The protective Effect of *Ocimum basilicum* and *Melissa officinalis* Aqueous Extract on Aluminum -Induced Brain Toxicity in Rats

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Abstract

A lot of products that are made commercially contain aluminum chloride (AlCl3). Excessive exposure of brain cells to aluminum leads to toxicity by aluminum which enables it to pass through the blood-brain barrier, accumulate in the brain and (Al) may also change brain neurotransmitters and impede the function of antioxidant enzymes which lead to worsen neurological dysfunction and cause brain toxicity. This study aimed to protect and enhance brain cells from harmful effects of (Al3Cl) via utilization herbs are known to have contents of strong antioxidants that scavenge free radicals. Sweet basil and lemon balm contained mimic phenolic compounds and flavonoids such as rosmarinic acid and luteolin. Rats were divided into seven groups: negative control group(normal), positive control group (untreated group), 1 ml sweet basil aqueous extract,2 ml (SBAE),1 ml lemon balm aqueous extract,2 ml (LBAE) and (1+1) (SBAE) and (LABE). The best result in all groups was (1+1) (SBAE) and (LBAE) recorded the highest increase in (FI), (BWG) and (FER). Furthermore, this group recorded an increase in norepinephrine dopamine, serotonin, (HDL), (MDA), (SOD), (CAT) and (GSH). Whereas these groups recorded the lowest reduction in (AST), (ALT), (ALP), (TC), (TG), (LDL), (VLDL), urea nitrogen, creatinine and uric acid. Utilization: dried leaves of lemon balm and sweet basil possess many health benefits so use these herbs for 30 days to enhance many body functions.

Keywords: Brain Toxicity-Oxidative stress- Aluminum chloride-sweet basil-Lemon balm.

INTRODUCTION

Many studies have shown the presence of toxic metals in the body and occurring neurological dysfunction (**Hussien *et al.*, 2018)**. Aluminum (Al) is the primary heavy metal implicated in the genesis and progression of neurological disorders. The utilization of aluminum chloride (AlCl3) in many products that we use daily, including personal care products, processed foods and cookware **(Cao *et al.*, 2017)**. (Al) that penetrated the blood-brain barrier easily. (Al) reaches the body via water, food, medicine and household detergents, was linked the induced of (AD) **(Exley and Vickers, 2014)**.

The human brain is highly sensitive to toxic substances such as (Al). Due to its high permeability, (Al) penetrates the blood-brain barrier (BBB) and accumulates mostly in the brain's frontal cortex and hippocampal regions **(Zhao *et al.*, 2020)**. Furthermore, long-term exposure to (Al) causes worsening neurological dysfunction. (Al) can inhibit antioxidant enzymes, which affected neurotransmitters, and caused (DNA) damage in the brain **(Liaquat *et al.*, 2019)**. The most studies on experimental animals which exposed animals' high concentration of (Al) found that worsening effects on nerves especially brain cells. In (Al)-provoked (AD) in animals, morphological abnormalities in the hippocampus, cerebral cortex, and spinal cord, as well as biochemical alterations were detected. As a result, it is hypothesized that AlCl3-induced (AD) in animals is the well-developed animal model for reproducing human (AD) **(Chen *et al.*, 2021)**.

Sweet basil, or *Ocimum basilicum L*. (*Lamiaceae*), is used in traditional medicine to treat neurological problems, stress, diabetes, hypertension, dementia, and other conditions by acting as a brain and nerve tonic. **(Aminian *et al.*,2022)** Pharmacological studies bolster this plant's historical significance.

(Singh *et al.* 2016). Sweet basil was found to contain flavonoids, phenolic compounds, terpenes, and anthocyanins, according to phytochemical investigations. Several components are thought to be responsible for sweet basil well-established antioxidant activity in both in vitro and in vivo studies. Sweet basil extract's antioxidant properties may help to prevent brain damage. **(Bora *et al.* 2011)**.

