosa rugosa Thunb. had the highest TAC, ORAC, SHRC, and SSARC values, respectively. When hypoxia-reoxygenation damages rCMEC, the antioxidant properties of most aqueous extracts of edible flowers may be relied on. Lonicera japonica Thunb, Carthamus tinctorius L., Magnolia officinalis Rehd. et Wils., Rosmarinus officinalis L., Chrysanthemum morifolium Ramat., and Chrysanthemum morifolium Ramat. aqueous extracts were also shown to reduce malonaldehyde content in hyperlipidemia rats. Edible flowers should be investigated for their antioxidant properties and potential use in the treatment of disorders associated with chronic exposure to free radicals, according to these results.

ischaemia/reperfusion; HDL-C: high density lipoprotein cholesterol; lactate dehydrogenase; LDL-C: low density lipoprotein cholesterol; malonaldehyde. RCMEC: rat coronary microvascular endothelial cells; SHRC: hydroxyl radical scavenger; SUPEROXIDE DISMUTASE: Superoxide dismutase; SSARC: radical scavenger for superoxide anion; ORAC: oxygen radical absorbance capacity Triacylglycerol (TG) is a polyunsaturated fatty acid that is a component of total cholesterol.

introduction

Numerous studies have shown the importance of free radicals, particularly reactive oxygen species (ROS), in several aspects such as cellular signal transmission, growth and differentiation of cells as well as cell death [1,2]. Many chronic disorders, such as hyperlipidemia, diabetes mellitus, hypertension, ageing and cancer may be caused by an excess of ROS in the body. Natural antiox idants have been extensively considered as preventative and therapy agents because of the possible health concerns and toxicity of synthetic antioxidants [6,7]. The practise

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of eating flowers to enhance the look and nutritional content of meals has been practised in many cultures, including mediaeval France and ancient China [8,9]. Many phenolic compounds found in edible flowers have antioxidant properties, including flavonoids, anthocyanins, carotenoids, alkaloids, and many more. By 2002, the Ministry of Health of the People's Republic of China has approved the use of roughly ten varieties of Chinese edible flowers as either health-care food or medication. Scented tea has recently grown in popularity in the contemporary diet. Indeed, the ritual of sipping scented tea has become an integral part of many people's lives.

of the daily activities of the Chinese people. Despite this, nothing is known about the health benefits of eating edible flowers. Few studies have looked at the effects of edible flowers on oxidative damage, such as ischaemia/reperfusion (I/R) and hyperlipidemia. It is our goal to determine the antioxidant activity of 12 edible flowers from China, using an aqueous extract, in order to determine the TAC, ORAC, SHRC, and scavenging capacity of the hydroxyl radical as well as the scavenging capacity of the superoxide anion radical (SSARC). The antioxidant effects on rat cardiac microvascular endothelial cells (rCMEC) treated with hypoxia-reoxygenation and hyperlipidemia rats produced by high-fat diet were also examined.

The tools and techniques used

Analyses of edible floral extracts' antioxidative properties Nanjing City in Jiangsu Province, China provided a total of 12 dried edible flowers for this study. Table 1 shows their colour, culinary usage, and traditional medicinal application. An edible flower's source was proven by Nanjing Agricultural University's College of Food Science & Technology, according to the Pharmacopoeia of China [13] and China's Flora [14]. A food processing grinder was used to crush the dried flowers into powder form. It was then ultrasonically treated for 30 minutes for each sample, which included 2 g and 10 ml of double distilled water. Centrifuged at 5000 rpm for 30 minutes to separate the liquid supernatant, which was then diluted to a final amount of 25 ml with double-distilled water for the measurement of antioxidant activity. A commercial kit was used to measure the TAC and SHRC of edible floral extracts in accordance with the manufacturer's instructions. SSARC was also measured using same kit. Based on earlier studies [15], the ORAC was calculated.

