Evaluation of the Anti-Pyretic Properties of Aqueous Leaf Extract of Luffa Cylindrica in Baker's Yeast-Induced Pyrexia in Wistar Rats

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ABSTRACT

Fever is a common clinical symptom of many infectious and inflammatory conditions, often managed with synthetic antipyretics that pose safety concerns in vulnerable populations. This study investigated the anti-pyretic potential of aqueous leaf extract of Luffa cylindrica using Baker's yeast-induced pyrexia model in Wistar rats. Twenty (20) rats were divided into five groups (n=4). Group 1 animals were treated with 0.5 ml distilled water as the normal control. Group 2 were treated with 0.4% Baker's yeast only as the negative control. Group 3 were treated with 0.4% yeast and 800 mg/kg Luffa cylindrica extract. Group 4 were treated with 0.4% yeast and 1600 mg/kg Luffa cylindrica extract. Group 5 were treated with 0.4% yeast and 500 mg/kg paracetamol considered as positive control. Increased rectal temperatures at 1, 2, 3, and 4 hours after administration of treatments in Baker's yeast-induced pyrexia rat model was measured with thermometer. Treatment with extract doses of 800 mg/kg and 1600 mg/kg were compared to paracetamol (500 mg/kg) and a significance decrease ($p<0.05$) was observed in the rectal temperatures, serum biomarkers, interleukin-6 (IL-6), nitric oxide (NO), and C-reactive protein (CRP) and hematological parameters. The extract significantly reduced fever, pro-inflammatory markers and hematological parameters in a dose-dependent manner, supporting its traditional use and potential as a safe natural antipyretic.

Keywords: Luffa cylindrica, pyrexia, fever, baker's yeast, IL-6, nitric oxide, C-reactive protein, Wistar rats

INTRODUCTION

Fever, or pyrexia, is a hallmark of inflammatory and infectious diseases. Though beneficial as part of the immune response, persistent or high fever necessitates intervention (Lai et al., 2021). Common antipyretics like acetaminophen and NSAIDs are effective but carry risks including hepatotoxicity and gastrointestinal distress, especially in children and the elderly (Grosser et al., 2011). Partap et al., (2012) describes Luffa cylindrica, otherwise commonly called sponge gourd, loofa, vegetable sponge, bath sponge or dish cloth gourd, as a member of cucurbitaceouse family. Other members of the family include: snake gourd, pumpkins and cucumbers (Azeez et al., 2013). It is a fibrous plant with smooth and cylindrically shaped fruits containing black seeds. One mature Luffa sponge will produce at least 30 seeds. Some will produce many more (Khan et al., 2017). Luffa cylindrica features alternate, palmately-lobed leaves attached by a petiole. The leaves typically measure around 13 cm in length and 30 cm in width, ending in a pointed lobe. They are smooth and have toothed margins. The plant produces yellow flowers that bloom between August and September (Joshi et al., 2004). Being monoecious, Luffa cylindrica bears both male and female flowers on the same plant—the male flowers form in raceme clusters, while the female flowers appear singly. Its fruit is a large, green, cylindrical gourd that grows by climbing over surrounding structures (Oboh & Aluyor, 2009). Luffa is a subtropical vegetable commonly grown in regions such as Asia, India, Brazil, and the United States, though there is no record of its cultivation in Nigeria (Akinwumi et al., 2022). Beyond its role as a food crop, Luffa has numerous other uses. It is employed in the production of packaging materials, shoe mats, soundproofing linings, bath and dishwashing sponges (Khan et

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al., 2017). Additionally, it serves as an effective adsorbent for removing heavy metals like nickel, lead, chromium, and copper from wastewater, and is used as a support matrix for immobilizing plants, algae, bacteria, and yeast (Oboh & Aluyor, 2009; Demir et al., 2008; Laidani et al., 2011). In an analysis carried by Akinwumi et al., (2022), it was discovered that the methanol extract of luffa cylindrica leaves displayed antipyretic activity by decreasing the rectal temperature of experimental animals at the studied doses. This analysis was based on an already propounded work by Saliu et al., (2019) that noted also that luffa impeded the compression of abdominal walls in experimental animals, which were induced with agony sensation depending on the dose. The search for safer, plant-based alternatives has drawn attention to Luffa cylindrica, a cucurbitaceous plant traditionally used in African medicine for managing fever and inflammation (Onyegbule et al., 2018). This study evaluates its anti-pyretic activity using a yeast-induced fever model, which closely mimics infectious fever in humans.

MATERIALS AND METHODS

Sample Collection and Preparation

Leaves of Luffa cylindrica were collected in Abraka, Delta State Nigeria, and was authenticated at the University of Port Harcourt Herbarium. The leaves were air dried in a control temperature 37^0C. After drying the leaves were pulverizing mechanical blender and was further macerated in deionized water, filtered with No.1 Whatman fitter paper and was evaporated with water bath at 40^0C, and stored at 4°C.