Lemon balm, or *Melissa officinalis*, is a fragrant member of the mint family (*Lamiaceae*) and an ancient natural medicinal plant whose antispasmodic qualities are often used to treat gastrointestinal ailments and aid in digestion when brewed as herbal tea. **(Sipos *et al.* 2021)**. The flavonoids, gallic acid, rosmarinic acid, and phenolic contents of lemon balm ethanolic extract contribute to its potential therapeutic benefits as an antioxidant, antiviral, anti-inflammatory, neuroprotective, and anticarcinogen. **(Kamdem *et al.* 2013)**. Consequently, a prior study confirmed the (LBME's) preventive function against degenerative diseases caused by oxidative stress. **(Sipos *et al.* 2021)**. Additionally, it has been demonstrated that (LBME) helps patients with learning and short-term memory. **(Abdel-Aziz., 2018)**.

Aim of Study:

The present study was undertaken to assess the protective effect of feeding on *Ocimum basilicum* and *Melissa officinalis* against aluminum-induced brain toxicity in rats.

Materials and method

Materials

- **Chemicals**: basal diet, casein, cellulose, vitamins, minerals, aluminum

chloride $AlCl_3$, and formalin, were obtained from the General Company for Commerce and Chemicals, Cairo, Egypt.

- **Kits** Diethyl either and kits for biochemical analysis of serum were purchased from Gama Trade Company for Chemicals, Cairo, Egypt.
- **Plant**: Fresh basil and lemon balm leaves were obtained a local herb market in Cairo, Egypt.
- **Animals:** Forty-two male Sprague-Dawley rats (weighing 160 –180 g) were obtained from the animal house of the National Research Center, Giza, Egypt. They were housed at constant conditions of room temperature and 55 ± 5% humidity under 12-hr light/12-hr dark cycles. All rats had continuous access to feed and water and were acclimated to laboratory conditions for 1 week.

Method

- **Fresh basil and lemon balm leaves aqueous extract preparation**

The dried leaves (100 g) were chopped up and extracted by hot maceration using 750 ml of distilled water for 5 h; the solvent was evaporated at 40°C using a rotary evaporator. A brownish residue weighing 11.5 g was obtained and kept in an airtight bottle in a refrigerator till used **(Ibrahim *et al*., 2020)**.

- **Induction of brain damage in rats**

Aluminum chloride was used to induce neurotoxicity in experimental rats. Aluminum chloride solution in water (100 mg/kg), which was used to be prepared fresh every day, was orally administered for 42 days according to (**Auti & Kulkarni, 2019)**.

- **Experimental animals and design**

Forty-two adult male Sprague-Dawley rats were fed a standard diet for one week for adaptation. Preparation of Basal Diet The basal diet (AIN-93M) was formulated according to (**Reeves *et al.*, 1993)** to meet recommended nutrients levels for rats. After one week, rats were randomly divided into seven experimental groups, each containing six rats.

Group 1: Served as the normal control, receiving a basal diet without treatments. **Group 2:** The disease control, was given aluminum chloride (100 mg/kg) by oral gavage for 42 days to induce brain toxicity. Group 3 received AlCl3 and was administered 1mL of aqueous basil extract once daily, while Group 4 received the same but with basil extract administered twice daily. Group 5 received AlCl3 and 1mL of aqueous lemon balm extract once daily, and Group 6 received the same with lemon balm extract administered twice daily. Group 7 received AlCl3 and a 2mL mixture of basil and lemon balm extracts once daily.

- **Biological Evaluation:**

Feed intake (FI) and body weight gain percent (BWG %) were calculated according to **(Chapman *et al.*, 1959)** using the following equation:

$$\textbf{BWG \%} = \frac{\textbf{Final body weight} - \textbf{Initial body weight}}{\textbf{Initial body weight}} \times \mathbf{100}$$

FER = weight gain (g) / feed intake (g)

At the end of the experimental period (42 days), animals were fasted for 12hours, except for water, and then serially anesthetized with diethyl ether. Rats

were euthanized and organs were dissected. Blood samples were collected from the posterior vena cava into dry clean centrifuge tubes and left at room temperature to clot and then centrifuged for 10 minutes at 3000 rpm for serum separation. Serum samples were frozen at -20°C for biochemical analysis.