Preparation of edible floral extracts for use in cell and animal experiments

Extraction of 300 grammes of each sample was carried out in boiling distilled water for one hour. For subsequent examination in both vitro and in vivo after chilling the extracts, the filter paper was used and the filtrates were dilute to the concentration of 0.3 g/ml and kept at 4°C for future analysis.

Primary rCMEC isolation

In accordance with a prior publication [16], the rCMEC was isolated. Endothelial cells in both the epicardium and the endocardium of Wistar rats (7–10 days old) were quickly removed, washed, and treated with 75 percent alcohol. For 30 minutes at 37°C, hearts were chopped and re-suspended in 2 ml 0.2 percent type II collagenase. For ten minutes, they were digested with a solution containing just 0.02% pancreatic enzyme. A sterile nylon mesh was used to filter the cells after digestion, and the cells were centrifuged at 1000 rpm for five minutes. For plating, we used DMEM (Life Technologies/Gibco, Grand Island, NY) containing 10% foetal calf serum (FCS, Life Technologies/Gibco, Grand Island, NY), 100 units of penicillin and 100 micrograms of streptomycin (Life Technologies/Gibco, Gaithersburg, MD). The gelatin-coated flasks were used to prevent the cells from adhering to the walls of the flasks. After being incubated at 37°C for four hours, non-adherent cells were collected and discarded. rCMEC was the kind of cell adhering to the surface. The Southeast University Institutional Animal Care and Use Committee has approved these procedures.

Table 1. The colour, edible use and traditional medicinal use of edible flowers.

Edible flowers	Colour	Edible use
Lonicera japonica Thunb.	Yellow-green	Tea, soup
Jasminum sambac (L.) Aiton	White	Tea, porridge
Carthamus tinctorius L.	Red	Tea, cake
Gardenia jasminoides Ellis	Reddish brown	Tea, soup
Magnolia officinalis Rehd. et Wils.	Reddish brown	Tea
Rosa rugosa Thunb.	Prunosus	Tea, soup
Rosmarinus officinalis L.	Yellow-green	Tea, natural perfume
Chrysanthemum indicum L.	Brown-yellow	Tea, cake
Chrysanthemum morifolium Ramat.	Yellow-white	Tea, cake
Eugenia caryophyllata Thunb.	Dark brown	Tea
Sophora japonica L.	Yellow	Tea, cake
Myosotis silvatica Ehrh. ex Hoffm.	Blue	Tea

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Primary rCMEC hypoxia and reoxygenation

One hour was spent incubating rCMEC at 37°C in a CO2 incubator with a de-oxidant sodium dithionite solution supplemented with 0.5 mol/L for hypoxia and re-oxygenation treatment. It was then maintained at 37°C and 5 percent CO2 in DMEM medium, supplemented with 10% foetal bovine serum, for an additional one hour.

The apoptosis and cell proliferation test

Cells were seeded onto 24-well plates and split into 14 groups, including the control group (normal cells), the model group (hypoxia for one hour, followed by re-oxygenation for one hour), and the model group with 12 extracts of edible flowers (rCMEC, 2.5 103/well) (12 groups, respectively). Extracted edible flowers were added to the cells for 24 hours before they were exposed to hypoxia and re-oxygenation for one hour. The MTT technique was used to assess cell growth. There were 2 105 cells in each 24-well plate of rCMEC, and they were treated as stated previously. Flow cytometric analysis with propidium iodide (PI) (Sigma, USA) staining was used to determine the degree of cell death. To summarise, cells were harvested using trypsinization and phosphate-buffered saline washes before being analysed (PBS). 95 percent acetic acid was used to fix the cells, which were then kept at 4°C for the duration of the experiment. PI (50 g/ml) was used to stain the cells for 30 minutes in the dark after they had been rinsed with PBS and treated with RNase A (50 g/ml). Analysis of the cells was carried out using flow cytometry (CoulterEPICS-XL System II). An test of the antioxidant capacity of cells

One group was used to test the model (hypoxia for one hour followed by reoxygenation for one hour) and the other 13 were used to test the model plus 12 edible floral extracts (12 groups, respectively). In accordance with the manufacturer's instructions, samples of cell culture supernatant were collected and tested for the presence of lactate dehy drogenase (LDH), malonaldehyde (MDA), and superoxide dismutase (SOD).

