ABSTRACT

Objective: To investigate the anti-hyperlipidemic, anti-inflammatory and analgesic properties of Eurycoma longifolia root extract in animal models.

Methods: In this study, glucose-fructose enriched diet-induced hyperlipidemia, carrageenan-induced paw edema and acetic acid-induced writhing were used to evaluate the anti-hyperlipidemic, anti-inflammatory and analgesic activities, respectively. At the end of the experiment, the results demonstrated a significant reduction of triglyceride levels (p<0.05) compared with the control group in glucose-fructose enriched diet in rats. In anti-inflammatory test, the extract significantly inhibited the carrageenan-induced paw edema formation (p<0.05). The extract also significantly decreased the number of writhing in acetic acid-induced mice (p<0.05).

Conclusion: E. longifolia root extract demonstrated a significant reduction of triglyceride levels (p<0.05) compared with the control group in glucose-fructose enriched diet in rats. In anti-inflammatory test, the extract significantly inhibited the carrageenan-induced paw edema formation (p<0.05). The extract also significantly decreased the number of writhing in acetic acid-induced mice (p<0.05).

Keywords: Eurycoma longifolia, Antihyperlipidemic, Antihypertriglyceridemia, Anti-inflammatory, Analgesic

INTRODUCTION

Obesity and the metabolic syndrome continue to plague the world at an alarming rate. Those will cause both substantial socio-economic and physical burden in society. WHO reported that in 2014, over 1.9 billion adults were estimated to be overweight and more than 600 million obese [1].

Recently people have been using natural products and plant to treat a wide variety of clinical disease. One of the most popular traditional plants Eurycoma longifolia Jack (Simaroubaceae) is a well-known folklore herbal medication in Southeast Asia. Wide spectrum of pharmacological activities of E. longifolia has been reported [2-5]. Despite wide range of traditional uses known, it is most solely for its aphrodisiac and anti-malarial properties [2-7]. Previous research shows that extracts from the roots of E. longifolia suppressed intracellular lipid accumulation in 3T3-L1 adipocytes, a treatment target for an obesity agent [8]. Based on the previous study and traditional use, the present investigation was carried out to evaluate the antihyperlipidemic, anti-inflammatory and analgesic activities of E. longifolia root extract in animal models.

MATERIALS AND METHODS

Plant material and chemicals

E. longifolia was supplied by Merapi Farma Herbal Co. (Batch No. SL.1A.2015. PB; Yogyakarta, Indonesia) and were collected from Kalimantan Island Indonesia. The voucher specimen was deposited at the Laboratory of Pharmaceutical Biology, Faculty of Pharmacy Sanata Dharma University in Yogyakarta Indonesia. The following chemicals were used: sodium carboxy methyl cellulose/CMC-Na (Bratoco Chemika, Indonesia); glucose, fructose, methanol and acetic acid (E. Merck, Darmstadt, Germany); and carrageenan (Sigma Chemical Company). Diagnostic kit for the estimation of Cholesterol, high-density lipoprotein cholesterol (HDL-c), low-density lipoprotein cholesterol (LDL-c), triglyceride (TG) kits were purchased were from Roche Diagnostics GmbH, Mannheim, Germany. All other chemicals were of analytical grade and were purchased from E. Merck, Darmstadt, Germany. Instruments used in this study included Cobas C501 (Roche Diagnostics) for serum chemistry analysis.

Preparation of E. longifolia root extract

The root of E. longifolia were powdered and extracted with 95% (v/v) methanol for 48 h at room temperature. The methanol extract was then distilled, evaporated to obtain semisolid E. longifolia root extract (EL) (yield 9.32%) and re-dissolved in CMC-Na (1% w/v).

Test animals and housing

28 adult male Wistar rats (150-250 g), and 25 adult male and 25 female Swiss mice (20-30 g) were obtained from the Imuno Laboratory, Sanata Dharma University, Indonesia. The animals were maintained under standard laboratory condition. They were housed in standard cages (five animals per cage) at temperature 22 ±2 °C and 12:12 light dark cycle. The animals were provided with pelleted diet as normal diet or glucose-fructose enriched diet (GFED) and water ad libitum. All procedures described were reviewed and approved with approval number KE/KF/337/EC by Medical and Health Research Ethics Committee Faculty of Medicine Gadjah Mada University Yogyakarta Indonesia.