- **Biochemical Analysis:**

Brain neurotransmitters

Determination of serotonin (5-HT) and dopamine (DA) were carried out as reported by (**Hussein *et al.* 2016)** utilizing high performance liquid chromatography (HPLC) system. The AChE activity was assessed in accordance to (**Ellman *et al.* 1961)**.

Serum Lipid Profile:

According to **(Allain 1974), (Fassati and Prencipe 1982)**, and **(Albers *et al.*, 1983)**, the serum total cholesterol (TC), triglycerides (TG), and cholesterol contents of high-density lipoprotein (HDL-c) were measured, respectively. low-density lipoprotein (LDL) and very low-density lipoprotein (VLDL) were calculated according to **(Friedewald *et al.*, 1972)**.

$$\textbf{LDL-c = TC- [HDL-c + (TG/5)]}$$
$$\textbf{VLDL-c = TG/5}$$

Liver Function:

Serum aspartate aminotransferase (AST) and alanine aminotransferase (ALT) were measured according to **(Bergmeyer *et al.* 1978)**, serum alkaline phosphates (ALP) were measured **(Belfield & Goldberg 1971)**.

Kidney Function:

According to **Kaplan** (**1984), Patton and Crouch (1977),** and **Murray (1984).** Serum urea, uric acid, and creatinine were determined, respectively.

Oxidative and Antioxidant Biomarkers:

Following **(Draper and Hadley 1990)** methodology, the plasma level of malondialdehyde (MDA) was calculated to measure lipid peroxidation. Superoxide dismutase (SOD) activity was evaluated by **(VINCENT *et al.*, 1989)**. Catalase (CAT) was measured by (**Aebi, 1984)**.

Statistical analysis:

All data obtained results were analyzed using Statistical Package for the Social Sciences (SPSS) for Windows, version 20 (SPSS Inc., Chicago, IL, USA). Collected data were presented as mean ± standard deviation (SD). Analysis of Variance (ANOVA) test was used for determining the significances among different groups according to **Senedecor and Cochran (1989)**. All differences will be considered significant if P-values were ($P< 0.05$).

Results & Discussion

Table 1. Explains the effects of aqueous extracts of lemon balm and sweet basil on the body weight status of rats induced brain poisoning. The initial body weight (IBW) of any of the treated groups did not differ significantly from the final body weight (FBW), which decreased in the (+ve group). In contrast, the (FBW) increased in all treated groups and the (-ve group) feed intake (FI), body weight gain (BWG), feed efficiency ratio (FER), and (BWG%) increased in 2 ml (1+1) extracts of lemon balm and basil when compared to the (-ve group) and the normal group. This indicates that the best results were achieved when

the herbs were combined in equal amounts. However, in contrast to all other groups, the (+ve group) (untreated group) recorded significant decreases in (FI), (BWG), (FBW), (BWG%) and (FER) when compared to all treated groups. These results supported those of **(Nasef and El-banna, 2024)** and **(Ismail *et al*., 2023)** who found that (AlCl3) significantly reduced the (BWG) of experimental subgroups in comparison to the (-ve group). **(Ogbu et al., 2024)** study showed that sweet basil aqueous extract recorded an insignificant increase in body weight. Many doses of (SBAE) enhanced the levels of body weight as compared to the untreated groups significantly ($p \leq 0.05$). (**Lieshchova and Brygadyrenko, 2021)** showed that a supplementation diet with lemon balm increased the level of daily weight significantly while reducing the ratio of brain weight.