Treatment of animals

The Institutional Animal Care and Use Committee of Southeast University examined and approved the animal experiment procedures utilised in this investigation. Wistar rats weighing between 90 and 110 grammes were bought from the Shanghai Experiment Animal Center of China.

Table 2. Diet composition of animal experiment.

Component (weight %)	Chow diet	High-fat diet
Casein	23.0	20.0
Maize starch	32.0	29.0
Sucrose	31.0	25.3
Cellulose	4.0	4.0
Colza oil	5.0	0.0
Lard	0.0	10.0
Egg yolk powder	0.0	5.0
Cholesterol	0.0	1.5
Bile salts	0.0	0.2
Mineral mix (AIN-76A)	3.5	3.5
Vitamin mix (AIN-76A)	1.0	1.0
DL-Methionine	0.3	0.3
Choline chloride	0.2	0.2
Total	100.0	100.0

Nobel Prize in Physics (Shanghai, China). A 12-hour light/12-hour dark cycle was used to keep the animals at their ideal temperature of 20–25°C. The blood total cholesterol (TC) levels of Wistar rats were measured after a 7-day adaption period and a 12-hour starvation session. Rats were randomly separated into 14 groups (n = 10) based on their TC levels and weights, with the chow diet, a high-fat diet, and a high-fat diet with 12 edible flower extracts all being included (12 groups, respec tively). Table 2 shows the nutritional content of the diets. A daily dosage of 3 g/kg bw of 12 different edible floral extracts was given by gavage to mice. The chow diet and the high-fat diet group were fed distilled water by gavage. In all, the diet and edible flower extracts therapy lasted for six weeks

Tests for antioxidant capacity in the blood and lipids

The rats were starved and anaesthetized with sodium pentothal at the end of six weeks. The abdominal aorta was the source of the blood samples. The serum samples were then centrifuged at 3000 rpm for 10 minutes to separate them. MDA, SOD, and GSH-Px were measured using commercial kits (Nanjing Jiancheng Bioengineering Institute, China) in accordance with the manufacturer's procedure. A commercial kit (Nanjing Jianchen Bioengineering Institute, Nanjing, China) was used to measure blood

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TC, triacylglycerol (TG), high density lipoprotein cholesterol HDL-C and low density lipoprotein cholesterol (LDL-C).

a study based on numbers

Every value was represented as the mean minus the standard deviation. One-way Analysis of Variance was used to examine the data.

(ANOVA). PASW Statistics 18.0 was used for all of the analyses (SPSS Inc, Chicago, IL, USA). A p value of less than 0.05 has been deemed statistically significant in the past.

Results

Edible floral extracts have antioxidative properties.

TAC, ORAC, SHRC, and SSARC were four of the antioxidant models utilised to assess the antioxidant activity of edible floral extracts, as shown in Table 3. Rosmarinus officinalis L., Chrysanthemum indicum L., and Myosotis silvatica Ehrh. ex Hoffm. were the next highest in TAC, followed by Lonicera japonica Thunb. The lowest TAC is found in Jasminum sambac (L.) Aiton, which is 4.3 times lower than that of Lonicera japonica Thunb. For example, Jasminum sambac (Aiton) has an ORAC of 46.11 0.10 mol TE/g (Jasminum sambac (Aiton)) (Rosa rugosa Thunb.). With more than 1100.00 U/g, Chrysanthemum indicum L, Myosotis silvatica Ehr. ex Hoffm, and Chrysanthemum morifolium Ramat. displayed the highest SHRC values. All extracts except Rosmarinus officinalis L and Rosmarinus morifolium Ramat demonstrated a greater SSARC compared to the Rosa rugosa Thunb. and Rosmarinus officinalis L extracts, respectively. Only Gardenia jasminoides Ellis had the lowest SSARC value of 103.02 U/g.

