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Utilization of *Jatropha curcas* L. Leaf Extract Gel for Improving Temperature, Infarct Volume, TNF-A, and IL-1*β* in Post-Ischemic Brain Mice

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ABSTRACT

This study is motivated by the urgent needs for novel approaches to alleviate the detrimental effects of brain ischemia, a condition marked by reduced blood flow to the brain and severe neurological consequences. The effect of a gel compress made from extracts of Jatropha leaves (*Jatropha curcas* L) is evaluated on temperature improvement, infarct volume, TNF-α, and IL-1*β* in a post-brain ischemic mice model. The study employed a pure experimental research design with a Randomized Post Design Test-Only Control Group design. Ischemic conditions in mice were induced through unilateral carotid artery occlusion for 45 minutes, followed by applying *Jatropha curcas* L leaf extract gel compress. The analysis results indicate that *Jatropha curcas* L leaf extract gel compress significantly affected temperature improvement, TNF-α, and IL-1*β* levels ($p<0.05$). However, no significant effect was observed on infarct volume ($p>0.05$). Further post hoc analysis revealed that treatment with a 1% concentration and 1.5% concentration of the *Jatropha curcas* L leaf extract gel compress resulted in a significant temperature drop compared to the control group. Moreover, these concentrations significantly influenced TNF-α levels, while all concentrations significantly improved IL-1*β* levels. In conclusion, this research demonstrates that a 1.5% concentration of *Jatropha curcas* L leaf extract gel compress yields the most favorable outcomes regarding temperature improvement, infarct volumes, TNF-α, and IL-1*β* in a post-brain ischemic mouse model. This study contributes valuable insights into the potential therapeutic applications of *Jatropha curcas* L leaf extract in mitigating the adverse effects of brain ischemia.

Keywords: compress gel, *Jatropha curcas*, interleukin, mice

Introduction

Strokes pose a significant contemporary health challenge, ranking as the second leading cause of death and the primary cause of disability globally.[1] According to data from the Riskesdas Prevalence Study, there has been a troubling increase in stroke incidence from 7% in 2013 to 10.9% in 2018.[2-3] The consequences of a stroke are profound, often leading to long-term disability, making it a major contributor to disability worldwide. A seven-year research study involving over 20,000 people revealed that 425 individuals suffered a stroke, and over 100,000 experienced significant stress.[4]

Paralysis, speech difficulties, and emotional disturbances due to brain damage are often follows the stroke. Post-stroke inflammation, closely linked to this condition, can exacerbate its effects. This inflammatory response can worsen the consequences of ischemic stroke by hastening the development of the penumbra region, making it more susceptible to becoming an infarct.[5] Two key players in this inflammatory process are the cytokines TNF-α and IL-1*β*, as they influence infarction expansion.[6]

Confronting health challenges extends beyond individual endeavors and requires active engagement from the broader society, especially from families with individuals who have undergone strokes.

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Families play a crucial role in identifying health issues, offering care to affected members, creating a supportive home atmosphere, adjusting their surroundings to promote family health, and acquiring and adopting health-conscious behaviors within their community.[7]

Researchers are investigating novel methods to enhance health results and minimize disability in individuals recovering from strokes.[8] One such approach involves the application of a gel compress made from *Jatropha curcas* L. leaf extracts.[9] *Jatropha curcas* L. is a robust plant with a height ranging from 1 to 7 meters, characterized by irregular branching. This approach aims to tackle several critical aspects of post-stroke recovery, including temperature regulation, reduction in infarct volume, and the modulation of pro-inflammatory factors like TNF-α and IL-1*β*. This innovative method offers a promising avenue for improving the health status and quality of life of post-stroke patients.

The production of a gel leaf compress using *Jatropha curcas* L. leaf extracts is a relatively straightforward process, utilizing readily available materials. Since Jatropha is a common plant used for various purposes, families can easily engage in producing this gel to care for their loved ones who have suffered a stroke. The significance of this study lies in its potential to contribute to the field of health science by offering a viable technological intervention for healthcare. Notably, there exists a knowledge gap in understanding the optimal methods for utilizing Jatropha curcas L. leaf extract gel compresses in stroke patient care. This research aims to address this gap, exploring the potential of these compresses to expedite the recovery of ischemic stroke patients, prevent the expansion of infarcts, and reduce the likelihood of severe recurrent strokes. Consequently, stroke patients can regain their independence, and this study will contribute valuable insights to the current understanding and support for stroke patient care.