Antiobesity study

Healthy male rats were fasted overnight and randomly divided into four groups each containing 7 animals. The control group was fed normal diet until the end of treatment. The remaining groups were fed GFED for 42 d [9]. Following confirmation of GFED-induced hypertriglyceridemia, the three groups were then divided into group I (EL 75 mg/kg/b/w), group II (EL 150 mg/kg/b/w) [10], and group GFED-control (continued with vehicle). All treatments were continued for 5 d following oral administration. At the end of treatment, rats in all groups were anesthetized with ketamine. The blood was collected from all groups of rats by retro-orbital sampling for serum chemistry analysis. Serum lipid profile tests were measured using commercial kits (Roche Diagnostics).
Anti-inflammatory study

Male Swiss mice were divided into five groups randomly (negative control, positive control and dose groups), consisting of 5 mice in each group. Acute edema was induced by the injection of carrageenan1% (prepared in normal saline) into the sub-plantar region of hind-paw of mice [11]. Then, each group was treated orally with 1% CMC-Na (negative control), 4.48 mg/kg BW of diclofenac sodium (positive control), and treatment doses of 105, 210 and 420 mg/kg BW EL [10]. Edema thickness was measured using digital caliper at 0, 15, 30, 45, 60, 90, 120, 150, 180, 210, 240, 270, 300, 330, and 360 min after carrageenan injection [12, 13]. The calculation of the edema volume was conducted using formula area under curve (AUC) and percentage of inhibition of inflammation [13-15].

Area under curve (AUC) was calculated for each minute within 0-6 h using trapezoid method formula, as below:

\[
AUC_{t_n} = \frac{AUC_{t_n+1} + T_{n}}{2} (t_n - t_{n+1})
\]

\(T_{n}\): Average edema volume on \(t_{n+1}\)

\(T_{n}\): Average edema volume on \(t_n\)

Analgesic study

The analgesic activity of EL was tested using acetic acid-induced writhing method [11, 14, 15, 17]. Female mice Swiss were divided randomly into five groups (n=5). Group I as negative control received 1% CMC-Na, group II as positive control received 91 mg/kg BW of aspirin, group III-V received 105, 210 and 420 mg/kg BW of EL respectively. After 5 min of treatment, all animals were administered 1% with 50 mg/kg BW of acetic acid intraperitoneally. The total number of writhes was recorded at intervals of 5 min for a period of 1 h. The calculation of percentage of inhibition using the following ratio: (control mean–treated mean)/control mean x 100 [14, 15].

Table 1: Effect of E. longifolia root extract on lipid parameters in rats feeds with glucose-fructose enrich diet (GFED)

| Treatment               | Cholesterol (mmol/l) | Triglyceride (mmol/l) | HDL-c (mmol/l) | LDL-c (mmol/l) |
|-------------------------|----------------------|-----------------------|----------------|----------------|
| Normal diet             | 1.74±0.16            | 1.08±0.09a            | 1.65±0.08b     | 0.21±0.05      |
| GFED                   | 1.86±0.05            | 3.08±0.21b            | 0.94±0.07b     | 0.24±0.04      |
| GFED+EL 75 mg/kg BW    | 1.69±0.26            | 2.69±0.34ab           | 0.92±0.07b     | 0.25±0.06      |
| GFED+EL 150 mg/kg BW   | 1.88±0.17            | 0.43±0.05ab           | 0.70±0.08ab    | 0.37±0.07ab    |

Values are expressed as mean±SD of seven animals in each group; a: p<0.05 vs normal diet; b: p<0.05 vs GFED

Effect of E. longifolia root extract on carrageenan-induced mice

The anti-inflammatory activity of E. longifolia root extract against carrageenan induced paw edema showed that the extracts exhibit significantly (p<0.05) and dose-dependently reduced the paw edema swelling (table 2). The percentage inhibition in the paw edema in mice treated with E. longifolia root extract was found to be 15.7; 22.0 and 26.8% at the dose of 105; 210 and 420 mg/kg BW respectively.