Results of rCMEC studies using edible floral extracts

apoptosis and proliferation The proliferation of rCMEC decreased significantly after a one-hour period of hypoxia and re-oxygenation. Carthamus tinctorius L. Carthamus indica L. and Chrysanthemum morifolium Ramat were shown to be particularly effective in attenuating this damage in the cells pre-treated with edible floral extracts.

rCMEC proliferation and apoptosis were affected by the extracts of edible flowers.

Group	Proliferation	Apoptosis (%)
Normal cell	63.57 ± 0.83	4.58 ± 0.41
Hypoxia-re-oxygenation cell	24.89 ± 1.21[a]	54.04 ± 1.91[a]
Lonicera japonica Thunb.	22.74 ± 0.67	Nd
Jasminum sambac (L.) Aiton	26.60 ± 1.14	Nd
Carthamus tinctorius L.	45.92 ± 0.72[b]	29.06 ± 1.18[b]
Gardenia jasminoides Ellis	34.76 ± 1.33[b]	Nd
Magnolia officinalis Rehd. et Wils.	28.75 ± 0.96[b]	Nd
Rosa rugosa Thunb.	15.02 ± 1.31	Nd
Rosmarinus officinalis L.	28.32 ± 0.89[b]	Nd
Chrysanthemum indicum L.	52.78 ± 1.02[b]	29.88 ± 1.27[b]
Chrysanthemum morifolium Ramat.	51.93 ± 0.93[b]	5.04 ± 0.27[b]
Eugenia caryophyllata Thunb.	14.16 ± 0.76	Nd
Sophora japonica L.	39.05 ± 1.34[b]	Nd
Myosotis silvatica Ehrh. ex Hoffm.	32.61 ± 1.32[b]	Nd

Values represent the means ± SD of 5 for each group, [a] $P < 0.05$ vs. Normal cell group, [b] $P < 0.05$ vs. Hypoxia-re-oxygenation cell group.
Nd, not detect.

The flow cytometric investigation of cell apoptosis was performed on the three extracts of edible flowers listed above. According to the data, the hypoxic re-oxygenation treatment group had an increase in cell apoptosis, whereas the edible flowers extract group saw a reduction in cell apoptosis, particularly in Chrysanthemum morifolium Ramat (Table 4).

On rCMEC induced hypoxia-reoxygenation, edible floral extracts have antioxidant properties.

Circulating antioxidant enzymes like SOD were shown to be lowered in the hypoxia-reoxygenation cells, whereas LDH and MDA levels rose when compared to those of the normal cells (Table 5). With a few notable exceptions (such as Myosotis silvatica Ehrh. ex Hoffm.), most edible floral extracts showed excellent antioxidant properties.

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Table 3. Antioxidant activities of edible flowers extracts *in vitro*.

Edible flowers	TAC (U/g)
Lonicera japonica Thunb.	2205.2 ± 4.6
Jasminum sambac (L.) Aiton	517.1 ± 3.1
Carthamus tinctorius L.	885.1 ± 5.5
Gardenia jasminoides Ellis	1085.9 ± 5.6
Magnolia officinalis Rehd. et Wils.	540.6 ± 2.0
Rosa rugosa Thunb.	720.9 ± 3.7
Rosmarinus officinalis L.	2077.5 ± 7.9
Chrysanthemum indicum L.	1499.5 ± 2.9
Chrysanthemum morifolium Ramat.	1174.1 ± 6.1
Eugenia caryophyllata Thunb.	1940.6 ± 1.4
Sophora japonica L.	763.5 ± 1.8
Myosotis silvatica Ehrh. ex Hoffm.	1752.0 ± 2.7

Values represent the means ± SD of 3 for each group.
TAC, total antioxidant capacity; ORAC, oxygen radical absorbance capacity; SH radical capacity.