Materials and Methods

This study utilized gel compress derived from the leaves of *Jatropha curcas* L, a plant belonging to the Euphorbiaceae family classified under the Jatropha genus, which was collected in February 2022 in Surabaya (7.2575° S, 112.7521° E).[10] The extraction method employed in this research is maceration, using 96% ethanol as the solvent, resulting in a liquid extract. The extract was then evaporated using a rotary evaporator for 6 minutes at a temperature of 42°C, yielding a concentrated extract. Subsequently, the chemical compound content of the extract was examined through phytochemical screening. Following this, the extract was incorporated into a gel in concentrations of 0.5%, 1%, and 1.5%, forming a compress gel formulation. The physical properties of the compress gel, including pH, normality, homogeneity, spreading ability, and viscosity, were tested in the laboratory at the Faculty of Pharmacy, Universitas Airlangga.

Adult white Wistar strain mice (*Rattus Norvegicus*) aged 8-10 weeks were used in this study, with weights ranging from 150 to 200 grams. These mice were healthy, exhibited regular activity, and had no anatomical abnormalities. To create an ischemic stroke model, the Unilateral Cerebral Artery Occlusion (UCAO) method were employed, which involved occluding the cerebral artery unilaterally for 45 minutes before releasing the ligation.[11] The use of animals in this study was approved by ethical committee of the Brawijaya University No 030-KEP-UB-2023.

Sample size determination led to a calculation that indicated a requirement for six mice per group, with an additional backup mice for each group, resulting in seven mice per group. Notably, one mice from the control group did not survive the experiment.

The study comprised four groups, i.e., the control group, treatment I, treatment II, and treatment III. The control group consisted of mice that received gel compress without leaf extract. Treatment Group I: mice in this group were administered gel compress with Jatropha leaf extract at a concentration of 0.5%. Treatment Group II: mice in this group received gel compress with Jatropha leaf extract at a concentration of 1%. Treatment Group III: mice in this group were given gel compress with Jatropha leaf extract at a concentration of 1.5%.

During the research, gel compress applications were applied twice a day, with each application lasting two hours. The first application was performed from 8 AM to 10 AM, followed by a second application from 2 PM to 4 PM, after which the compress was removed.

This study utilized Multivariate Analysis of Variance (MANOVA) to examine whether there were differences in temperature, infarct volume, TNF-alpha, and IL-1*β* among the mice used as the ischemic stroke model after receiving the gel compress treatment with Jatropha leaf extract at concentrations of 0.5%, 1%, and 1.5%. If significant effects were observed, post hoc analysis using the Least Significant Difference (LSD) test was conducted to compare each group and determine the optimal variables under investigation.

Results and Discussion

In this study, the body temperature of mice across four groups (one control group and three treatments: 0.5%, 1%, and 1.5%) were monitred over an 8-week experimental period (Table 1). The data provided in the table reveals the initial body temperatures before the measurement, reflecting the baseline conditions for each sample group before the experiment (Pre-treatment). The subsequent columns in the table represent temperature measurements over the following weeks (1 to 8), which allowed us to track and analyze how these temperatures evolved over time. Not available (NA) data in the table indicates animals that did not survive. This data provides a comprehensive view of the temperature dynamics within each group and serves as a foundational element for current experimental observations and conclusions.

Table 2 reports the outcomes of this study in investigating infarct brain volume in mice to assess the influence of various treatments on brain infarction, a condition characterized by localized brain tissue death due to restricted blood supply. The table is categorized into four groups: the Control Group, Treatment I (0.5%), Treatment II (1%), and Treatment III (1.5%). In this context, "Σp" denotes the total percentage of preserved brain volume after infarction, serving as a critical gauge for evaluating brain tissue damage. Moreover, "Brain volume (mm3)" is a measurement in cubic millimeters, offering a quantifiable assessment of the infarcted area's size within the brain. Notably, instances marked as "NA" signify that the corresponding mice samples did not survive, rendering data regarding Σp and brain volume inapplicable to those specific cases.