Experimental Animals

Adult Wistar rats (150–295g) were purchased and housed under standard laboratory guide conditions. Two acclimatization of animals was done and the animals were allowed access to food and water.

Study Groups and Dosing

Twenty (20) rats were divided into five groups (n=4):

Group 1 were treated with 0.5 ml distilled water as the normal control

Group 2 were treated with 0.4% baker's yeast only as the negative control.

Group 3 were treated with 0.4% yeast and 800 mg/kg Luffa cylindrica extract.

Group 4 were treated with 0.4% yeast and 1600 mg/kg Luffa cylindrica extract.

Group 5 were treated with 0.4% yeast and 500 mg/kg paracetamol considered as positive control

Induction of Pyrexia

Baker's yeast was used for the induction of pyrexia in rats. The pyrexia was induced with subcutaneous injection of 0.05 ml of 0.4% baker's yeast demonstrated by Guo et al., (2014). After 17 hours, rectal temperatures were measured using a digital thermometer. Rats with a temperature increase of ≥ 0.9°C were used for the study.

Treatment and Monitoring

Treatment was administered to the rats and rectal temperatures were measured at 1, 2, 3, and 4 hours post-treatment (Chomchuen et al., 2010).

Biochemical Analysis

Blood samples were collected from all groups, whole blood was used for hematological parameters using auto-analyzer hematological machine and serum levels of IL-6, NO, and CRP were determined using ELISA kits following manufacturer protocols (Boster Bio, USA).

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Statistical Analysis

The results obtained were analyzed statistically. Data are presented as Mean ± SEM. ANOVA followed by LSD post hoc test was used, with significance set at $p \leq 0.05$.

RESULTS

Effect of administration of aqueous leaf of extract of Luffa cylindrica on baker's yeast-induced pyrexia in rats

Table 1 revealed significant differences ($p \leq 0.05$) in rectal temperature in Group 5 when compared with Group 1 and 2 at 1 and 2 hours. At 4 hours, significant reduction ($p \leq 0.05$) in rectal temperature was observed in Group 3 when compared to Group 2.

Table 1: Effect of administration of aqueous leaf of extract of Luffa cylindrica on baker's yeast-induced pyrexia in Wistar rats

Group	Treatment	Initial rectal temperature (ºC)	Rectal temperature (ºC) after drug administration			
			1 hour	2 hours	3 hours	4 hours
1	Control (0.5ml distilled water)	36.50 ± 0.20^{abcde}	36.65 ± 0.22^{ae}	36.15 ± 0.06^{a}	36.15 ± 0.02^{ae}	36.50 ± 0.04^{abcde}
2	Control (-ve) 0.4% yeast	36.85 ± 1.80^{abcde}	38.75 ± 0.53^{bcd}	39.13 ± 0.50^{bd}	37.55 ± 0.10^{bcde}	37.43 ± 0.19^{abde}
3	0.4% yeast + 800mg/kg Luffa cylindrica	36.70 ± 0.46^{abcde}	37.87 ± 0.16^{bcde}	38.13 ± 0.17^{cd}	37.48 ± 0.39^{bcde}	35.97 ± 0.12^{acde}
4	0.4% yeast + 1600mg/kg Luffa cylindrica	37.08 ± 0.22^{abcde}	37.98 ± 0.28^{bcde}	38.40 ± 0.20^{bcd}	37.35 ± 0.56^{bcde}	37.03 ± 0.60^{abcde}
5	0.4% yeast + 500mg/kg Paracetamol	37.08 ± 0.53^{abcde}	37.10 ± 0.26^{acde}	37.28 ± 0.25^{e}	37.08 ± 0.21^{abcde}	36.40 ± 0.64^{abcde}

Values are presented as Mean ± SEM of quadruplicate determinations (n =4). Different superscript letters down the column show significant differences ($p \leq 0.05$) while similar superscript letters indicate non-significant differences.

Effect of oral administration of aqueous leaf extract of Luffa cylindrica on selected biochemical parameters of yeast-induced pyrexia in Wistar rats

Results on Table 2 showed a significant decrease ($p \leq 0.05$) in nitric oxide concentration in Groups 3, 4 and 5 when compared with Group 2. The concentration of nitric oxide of Group 5 administered 500 mg/kg of paracetamol was comparable with that of Groups 3 and 4. Table 3.2 also showed a significant decrease ($p \leq 0.05$) in interleukin-6 concentration in Groups 3 and 5 compared with Group 2. The results also showed a significant decrease ($p \leq 0.05$) in C-reactive protein concentrations in Groups 3, 4 and 5 when compared with Group 2. However, a non-significant increase ($p \geq 0.05$) in C-reactive protein was recorded in Groups 3 and 4 when compared with Group 5.