Table 5. Antioxidant effects of edible flowers extracts on rCMEC

Group	LDH (U/L)
Normal cell	138.80 ± 11.25
Hypoxia-re-oxygenation cell	191.37 ± 15.37[a]
Lonicera japonica Thunb.	172.59 ± 7.61[b]
Jasminum sambac (L.) Aiton	176.59 ± 7.61[b]
Carthamus tinctorius L.	158.52 ± 9.71[b]
Gardenia jasminoides Ellis	168.37 ± 10.03[b]
Magnolia officinalis Rehd. et Wils.	169.19 ± 9.73[b]
Rosa rugosa Thunb.	158.52 ± 8.76[b]
Rosmarinus officinalis L.	166.73 ± 9.91[b]
Chrysanthemum indicum L.	155.23 ± 13.14[b]
Chrysanthemum morifolium Ramat.	151.12 ± 8.46[b]
Eugenia caryophyllata Thunb.	167.55 ± 12.23[b]
Sophora japonica L.	160.98 ± 9.14[b]
Myosotis silvatica Ehrh. ex Hoffm.	188.09 ± 10.27

Values represent the means ± SD of 5 for each group, [a] $P < 0.05$ vs. Normal
LDH, lactate dehydrogenase; MDA, malonaldehyde; SOD, superoxide dismuta

Efficacy of edible flower extracts in the treatment of hyperlipidemia in rats

MDA, TC, TG, LDL-C, and HDL-C were shown to rise in rats given high-fat diets for six weeks, whereas SOD, GSH-Px, and HDL-C were found to fall in rats on chow diets (Table 6). Carthamus tinctorius, Gardenia jasminoides Ellis, Magnolia officinalis Rehd. and Wils., Rosmarinus officinalis, Chrysanthemum indicum L., Chrysanthemum morifo lium Ramat., and Sophora japonica L. all showed significant decreases in serum MDA levels; however, the serum SOD and GSH-Px levels were significantly increased in the groups of Lonicera japonica Thunb., Carthamus tinctorius, Magnolia officinalis, Rosmarinus officinalis L., Chrysanthemum indicum, Chrysanthemum morifo The aqueous extracts of Gardenia jas minoides Ellis and Magnolia officinalis Rehd. et Wils. might reduce hyperlipidemia by decreasing blood TC, TG and LDL-C and boosting serum HDL-C.

Discussion

Fewer than a tenth of the world's edible flowers have been investigated for their antioxidant properties. It's also unclear how edible flowers affect oxidative damage, such as hypoxia-reoxygenation and hyperli pidemia. A total of four distinct techniques were used to evaluate the antioxidant activity of aqueous extracts from 12 different Chinese edible flowers in this research. rCMEC treated with hypoxia-reoxygenation and hyperlipidemia rats caused by a high-fat diet were examined for possible antioxidant benefits. The antioxidant capacity of Rosa rugosa Thunb. was shown to be the greatest in both ORAC and SSARC, which is in line with previous research [17–19]. Gallic acid derivatives and polysaccharides were shown to be the main antiox idant components of the aqueous extract of Rosa rugosa Thunb. [20]. Antioxidant activity is also critical for

Table 6. Antioxidation and lipid regulation of edible flowers extracts in hyperlip