Table 3 displays the results of the TNF-α (Tumor Necrosis Factor-alpha) examination in mice. The table is organized into four distinct groups, namely the Control group, Treatment I (0.5%), Treatment II (1%), and Treatment III (1.5%). Within each group, replicates, mean values, and concentrations measured in nanograms per liter (ng/L) are provided for the TNF-α levels. This data provides insights into the impact of different treatments on TNF-α expression in mice, serving as a valuable resource for assessing the effects of the treatments on inflammatory responses in the study subjects.

Table 4 presents the outcomes of the 1L-1β examination conducted on mice. The table is divided into four distinct groups: the control group, Treatment I (0.5%), Treatment II (1%), and Treatment III (1.5%). Each group records data for replicates, mean values, and concentrations measured in nanograms per liter (ng/L). IL-1*β* plays a crucial role in regulating various immune and inflammatory processes. It is produced by immune cells in response to various stimuli, such as infection or tissue damage, and it is involved in initiating and regulating the inflammatory response. Abnormal levels of IL-1*β* are associated with various inflammatory and autoimmune diseases.

Table 5 presents the results of a comprehensive statistical analysis utilizing Multivariate Analysis of Variance (MANOVA). This analysis was conducted to investigate variations in key parameters, including delta temperature, brain infarct volume, TNF-α levels, and 1L-1β levels, following the application of a gel compress containing extract from Jatropha leaves. The research explores the effects of this treatment on these critical variables in the mice models. The "Group" column categorizes the observations into their respective treatment groups. The "Average values" columns provide the mean values for delta temperature, brain infarct volume, TNF-α, and 1L-1β across the four groups. Furthermore, the corrected model statistics are presented, denoting the impact of treatment on these parameters.

As observed in Table 5, the analysis of TNF-α and IL-1*β* levels reveals the most promising results in groups administered with Jatropha leaves extract. The most significant temperature decline was noted in the groups treated with gel compresses containing 1% and 1.5% concentrations of Jatropha leaf extract. Infarction volume exhibited a consistent trend across all four treatment groups, showing no statistically significant variation. The results from the MANOVA analysis underscore the significant impact of the treatment. Specifically, the corrected model values for TNF-α, IL-1*β*, and delta temperature demonstrate statistical significance with a p-value of <0.05. This implies that the concentration of the extract exerts a discernible effect on these three variables. However, this significant influence does not extend to infarction volume ($p>0.05$).

Post hoc tests were conducted to enable a detailed comparison of each group to gain deeper insights, further clarifying the superior performance of specific variables within the study. This analysis helps to substantiate the therapeutic potential of the Jatropha leaf extract gel and its distinct impact on various variables of interest in the current experimental model.

Table 6 provides the results of post hoc tests for comparing the four different treatment groups: Control, 0.5% Jatropha leaf extract, 1.0% extract, and 1.5% extract, across various key parameters, including delta temperature, brain infarction volume, TNF-α levels, and 1L-1β levels in a mice model. The values in the table represent the significance levels, which are p-values, for these post hoc comparisons.

For delta temperature, it is evident that the Control group is significantly different from the 1.0% and 1.5% treatment groups, with p-values of 0.02 ($p<0.05$), indicating a substantial temperature reduction in these two treatment groups. The 0.5% treatment group differs significantly from the 1.0% and 1.5% groups. This implies that

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the 1.0% and 1.5% Jatropha leaf extract treatments led to notable temperature declines compared to the Control and 0.5% groups. All groups exhibit a p-value of 1.00 regarding brain infarction volume, suggesting no significant differences among them in this aspect. The results for TNF-α and 1L-1β levels follow a similar pattern, with the 1.0% and 1.5% treatment groups demonstrating significant differences compared to the Control and 0.5% groups.

The post hoc tests revealed that the 1.0% and 1.5% Jatropha leaf extract treatments have distinct and significant effects on temperature reduction, TNF-α levels, and 1L-1β levels compared to the Control and 0.5% groups. However, all the groups have no significant differences in brain infarction volume. These findings provide valuable insights into the impact of different Jatropha leaf extract concentrations on various physiological parameters in the mice model.

This study aimed to evaluate the impact of *Jatropha curcas* L. leaf extract, administered as a gel, on body temperature in mice models subjected to Unilateral Cerebral Artery Occlusion (UCAO) for 45 minutes. The results indicate that the control group exhibited an average temperature change from 35.0°C to 35.3°C throughout the experiment period, excluding the mice samples that did not survive (Table 1).