The effects of lemon balm and basil extracts on norepinephrine, dopamine, and serotonin (neurotransmitters) were shown in **Table 2.** Result showed that significant decrease in norepinephrine, dopamine, and serotonin levels in the (+ve group) when compared to the (-ve group). Furthermore, all treated groups recorded enhancement in norepinephrine, dopamine, and serotonin when compared (+ve group). Whereas 2 ml (1+1) of lemon balm and sweet basil extract recorded the best result and the highest increase in neurotransmitters when compared (-ve group). These results are are in agreementwith (**Nasef and El-banna, 2024)** showing that gavage (AlCl3) to rats, to rats caused lower levels of dopamine and serotonin in the brain cortex. Exposed to AlCl3-induced changes in the brain such as metabolic, cognitive functions and neurochemical mutations. **(Waggas, 2010)** showed that giving high-dose of sweet basil leaves extract (400 mg/kg) caused a significant decrease in (NE), (DA) and (5-HT) content in all investigated brain parts at most of several studies. This correlated to the presence of phenolic compounds (rosmarinic acid

and caffeic acid) in the extract which inhibited the α-adrenoceptor system. On the other hand, rosmarinic acid and caffeic acid affected the uptake of monoamines; as a result, the content of neurotransmitter is decreased. **(Lieshchova and Brygadyrenko, 2021)** High levels of antioxidants in lemon balm exerted through phenolic compounds, rosmarinic acid, gallic acid, and flavonoids. A numerous research confirmed the antioxidative action of lemon balm, and its effect in treating and prevention diseases which correlated to oxidative stress.

Effects of lemon balm and sweet basil extracts on serum lipid profiles were recorded in **Table 3** Data revealed that (+ve group) rats had a significant ($P<0.05$) increase in serum levels of (TC), (TG), (LDL), (VLDL) and a significant decrease ($P<0.05$) in high density lipoprotein (HDL) when compared to the negative control group. Rats that were treated with 2 ml (1+1) of lemon balm and sweet basil extracts had a significant ($P<0.05$) reduction in the elevated serum (TC), (TG), (LDL) and (VLDL) levels and an increase in serum (HDL) when compared with the negative control group. These results are in line with **Ogbu *et al*. (2024)**, results showed that sweet basil aqueous extract demonstrated a decrease in the levels of of (TC), (TG), and (VLDL), while demonstrating an increase in HDL Sweet basil aqueous extract had promoted anti-hyperlipedemic activity which occurred by its bioactive contents which aid lipid elimination from the body. **(Lieshchova and Brygadyrenko, 2021)** observed that used lemon balm had decreases in triglycerides (63%). Daily drinking of lemon balm tea can regulate (TG) and cholesterol in humans.

The effect of lemon balm and sweet basil extracts on aspartate aminotransferase (AST), alanine aminotransferase (ALT), and alkaline phosphatase (ALP) (liver

function) is explained in **Table 4.** Results of serum concentration of (AST), (ALT) and (ALP) significantly increased ($P<0.05$) in the positive control group when compared to the negative control group. Lemon balm and sweet basil extracts with different concentrations decreased (ALT), also this result applied to AST and applied to (ALP) whereas the best result was 2 ml (1+1) lemon balm and sweet basil extracts, which showed a significant reduction in (AST), (ALT) and ALP when compared to the negative control group. These results are compatible with **(Teoflovi´c *et al.*, 2021)** finding that demonstrated hepatoprotective effects of sweet basil aqueous extract in a model of acetaminophen induced liver injury via the increase in the activity of antioxidant enzymes, decreased lipid peroxidation and serum activity of liver transferase enzymes. **(Eivani *et al.*, 2023)** found that oral use of lemon balm extract (100 mg/kg) reduced liver enzymes in lead-poisoned rats, it's may be beneficial in lead-induced liver and kidney dysfunction. (**Panggabean *et al.*, 2021)** and **(Soliman *et al.*, 2020)** found that lemon balm extract at a high dose is more effective in preventing liver damage.

Effects of lemon balm and sweet basil extracts on urea nitrogen, creatinine, and uric acid undeceived in **Table 5**. Data revealed that (+ve group) rats had significant ($P<0.05$) increases in urea nitrogen, creatinine and uric acid in (+ve group) when compared (-ve group) while all treated groups showed significant decreases in urea nitrogen, creatinine and uric acid. significant decreases, the best result was 2ml (1+1) of lemon balm and sweet basil extracts when compared to (-ve group). These results are consistent with **(Ben Mansour *et al.*, 2024)** who showed that sweet basil (200 mg/kg BW) resulted in a decrease in (CCl4) levels of kidney markers, urea and creatinine, an elevation of uric acid compared with the (CCl4)-only group. **(Eivani *et al.*, 2023)** discovered

that oral use of LBE (100 mg/kg) reduced markers of renal function (urea, uric acid and creatinine) in lead-poisoned rats.