Group	MDA (nmol/ml)	SOD (U/ml)	GSH-Px (U/ml)	
Chow diet	3.74 ± 0.20	175.48 ± 7.72	675.48 ± 235.38	2.
High-fat diet	5.58 ± 1.24[a]	154.46 ± 8.17[a]	288.38 ± 241.10[a]	5.
Lonicera japonica Thunb.	4.78 ± 0.64[b]	164.45 ± 5.56[b]	504.68 ± 248.49[b]	4.
Jasminum sambac (L.) Aiton	5.04 ± 1.12	157.13 ± 7.91	349.83 ± 82.56	5.
Carthamus tinctorius L.	4.11 ± 0.77[b]	160.89 ± 5.92[b]	630.48 ± 291.26[b]	4.
Gardenia jasminoides Ellis	4.80 ± 1.36[b]	161.48 ± 7.35[b]	453.39 ± 240.53	4.
Magnolia officinalis Rehd. et Wils.	4.37 ± 0.89[b]	160.72 ± 8.82[b]	566.61 ± 96.92[b]	4.
Rosa rugosa Thunb.	4.92 ± 0.83	159.85 ± 6.02	339.19 ± 174.24	4.
Rosmarinus officinalis L.	4.71 ± 0.78[b]	161.68 ± 6.10[b]	668.23 ± 210.24[b]	4.
Chrysanthemum indicum L.	3.75 ± 0.67[b]	159.99 ± 7.29	590.32 ± 147.35[b]	4.
Chrysanthemum morifolium Ramat.	3.95 ± 0.32[b]	163.37 ± 2.51[b]	665.81 ± 149.37[b]	4.
Eugenia caryophyllata Thunb.	4.93 ± 0.82	159.85 ± 6.02[b]	493.55 ± 289.48[b]	5.
Sophora japonica L.	4.20 ± 0.29[b]	158.20 ± 5.83	456.29 ± 222.67	5.
Myosotis silvatica Ehrh. ex Hoffm.	5.25 ± 0.79	156.20 ± 6.76	329.52 ± 219.96	5.

Values represent the means ± SD of 10 for each group, [a] $P < 0.05$ vs. Chow diet group, [b] $P <$
MDA, malonaldehyde; SOD, superoxide dismutase; GSH-Px, glutathion peroxidase; TC, total cho
HDL-C, high density lipoprotein cholesterol; LDL-C, low density lipoprotein cholesterol.

Chrysanthemum indicum L. and Lonicera japonica Thunb. were also cited, for example by Zeng et al. [21]. Antioxidant activity was studied lately using ethanol extracts of eight edible flowers gathered in Italy. Edible flowers may act as natural antioxidants, according to new research [22]. The antioxidant properties of edible floral extracts vary, and this is something to keep in mind. Litchi chinenesis Sonn. extracts were reported to have antiox idant capabilities in decreasing order: acetone extract, methanol extract, and water extract [23]. Methanol was shown to be more effective than ethanol and