Table 1: The average measurement result of mice's body temperature during the experiment

Group/ Sample	Average temperature (°C) for each week								
	Pre	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**
Group 1: Control group									
1.1	35.4	35.5	36.1	34.5	34.8	34.1	34.3	35.1	34.1
1.2	33.5	33.9	34.6	34.5	35.1	35.2	35.4	35.1	34.8
1.3	NA	NA	NA	NA	NA	NA	NA	NA	NA
1.4	35.9	35.8	36.3	36.4	36.9	36.6	36.1	36.3	35.8
1.5	35.0	35.2	35.5	33.5	35.6	34.8	35.0	34.5	36.8
1.6	35.2	35.5	35.9	36.0	36.2	36.5	36.7	36.9	35.0
1.7	34.5	34.7	35.8	36.0	36.4	36.5	36.2	36.6	NA
	34.9 ± 0.8	35.1 ± 0.7	35.7 ± 0.6	35.2 ± 1.1	35.8 ± 0.8	35.6 ± 1.1	35.6 ± 0.9	35.8 ± 1.0	35.3 ± 1.0
Group 2: Treatment I with the formula level of 0.5%									
2.1	35.5	35.4	35.2	34.7	34.6	35.8	34.7	34.7	36.3
2.2	35.0	34.8	35.8	34.3	34.6	33.8	33.5	33.7	33.7
2.3	35.5	35.2	35.4	35.6	34.8	33.9	34.1	34.6	34.3
2.4	35.0	34.8	35.2	34.5	34.9	34.7	34.6	35.1	34.4
2.5	34.7	34.3	35.4	34.8	35.0	34.0	34.1	35.7	35.4
2.6	34.0	33.9	34.5	34.6	33.4	33.6	34.5	34.6	37.0
2.7	34.8	34.5	33.6	33.7	35.3	34.8	35.0	35.5	35.6
	34.9 ± 0.5	34.7 ± 0.5	35.0 ± 0.7	34.6 ± 0.6	34.7 ± 0.6	34.4 ± 0.8	34.4 ± 0.5	34.8 ± 0.7	35.2 ± 1.2
Group 3: Treatment II with the formula level of 1%									
3.1	36.0	35.8	35.5	35.8	35.1	35.0	34.5	34.1	35.2
3.2	35.7	35.2	35.0	35.1	34.3	34.1	34.2	34.0	35.8
3.3	35.0	34.6	34.4	34.1	34.0	33.9	33.7	33.5	36.3
3.4	35.6	35.1	35.0	34.6	34.3	34.1	34.0	33.7	35.6
3.5	36.0	35.5	35.8	35.6	35.7	34.7	34.8	34.1	36.7
3.6	36.2	36.0	35.9	35.5	34.6	34.4	34.1	34.0	36.9
3.7	36.5	36.2	35.0	34.9	34.8	34.5	34.3	34.0	36.5
	35.9 ± 0.5	35.5 ± 0.6	35.2 ± 0.5	35.1 ± 0.6	34.7 ± 0.6	34.4 ± 0.4	34.2 ± 0.4	33.9 ± 0.2	36.1 ± 0.6
Group 4: Treatment III with the formula level of 1.5%									
4.1	35.6	35.4	35.7	36.3	34.3	34.0	35.4	36.2	35.7
4.2	36.7	36.4	35.0	34.7	37.0	35.1	36.4	35.2	32.7
4.3	36.3	36.1	34.1	33.9	34.8	35.1	36.6	34.8	35.2
4.4	36.8	36.6	35.3	34.5	34.8	35.1	36.6	34.8	34.2
4.5	36.9	35.7	35.4	35.1	34.7	35.2	35.7	35.2	36.3
4.6	35.7	35.5	35.1	35.6	35.7	35.6	35.5	36.3	36.5
4.7	36.3	36.3	36.0	35.8	34.8	34.8	36.1	35.2	36.2
	36.3 ± 0.5	36.0 ± 0.5	35.2 ± 0.6	35.1 ± 0.8	35.2 ± 0.9	35.0 ± 0.5	36.0 ± 0.5	35.4 ± 0.6	35.3 ± 1.4

NA: the mice sample did not survive

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Table 2: The result of mice brain infarct volume during the experiment