Table 2: Effect of oral administration of aqueous leaf extract of Luffa cylindrica on selected biochemical parameters of yeast-induced pyrexia in Wistar rats

Group	Treatment	Interleukin-6(Pg/ml)	C-reactive protein(mg/L)	Nitric Oxide(mg/ml)
1	Control (0.5ml distilled water)	249.75 ± 59.79^{abcd}	0.06 ± 0.00^{acde}	0.09 ± 0.00^{acde}
2	Control (-ve) 0.4% yeast	280.10 ± 44.14^{abd}	59.80 ± 4.47^{b}	39.23 ± 10.56^{b}

3	0.4% yeast + 800mg/kg Luffa cylindrica	128.73±15.21^{acde}	0.32±0.26^{acde}	1.98±0.53^{acde}
4	0.4% yeast + 1600mg/kg Luffa cylindrica	168.88±47.59^{acde}	6.82±2.93^{acde}	0.62±0.27^{acde}
5	0.4% yeast + 500mg/kg Paracetamol	101.34±28.61^{cde}	0.28±0.14^{acde}	0.98±0.55^{acde}

Values are presented as Mean ± SEM of quadruplicate determinations (n =4). Different superscript letters down the column show significant differences ($p \leq 0.05$) while similar superscript letters indicate non-significant differences.

Effect of oral administration of aqueous leaf extract of Luffa cylindrica on selected hematological parameters of yeast-induced pyrexia in rats

Results from Table 3 showed non-significant differences in basophils, eosinophils, lymphocytes, neutrophils and ESR counts in all the treated groups when compared to normal and negative control groups. However, monocytes count was significantly higher in Groups 2, 3, 4 and 5 when compared to the control group.

Table 3.3: Effect of oral administration of aqueous leaf extract of Luffa cylindrica on selected hematological parameters of yeast-induced pyrexia in rats

Group	Treatment	ESR (mm/hour)	WBC(X 10^9/L)	Neutrophils (%)	Lymphocytes (%)	Monocytes (%)	Eosinophils (%)	Basophils (%)
1	Control (0.5ml distilled water)	0.00±0.00^{abde}	9.00±0.24^{abcde}	40.00±1.22^{abcde}	48.50±0.61^{abe}	5.00±0.4^{acde}	1.50±0.20^{abde}	0.00±0.00^{abcde}
2	Control (-ve) 0.4% yeast	19.00±6.19^{abcde}	8.30±1.17^{abcde}	39.50±6.90^{abcde}	39.50±3.33^{abcde}	14.00±3.03^{b}	5.25±1.38^{abcde}	0.75±0.48^{abcde}
3	0.4% yeast + 800mg/kg Luffa cylindrica	35.00±15.78^{bcde}	9.90±1.45^{abcde}	54.00±4.43^{abcde}	33.25±3.04^{bcde}	7.75±1.11^{acde}	7.00±1.08^{bcde}	0.50±0.29^{abcde}
4	0.4% yeast + 1600mg/kg Luffa cylindrica	17.00±7.72^{abcde}	6.90±0.49^{abcd}	53.25±5.17^{abcde}	33.50±3.10^{bcde}	7.50±1.71^{acde}	5.50±1.55^{abcde}	0.25±0.25^{abcde}
5	0.4% yeast + 500mg/kg Paracetamol	25.00±5.97^{abcde}	12.55±3.40^{abce}	45.75±8.15^{abcde}	42.25±6.18^{abcde}	6.50±2.60^{acde}	4.00±2.12^{abcde}	1.50±1.19^{abcde}

Values are presented as Mean ± SEM of quadruplicate determinations (n =4). Different superscript letters down the column show significant differences ($p \leq 0.05$) while similar superscript letters indicate non-significant differences.

DISCUSSION

Table 1 presents the initial and subsequent rectal temperatures at 1, 2, 3, and 4 hours after administration of treatments in a Baker's yeast-induced pyrexia rat model. The data reflects the antipyretic efficacy of Luffa cylindrica aqueous leaf extract compared to paracetamol and controls. Baseline rectal temperatures across all groups were similar (36.50°C to 37.08°C), indicating homogeneity prior to intervention. The negative control group administered 0.4% yeast (Group 2) exhibited a significant rise in rectal temperature peaking at 39.13 ± 0.50°C at 2 hours post-administration, consistent with the induction of pyrexia (Farkas et al., 2021). Elevated temperatures persisted at 3 and 4 hours, confirming sustained febrile response. Rats treated with 800 mg/kg Luffa cylindrica (Group 3) showed a moderate increase in temperature at 2 hours (37.87 ± 0.16°C) and 3 hours (38.13 ± 0.17°C), which was significantly lower than the yeast-only group (Group 2). This suggests partial attenuation of fever. At 4 hours, the temperature reduced to 35.97 ± 0.12°C, lower than baseline and the yeast control, indicating effective antipyretic activity over time. The 1600 mg/kg dose (Group 4) also demonstrated a significant reduction compared to yeast-only, with temperatures decreasing gradually from 37.98 ± 0.28°C at 2 hours to 37.03 ± 0.60°C at 4 hours, supporting a dose-dependent antipyretic effect. The paracetamol-treated group (500 mg/kg, Group 5) exhibited the most pronounced antipyretic effect. Rectal temperature peaked at 37.28 ± 0.25°C at 2 hours, significantly lower than yeast-only, and decreased steadily to 36.40 ± 0.64°C by 4 hours, near normal physiological temperature. This aligns with paracetamol's well-established antipyretic