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water in the antioxidant activity of Rosmarinus officinalis L. Only aqueous extracts from edible flowers were tested for their antioxidant properties in our study. This method of extraction is in line with how scented tea is manufactured, and it may serve as a model for the creation and use of edible flower-based drinks. The antioxidant activity in vitro may, however, be influenced by the digestion and metabolism of food in the diet. The fundamental underlying mechanisms of I/R, which recovers blood flow after a brief period of hypoxia, include oxidative damage [25]. In the reperfusion stage, oxygen inflowing with nutritive blood activates the hypoxanthine-xanthine oxidase system, leading to an overproduction of superoxide anion free radicals [26].. As essential as rCMEC's hypoxia-reoxygenation injury is in understanding I/R pathways, its nutraceutical potential, especially in edible flowers, remains little unexplored. Edible flower extracts were demonstrated to protect primary rCMEC from apoptosis and relieve impairment caused by hypoxia-re-oxygenation in this investigation. It has previously been shown that Hibiscus L. extract may decrease intracellular reactive oxygen species production of primary vascular endothelial cells and increase cell viability after exposure to oxidative stress [28]. The antioxidant activity of phenolic chemicals found in edible flowers is clearly responsible for these health benefits [15]. Other compounds that help protect against I/R damage include rutin (quercetin-3-rhamnoglucoside), chlorogenic acid, and caffeic acid [29, 30]. We do not address the identification and quantification of phenolic chemicals in our investigation. There is a lot to learn from these questions. Oxidative stress and hyperlipidemia, both of which contribute to cardiovascular disease, are directly linked to the high-fat diet [31,32]. The antioxidant system tries to increase endogenous antioxidants, such as SOD and GSH-Px, in order to protect cells from oxidative damage [34,35]. Lonicera japonica Thunb., Carthamus tinc torius L; Magnolia officinalis Rehd. & Wils.; Rosmarinus officinalis L; and Chrysanthemum morifolium Ramat. aqueous extracts inhibited the increase in oxidative stress in the high-fat diet group, which was demonstrated by a decrease in serum MDA content and an increase in SOD and GSH-Px levels. To a large extent, the effectiveness of this edible flower as a natural antioxid idant may be attributed to the quantity of total phenolic and total flavonoid content. There is no doubt that Luteolin glucoside 7-O-(6″O-malonyl) glucoside is the most prominent flavonoid in Chrysanthemum morifolium Ramat. [38]. Preventive benefits on liver damage in mice generated by carbon tetrachloride injection have also been indicated for substances with chemical structures such as Luteolin 7-O-(6″O-malonyl)-glucoside [39]. Further investigation is needed, especially in the area of identifying chemicals that may be responsible for the positive impacts on antioxidant status. The function of edible flowers in reducing cardiovascular and metabolic risk factors has been bolstered by recent breakthroughs in research [40,41]. Eating edible flower extracts may have a positive impact on the risk factors for hyperlipidemia by boosting favourable lipid profiles, according to these research Traditional Chinese medicine uses the flower of P. notoginseng and P. pashia to regulate blood cholesterol levels [42,43]. Antioxidant and lipid-lowering properties were found in the current research for Gardenia jasminoides Ellis and Magnolia officinalis Rehd. and Wils. Although the particular mechanisms for how edible flowers extract reduced blood lipid profiles in hyperlipidemia mice were not investigated, the results were promising. One possible explanation for the enhanced lipid-increasing activity of edible floral extracts is the makeup of their nutrients. The toxicity of edible flowers is largely unexplored despite increased interest in the beneficial function edible flowers may play in the development of oxidative damage and hyperlipidemia. The most recent assessment found that when eaten in moderation, edible flowers were not hazardous [44]. Chrysanthemum morifolium Ramat. from China 6 F., for example, was shown to be acutely poisonous to rats after a single oral dosage of 15 g/kg bw ethanolic extract. Long-term toxicity findings for WANG ET AL. [45] were identical to those discovered in the short-term toxicity research, which revealed no harmful effects. In RAW264.7 macrophage cells, Yoo et al. discovered that ethanol extracts of 0.1, 0.5, and 1.0 mg/ml of Lonicera japonica Thunb. were not cytotoxic [46]. However, further research is needed due to the limitations of the current data. Our research contained a number of flaws. Eating edible flower extracts to study their antioxidant effects on rats with rCMEC treated with hypoxia-re-oxygenation and hyperlipidemia caused by high fat diet is challenging due to the wide variety of extraction techniques. In the second place, we didn't go into depth about the bioactivity that was causing the symptoms we saw. Finally, there is just one dosage group, therefore the dose–effect

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relationship has not yet been characterised. It is required to discover and isolate the active components of edible flowers in the future research in order to better understand the antioxidant benefits of edible flowers Edible flowers' antioxidant processes and any negative effects need to be investigated further.

Conclusions

A variety of in vitro and in vivo methodologies were used to assess the antioxidant activity of aqueous extracts from 12 Chinese edible flowers in this research. Rosmarinus officinalis L. and Chrysanthemum mor ifolium Ramat. aqueous extracts showed strong antioxidant properties in vitro and in vivo, according to these findings. There was a significant improvement in hyperlipidemia rats' lipid metabolism when extracts from Gardenia jasminoides Ellis and Magnolia officinalis Rehd. It has been shown that edible flowers have anti-oxidant properties and might be used to enhance the treatment of disorders linked to oxidative stress. Our results emphasise experimental data from cell models and animal-based investigations

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