Group/Sample	Σp	Brain volume (mm^3)	Group/Subject	Σp	Brain volume (mm^3)
Group 1: Control Group			**Group 3: Treatment II (1%)**		
1.1	81.25	650	3.1	68.75	550
1.2	63.21	506	3.2	70.00	560
1.3	NA	NA	3.3	76.75	614
1.4	68.00	544	3.4	77.25	618
1.5	73.25	586	3.5	62.00	496
1.6	68.50	548	3.6	77.00	616
1.7	NA	NA	3.7	73.75	590
	70.8 ± 6.8	566.8 ± 54.5		72.2 ± 5.7	577.7 ± 45.3
Group 2: Treatment I (0.5%)			**Group 2: Treatment III (1.5%)**		
2.1	64.50	516	4.1	72.50	580
2.2	83.25	666	4.2	68.50	548
2.3	82.75	662	4.3	66.75	534
2.4	63.25	506	4.4	69.50	556
2.5	58.75	470	4.5	64.50	516
2.6	65.75	526	4.6	76.25	610
2.7	64.00	512	4.7	77.25	618
	68.9 ± 9.9	551.1 ± 79.1		70.8 ± 4.8	566.0 ± 38.3

NA: the mice sample did not survive

Table 3: Results of the TNF-α examination on mice during the experiment

Group/ Sample	Mean	Conc. (ng/L)	Group/ Sample	Mean	Conc. (ng/L)
1.1	1.007	288.710	3.1	0.364	74.491
1.2	1.096	318.267	3.2	0.188	15.750
1.3	NA	NA	3.3	0.347	68.667
1.4	1.122	326.985	3.4	0.353	70.667
1.5	1.110	322.929	3.5	0.470	109.667
1.6	0.676	178.413	3.6	0.554	137.667
1.7	NA	NA	3.7	0.198	19.000
	1.0 ± 0.2	287.1 ± 62.6		0.4 ± 0.1	70.8 ± 44.2
2.1	0.690	183.043	4.1	0.191	16.667
2.2	0.712	190.346	4.2	0.518	125.667
2.3	0.734	197.649	4.3	0.275	44.667
2.4	0.548	135.743	4.4	0.233	30.667
2.5	0.616	158.171	4.5	0.358	72.333
2.6	0.531	129.869	4.6	0.378	79.000
2.7	0.205	21.207	4.7	0.366	75.000
	0.6 ± 0.2	145.1 ± 60.7		0.3 ± 0.1	63.4 ± 36.4

The average minimum temperature for this group occurred during the third week (35.0°C). In contrast, the treatment groups displayed varying degrees of temperature reduction. Treatment group 1, which received 0.5% Jatropha leaf extract, exhibited an average temperature drop from 34.7°C to 34.4°C at week five. Treatment group 2, administered with 1% extract, displayed a decline from 35.9°C to 33.9°C at week seven, while treatment group 3, with a 1.5% extract, showed the average temperature reduction from 36.3°C to 35.0°C on week five.

The MANOVA results revealed significant temperature changes before and after treatment (Table 5). Post hoc Mann-Whitney tests further highlighted that the 1% and 1.5% Jatropha leaf extract treatments significantly influenced body temperature recovery ($p<0.05$) (Table 6). These findings align with previous research indicating that lower body temperatures can improve neuron function.[12] Notably, data linking body temperature to ischemia and post-ischemic neuron recovery in Indonesia remains limited.

In support of these results, meta-analyses conducted elsewhere emphasized the importance of temperature management in animal models of ischemia and stroke. Cooling therapy, with temperatures as low as <31°C, has been explored for its benefits in stroke treatment.[13] In this context, the UCAO technique offers an economical and reliable

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method to induce ischemia in the brain network, making it suitable for further investigations.

However, it is important to acknowledge that individual variation in treatment response may be influenced by various factors, including psychological, environmental, and endogenous factors.[14-15] Flavonoids present in Jatropha leaf extract are identified as key contributors to the observed antipyretic effects. Flavonoids, found in various parts of plants, have been associated with prostaglandin inhibition, potentially lowering the body's thermostat in the hypothalamus, thereby reducing body temperature.[16-19] These findings suggest that lower body temperature may be beneficial for stroke patients, as higher temperatures could exacerbate neurological deficits and volume of infarction, potentially leading to long-term disability or mortality.