Table 2: Effect of E. longifolia root extract on carrageenan-induced mice

| Treatment                        | AUC   | % inhibition |
|----------------------------------|-------|--------------|
| Negative control (CMC Na)        | 4267± 18.3b | 0.0          |
| Positive control (diclofenac sodium 4.48 mg/kg BW) | 2559 ± 16.8ab | 40.0          |
| EL 105 mg/kg BW                  | 3596 ± 5.8b | 15.7         |
| EL 210 mg/kg BW                  | 3330 ± 5.6b | 22.0         |
| EL 420 mg/kg BW                  | 3124 ± 4.9b | 26.8         |

Values are expressed as mean±SD of five animals in each group; a: p<0.05 vs negative control; b: p<0.05 vs positive control

Effect of E. longifolia root extract on acetic acid-induced writhing in mice

Table 3 showed the effect of E. longifolia root extract on acetic acid-induced writhing in mice. All of the doses of E. longifolia root extract produced significant (p<0.05) reduction of writhing by the acetic acid in a dose dependent manner.

Table 3: Effect of E. longifolia root extract on acetic acid induced writhing in mice

| Treatment                        | Number of writhing | % inhibition |
|----------------------------------|--------------------|--------------|
| Negative control (CMC Na)        | 57.6 ± 1.1a        | 0.0          |
| Positive control (aspirin 91 mg/kgBW) | 16.2 ± 1.3a        | 71.9         |
| EL 105 mg/kg BW                  | 43.0 ± 1.0ab       | 25.4         |
| EL 210 mg/kg BW                  | 24.6 ± 2.1ab       | 57.3         |
| EL 420 mg/kg BW                  | 23.6 ± 4.2ab       | 59.0         |

Values are expressed as mean±SD of five animals in each group; a: p<0.05 vs negative control; b: p<0.05 vs positive control
The authors declare that they have no conflicts of interest.

Several studies have reported that a high carbohydrate diet is responsible for the development of hypertriglyceridemia in rodent models [9, 18-20]. Hypertriglyceridemia occurs because high fructose in the blood leads to increased de novo hepatic fatty acid synthesis and, subsequently, this releases a high amount of TG [21]. The E. longifolia root extract used in our study reduced TG levels induced by glucose-fructose enrich diet. Therefore, the E. longifolia root extract has a potent anti-hypertriglyceridemic activity in rats. These reductions of TG may be associated with a previous in vitro report in which E. longifolia suppressed lipid accumulation in 3T3-L1 adipocytes [8].

Carrageenan, as irritant substances, induced inflammation in biphasic event. The initial phase is associated to the release of serotonin, histamine, and bradykinin; while the late phase is attributed to the release of prostaglandin and inducible cylooxygenase that increasing vascular permeability and the neutrophil infiltration into the inflammatory site and production of free radicals that cause edema [22]. In our results, the E. longifolia root extract significantly inhibited paw edema-induced carrageenan in all the dose level.

Additionally, the E. longifolia root extract showed significant analgesic action at V1a, V2, and V2a levels (105, 201, and 420 mg/kg BW). Analgesic effect was evaluated using acetic acid-induced writhing test in mice. Acetic acid injection has been associated with increased level of E and F prostaglandins in peritoneal fluids as well as lipooxygenase products [23]. The significant reduction of E. longifolia root extract might be due to the presence of analgesic principles acting with the prostaglandin pathways.

It has been reported that E. longifolia contains quassinoids, triterpene, bipherineoleinoglmal and alkaidogl [7, 24-26]. The presence of eurycomaolxone, 14,15-dihydroxyeurycomanol and 13, 21-dehydroeurycomanol in E. longifolia root were identified as potent NF-kB inhibitors [27, 28]. They act by inactivation of the NF-kB signaling pathway, a pro-inflammatory transcriptional factor. Therefore, their inhibition results in anti-inflammatory effect. Anti-inflammatory and analgesic effects of E. longifolia root extract in this study are in agreement with a previous study. Han et al. demonstrated that methanolic extract of E. longifolia root has a potential analgesic agent on both heat-induced pain and chemical induced pain in hot plate test and acetic acid-induced writhing test, respectively. Methanolic extract of E. longifolia root also has anti-inflammatory agent on carrageenan-induced paw edema [10].

CONCLUSION

In conclusion, we can confirm that E. longifolia root extract are endowed with anti-hypertriglyceridemic, anti-inflammatory and analgesic properties that support to the traditional use of this plant. However, further study is needed to investigate the mechanisms of pharmacological effects.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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