Effects of lemon balm and sweet basil on malondialdehyde (MDA) (a biomarker of oxidative stress), superoxide dismutase (SOD), catalase (CAT), and glutathione (GSH) (antioxidant enzymes) were shown **Table 6.** Result showed that the highest increase in (MDA) in (+ve group) when compared to (-ve group). While all showed a decrease in MDA, especially 2 mL (1+1) of lemon balm and sweet basil extracts. Furthermore, (+ve group) recoded significant decreases in (SOD), (CAT) and (GSH) when compared to the (-ve group) whereas all treated groups recorded increased in (SOD), (CAT) and (GSH) specially 2ml (1+1) lemon balm and sweet basil extracts when compared (-ve group). These results are in a line with **(Badiana *et al*., 2021)** showing that sweet basil reduced (MDA) levels and raised (CAT), (GSH), and (SOD) concentrations to dramatically restore the oxidative damage caused by monosodium glutamate. These findings imply that this plant, or its flavonoids, has the capacity to inhibit lipid peroxidation and neutralize hydroxyl (OH−) and superoxide (O2−) radicals. Lemon balm decreased the level of (MDA) and increased antioxidant enzymes **(Sief *et al*., 2015 and Eivani *et al*., 2023)**.

Conclusion

Basil is known as the sacred herb, as it was mentioned twice in the Holy Qur'an. It was also used in ancient folk medicine for enhancement of memory. Lemon balm is an ancient medicinal herb that is used as a sedative and hypnotic because of its good effects on the nervous system. It also works as an inhibitor of the cholinesterase enzyme, the main cause of neurodegenerative diseases. Both sweet basil and lemon balm contain similar bioactive compounds such as flavonoids and phenolic compounds especially rosmarinic which is present in study herbs in high concentration promoting its role as a strong antioxidant and

possessing many health benefits. This elucidates utilization sweet basil and lemon balm together gives best results in all biochemical analysis.

Table (1): Effect of lemon balm and basil extracts on Initial Body Weight (IBW), Final Body Weight (FBW), Feed Intake (FI), Body Weight Gain % (BWG)and Feed Efficiency Ratio (FER)

Parameters / Groups	IBW G	FBW G	FI g/d/rat	BWG G	BWG %	FER
Control (-Ve)	167.80±2.51a	208.20±2.15a	**22**	40.40±0.5a	24.10±0.49a	0.043±0.001a
Control (+Ve)	196.81±1.93a	190.00±2.46b	**15**	20.21±1.15f	11.89±0.65e	0.032±0.001d
Basil 1 ml	172.60±2.29a	196.80±2.43ab	**16**	24.20±0.37e	14.02±0.24de	0.036±0.001bcd
Basil 2 ml	172.80±1.77a	201.00±1.70ab	**17**	28.25±0.2cd	16.32±0.23cd	0.039±0.002ab
Lemon balm 1 ml	174.40±1.80a	199.80±1.71ab	**18**	25.40±0.24de	14.57±0.24d	0.033±0.001cd
Lemon balm 2 ml	173.20±2.63a	204.40±2.39a	**20**	31.20±0.58c	18.04±0.55bc	0.037±0.002bc
Basil+Lemon balm 2 ml (1+1)	173.80±2.37a	208.60±2.37a	**21**	35.20±0.37b	20.27±0.44b	0.039±0.001ab

Data are expressed as mean ± SE.

Means with different superscript letters in the column are significantly differences at ($P < 0.05$).