The examination of brain infarct volume in this study revealed intriguing results across different treatment groups (Table 2). The control group displayed the lowest infarct volume in sample 1.1, measuring 0.65 cm^3. Conversely, in the treatment groups, the lowest infarct volume was observed in sample 2.5, with a measurement of 0.47 cm^3, utilizing the 0.5% formula. For the second-level treatment group (sample 3.1) and the 1% formula, the infarct volume was recorded at 0.55 cm^3, while the III treatment group demonstrated the lowest result in sample 4.1, with an infarct volume of 0.58 cm^3 using the 1.5% formula. Statistical analysis through the Manova test yielded a significance result of 0.854, indicating that the differences in infarct volume between the control group and the treatment groups (I, II, and III) were not statistically significant ($p>0.05$). Furthermore, the post hoc tests also resulted in a significance level of $p>0.05$, suggesting no significant difference between the administration of gel compresses with Jatropha leaf extract at doses of 0.5%, 1%, and 1.5% (Table 5 and Table 6). These findings imply that the treatments did not significantly influence infarct volume in the study.

The observed infarction in this mechanization is induced through carotid artery occlusion, obstructing blood flow to the brain for 45 minutes, resulting in hypoxia in brain tissue.[20] Infarction occurs when blood flow is hindered, leading to brain tissue damage due to insufficient oxygen supply in the affected brain vessels. It is worth noting that the application of the gel leaf extract did not appear to improve infarct volume in mice significantly. Unfortunately, there is limited prior research on the specific effects of this treatment on infarct volume in the literature.[21] The expansion of infarcts in stroke patients is closely linked to the inflammatory response, which can accelerate the development of the penumbra region within the brain. This process exacerbates the composite ischemic condition, eventually merging with the infarct core. Therefore, a key goal in acute ischemic stroke therapy is to inhibit the ischemic process by restoring blood flow to the ischemic area as early as possible.[22] Moreover, arterial systems, particularly the carotid artery system, tend to be more affected, with atherosclerosis primarily occurring at specific sites. Notably, approximately 80% of stroke incidents are associated with the branches of the carotid artery.[23]

Table 4: Results of the 1L-1β examination on mice during the experiment

Group/ Sample	Mean	Conc. (ng/L)	Group/ Sample	Mean	Conc. (ng/L)
1.1	1.129	18.135	3.1	0.616	8.269
1.2	1.016	15.962	3.2	0.796	11.738
1.3	NA	NA	3.3	0.653	8.988
1.4	0.821	12.212	3.4	0.695	9.792
1.5	0.884	13.431	3.5	0.546	6.923
1.6	0.903	13.790	3.6	0.525	6.519
1.7	NA	NA	3.7	0.528	6.577
	1.0 ± 0.1	14.7 ± 2.3		0.6 ± 0.1	8.4 ± 1.9
2.1	0.807	11.950	4.1	0.576	7.500
2.2	0.804	11.885	4.2	0.536	6.731
2.3	0.593	7.827	4.3	0.564	7.269
2.4	0.549	6.981	4.4	0.433	4.750
2.5	0.724	10.346	4.5	0.358	3.308
2.6	0.689	9.673	4.6	0.378	3.692
2.7	0.633	8.596	4.7	0.366	3.462
	0.7 ± 0.1	9.6 ± 1.9		0.5 ± 0.1	5.2 ± 1.9

Table 5: Manova test of delta temperature, brain infarction volume, TNF-α, and 1L-1β of mice model

No	Group	Average value			
		Delta temperature	Infarct volume	TNF-α	1L-1β
1	Control	-0.40	566.80	287.06	14.71
2	0.5%	-0.14	551.14	145.15	9.61
3	1.0%	1.57	577.71	70.84	8.40
4	1.5%	1.57	566.00	63.43	5.24
Corrected model	F	14.44	0.26	23.05	22.25
	SIG.	0.00	0.854	0.00	0.00
Intercept	F	21.54	2540.74	195.66	574.41
	SIG.	0.00	0.00	0.00	0.00

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Table 6: Significant level of post hoc test of delta temperature, brain infarction volume, TNF-α, and 1L-1β of mice model for different doses

Observation		Control	0.5%	1.0%	1.5%
Delta	Control	-	0.97	0.02	0.02
temperature	0.5%	0.97	-	0.01	0.01
	1.0%	0.02	0.01	-	1
	1.5%	0.02	0.01	1	-
Brain infarction	Control	-	1	1.00	1.00
volume	0.5%	1	-	1	1
	1.0%	1.00	1	-	1
	1.5%	1.00	1	1	-
TNF-α levels	Control	-	0.001	0.00	0.00
	0.5%	0.001	-	0.075	0.04
	1.0%	0.00	0.075	-	1
	1.5%	0.00	0.04	1	-
1L-1β levels	Control	-	0.002	0.00	0.00
	0.5%	0.002	-	1	0.003
	1.0%	0.00	1	-	0.044
	1.5%	0.00	0.003	0.044	-

This study did not find a significant impact of Jatropha leaf extract on infarct volume. However, it is essential to acknowledge the complex interplay of factors in stroke and ischemia, including inflammatory responses and arterial systems. Further research is needed to explore the potential therapeutic effects of Jatropha leaf extract on infarct volume.

The effect of compressed Jatropha leaves (*Jatropha curcas* L) were evaluated on the levels of TNF-α and IL-1*β*, which are key inflammatory markers. The results showed variations in TNF-α and IL-1*β* levels among the different treatment groups and concentrations (Table 3 and Table 4). For TNF-α levels, the lowest results were observed in sample 1.6 of the control group, measuring 178.413 ng/L. In contrast, the treatment groups displayed variations in the lowest TNF-α levels: sample 2.7 (0.5% formula) at 21.207 ng/L, sample 3.2 (1% formula) at 15.750 ng/L, and sample 4.1 (1.5% formula) at 16.667 ng/L. Manova tests for TNF-α and IL-1*β* yielded significant results with p-values less than 0.05, indicating that the treatments influenced these inflammatory markers. Further analysis using post hoc tests revealed that the 1% and 1.5% concentrations of Jatropha leaf extract significantly impacted TNF-α levels (Table 5 and Table 6). Similarly, for IL-1*β*, all concentrations showed significant effects on its levels. Notably, the 0.5% concentration had a p-value of 0.002, suggesting that it may be less effective in improving IL-1*β* levels than the 1% and 1.5% concentrations.

Inflammation plays a crucial role in the onset of strokes and contributes to the subsequent damage.[24] Inflammation within the arterial system is closely linked to the development of atherosclerosis, and arterial thrombosis is associated with ulcerated plaques.[25] The high risk of stroke has been correlated with elevated levels of inflammatory markers such as C-reactive protein, ESR, Interleukin-6, TNF-α, and other pro-inflammatory molecules.[26-27] In stroke-related disabilities, the inflammatory response leads to the expansion of infarcts, characterized by heightened levels of inflammatory cytokines like TNF-α and IL-1*β*. As immune system proteins, cytokines significantly impact immune responses and regulate antibodies and cell interactions.[28] Specific cytokines, particularly TNF-α and IL-1*β*, are associated with the inflammatory processes that occur in acute ischemic stroke.[6]

The study results propose that the inflammatory reaction in ischemic stroke plays a crucial role during the initial phase. Both cellular (neutrophils) and molecular (cytokines) components contribute to this reaction. Specifically, the examined cytokines, TNF-α and IL-1*β*, are key contributors to the inflammatory response, especially in relation to macrophage activation. This research suggest that the use of compressed Jatropha leaves has a notable impact on TNF-α and IL-1*β* levels, indicating its potential as a therapeutic approach in addressing stroke and inflammatory responses. Further investigation is needed to understand the mechanisms behind these effects and to explore the clinical implications of these findings in stroke management.

Conclusion

In conclusion, this study underscores the considerable influence of *Jatropha curcas* leaf extract on enhancing temperature, mitigating TNF-α and IL-1*β* levels in the post-ischemic mouse brain. The observed disparities between the control and treatment groups highlight the potential therapeutic significance of Jatropha leaf extract in regulating these factors, excluding its impact on brain infarct volume. Subsequent post hoc analyses pinpoint the optimal compress gel formula, with the 1.5% concentration emerging as the most effective choice. This research contributes valuable insights aligned with the research objectives, shedding light on the promising therapeutic applications of *Jatropha curcas* L leaf extract in alleviating the adverse effects of brain ischemia.

Conflict of Interest

The authors declare no conflict of interest.

Authors' Declaration

The authors hereby declare that the work presented in this article is original and that any liability for claims relating to the content of this article will be borne by them.\

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