Table (2): Effect of lemon balm and basil extracts on Norepinephrine, Dopamine and Serotonin(neurotransmitters)

Parameters / Groups	Norepinephrine pg/mL	Dopamine Pg/mL	Serotonin ng/mL
Control (-Ve)	114.97±1.87a	88.36±0.52a	209.94±2.79a
Control (+Ve)	65.89±0.50f	71.16±0.79e	173.25±1.91f
Basil 1 ml	72.01±0.57e	73.08±0.50de	176.83±1.93ef
Basil 2 ml	77.26±0.43cd	75.84±0.67cd	181.24±1.70d
Lemon balm 1 ml	75.07±0.53de	74.30±0.46d	179.00±1.42de
Lemon balm 2 ml	79.18±0.97c	78.20±0.50bc	185.35±1.51c
Basil+Lemon balm 2 ml (1+1)	83.71±0.64b	81.05±0.49b	191.68±1.60b

Data are expressed as mean ± SE. Means with different superscript letters in the column are significantly differences at ($P < 0.05$).

Table (3): Effects of lemon balm and sweet basil on serum lipid profile

Parameters / Groups	TC (mg/dl)	TG (mg/dl)	HDL (mg/dl)	LDL (mg/dl)	VLDL (mg/dl)
Control (-Ve)	127.49±1.54d	82.25±0.37e	29.74±0.38a	81.17±0.50d	16.57±0.70e
Control (+Ve)	140.70±1.59a	90.52±0.74a	24.32±0.31d	98.27±0.48a	18.10±0.14a
Basil 1 ml	139.98±1.58a	89.19±0.35ab	25.53±0.80cd	96.60±0.53a	17.84±0.71ab
Basil 2 ml	138.84±1.42ab	86.79±0.44bcd	26.44±0.29bc	95.04±0.28a	17.36±0.80bcd
Lemon balm 1 ml	138.07±1.65ab	87.19±0.55bc	27.61±0.40b	93.01±0.49ab	17.44±0.11bc
Lemon balm 2 ml	134.59±1.57bc	85.99±0.34cd	27.75±0.41b	89.63±0.40bc	17.20±0.81cd
Basil+Lemon balm 2 ml (1+1)	132.49±2.11cd	84.19±0.34de	28.20±0.37ab	87.45±0.32c	16.84±0.60de

Data are expressed as mean ± SE. Means with different superscript letters in the column are significantly differences at ($P < 0.05$).

Table 4: Effect of lemon balm and sweet basil extracts on Serum Liver Functions:

Parameters / Groups	AST (µ /L)	ALT (µ /L)	ALP mg/dL
Control (-Ve)	20.42±0.67d	37.53±0.30f	116.58±1.96f
Control (+Ve)	48.18±0.53a	95.93±1.04a	172.58±1.56a
Basil 1 ml	41.38±0.42b	81.93±0.50b	165.18±1.92b
Basil 2 ml	32.38±0.77c	70.93±0.45cd	160.38±1.31bc
Lemon balm 1 ml	39.78±0.53b	75.13±0.61c	155.78±1.93c
Lemon balm 2 ml	٣٠.78±0.40c	66.53±0.55de	144.18±1.56d
Basil+Lemon balm 2 ml (1+1)	27.98±0.45c	61.73±0.34e	135.38±1.02e

Data are expressed as mean ± SE. Means with different superscript letters in the column are significantly differences at ($P < 0.05$).

Table (5): Effect of lemon balm and sweet basil extracts on Kidney function

Parameters / Groups	Urea Nitrogen (mg/dl)	Uric Acid (gm/dl)	Creatinine (mg/dl)
Control (-Ve)	21.92±0.28f	0.69±0.01f	2.76±0.05d
Control (+Ve)	48.73±0.32a	1.71±0.02a	5.84±0.31a
Basil 1 ml	43.14±0.56b	1.50±0.02b	4.82±0.25b
Basil 2 ml	36.05±0.45d	1.31±0.01c	3.53±0.16cd
Lemon balm 1 ml	39.48±0.59c	1.40±0.02bc	4.08±0.03bc
Lemon balm 2 ml	33.97±0.89d	1.16±0.01d	3.32±0.09cd
Basil+Lemon balm 2 ml (1+1)	28.21±0.55e	0.96±0.02e	2.95±0.01d

Data are expressed as mean ± SE. Means with different superscript letters in the column are significantly differences at ($P < 0.05$).

Table (6): Effect of lemon balm and sweet basil extracts on antioxidants enzymes

Parameters / Groups	MDA ng/mL	SOD U/mL	CAT Pg/mL	GSH µmol/mL
Control (-Ve)	111.83±1.52f	0.77±0.007a	19.17±0.37a	71.50±0.44a
Control (+Ve)	355.98±1.72a	0.54±0.005e	7.60±0.21e	52.58±0.68e
Basil 1 ml	341.81±1.48b	0.57±0.004d	8.16±0.27e	56.87±0.50d
Basil 2 ml	324.41±1.60c	0.60±0.006d	13.75±0.29c	59.21±0.31d
Lemon balm 1 ml	340.04±1.48b	0.58±0.005d	10.96±0.46d	58.13±0.48d
Lemon balm 2 ml	302.19±1.74d	0.64±0.003c	14.64±0.35c	63.24±0.55c
Basil+Lemon balm 2 ml (1+1)	287.34±1.71e	0.68±0.005b	16.65±0.34b	67.51±0.70b

Data are expressed as mean ± SE.

Means with different superscript letters in the column are significantly differences at ($P < 0.05$).

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الملخص العربي

تحتوي العديد من المنتجات المصنعة تجارياً على كلوريد الألومنيوم (AlCl3). يؤدي التعرض المفرط لخلايا المخ للألمنيوم إلى التسمم بالألمنيوم مما يسمح له بالمرور عبر حاجز الدم الدماغي والتراكم في المخ وقد يؤدي (الألمنيوم) أيضًا إلى تغيير النواقل العصبية في المخ وإعاقة وظيفة إنزيمات مضادات الأكسدة مما يؤدي إلى تفاقم الخلل العصبي والتسبب في سمية المخ. هدفت هذه الدراسة إلى حماية وتعزيز خلايا المخ من التأثيرات الضارة لـ (Al3Cl) من خلال الاستفادة من الأعشاب المعروفة بمحتواها من مضادات الأكسدة القوية التي تزيل الشقوق الحرة. يحتوي الريحان الحلو والبلسم الليموني على مركبات فنوليه مقلدة وفلافونويدات مثل حمض الروزمارينيك واللوتولين. وفي هذه الدراسة تم تقسيم الفئران إلى سبع مجموعات: المجموعة الضابطة السالبة (طبيعية) ومجموعة ضابطة إيجابية (مجموعة غير معالجة) و١ مل من مستخلص مائي للريحان الحلو و٢ مل (المستخلص المائي للريحان) و١ مل من مستخلص مائي للبلسم الليموني و٢ مل (المستخلص المائي لبلسم الليمون) و (١+١) (المستخلص المائي للريحان) و (المستخلص المائي لبلسم الليمون). كانت أفضل نتيجة في جميع المجموعات (١+١) وسجلت (المستخلص المائي للريحان) و (المستخلص المائي لبلسم الليمون) أعلى زيادة في المأكول من الطعام ومعدلات زيادة الوزن و كفاءة الطعام المأكول. كما سجلت هذه المجموعة زيادة في النورادرينالين والدوبامين والسيروتونين و (HDL) و (MDA) و (SOD) و (CAT) و (GSH). في حين سجلت هذه المجموعات أقل انخفاض في (AST) و (ALT) و (ALP) و (TC) و (TG) و (LDL) و (VLDL) ونيتروجين اليوريا والكرياتينين وحمض البوليك. وخلاصة التجربة أظهرت ان أوراق بلسم الليمون والريحان المجففة تمتلك العديد من الفوائد الصحية لذلك استخدم هذه الأعشاب لمدة ٣٠ يومًا لتعزيز العديد من وظائف الجسم.

الكلمات المفتاحية :سمية الدماغ - الإجهاد التأكسدي - كلوريد الألومنيوم - الريحان - بلسم الليمون.