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mechanisms via inhibition of prostaglandin synthesis in the hypothalamus (Suleyman et al., 2020). The data demonstrate that baker's yeast effectively induces pyrexia in Wistar rats, reflected by significant elevation in rectal temperatures. Treatment with aqueous leaf extract of Luffa cylindrica attenuates this febrile response in a dose-dependent manner, though the effect is less potent than paracetamol.

Table 2 presents the levels of key inflammatory biomarkers—Interleukin-6 (IL-6), C-reactive protein (CRP), and Nitric Oxide (NO)—following treatment with Luffa cylindrica leaf extract and paracetamol in a yeast-induced pyrexia model. Interleukin-6 (IL-6) is a pro-inflammatory cytokine pivotal in fever induction and acute-phase responses (da Silva et al., 2022). The control group (Group 1) had baseline IL-6 levels of approximately 250 pg/ml. Yeast treatment (Group 2) increased IL-6 slightly to 280 pg/ml, consistent with an activated inflammatory state (Tanaka et al., 2014). Treatment with Luffa cylindrica at 800 mg/kg (Group 3) significantly reduced IL-6 levels to 128.73 pg/ml, showing anti-inflammatory potential. The higher dose (1600 mg/kg, Group 4) also reduced IL-6 to 168.88 pg/ml, though less dramatically. Paracetamol treatment (Group 5) resulted in the lowest IL-6 levels (101.34 pg/ml), confirming its well-known anti-inflammatory effects (Prescott, 2000). C - reactive protein (CRP) is an acute-phase protein produced by the liver in response to IL-6 and serves as a systemic inflammation marker (Pepys & Hirschfield, 2003). The yeast control group (Group 2) showed a markedly elevated CRP level (59.80 mg/L) compared to the baseline control (0.06 mg/L), confirming systemic inflammation induction. Both doses of Luffa cylindrica dramatically reduced CRP levels to near baseline (0.32 mg/L and 6.82 mg/L for 800 mg/kg and 1600 mg/kg, respectively), indicating potent anti-inflammatory effects. Paracetamol also reduced CRP significantly to 0.28 mg/L. Nitric Oxide (NO) is a reactive nitrogen species involved in vasodilation and inflammatory signaling but can contribute to tissue damage when overproduced (Bogdan, 2001). Yeast treatment induced a substantial increase in NO levels (39.23 mg/ml), consistent with inflammatory stress. Luffa cylindrica at both doses reduced NO levels significantly (1.98 mg/ml at 800 mg/kg and 0.62 mg/ml at 1600 mg/kg), suggesting modulation of inflammatory mediators. Paracetamol also lowered NO to 0.98 mg/ml. Yeast-induced pyrexia in Wistar rats caused elevated levels of IL-6, CRP, and NO, reflecting a robust systemic inflammatory response. Treatment with aqueous leaf extract of Luffa cylindrica substantially suppressed these pro-inflammatory markers in a dose-dependent manner, comparable to paracetamol, a standard antipyretic and anti-inflammatory drug. These results support the anti-inflammatory and immunomodulatory potential of Luffa cylindrica, possibly linked to bioactive compounds such as flavonoids and saponins (Feng et al., 2022).

In table 3, control group (Group 1, distilled water) showed an Erythrocyte Sedimentation **(**ESR) of 0.00 mm/hour, indicating no inflammatory response. Yeast administration alone (Group 2) increased ESR markedly to 19.00 mm/hour, consistent with an inflammatory reaction, as ESR is a nonspecific marker of inflammation (Gabriel & Michaud, 2009). Treatment with 800 mg/kg Luffa cylindrica (Group 3) further increased ESR to 35.00 mm/hour, which may indicate an immune-modulating or pro-inflammatory effect at this dose or possibly a transient increase due to immune activation. The 1600 mg/kg dose (Group 4) lowered ESR back to 17.00 mm/hour, closer to the yeast control, suggesting a dose-dependent modulation of inflammatory response. Paracetamol treatment (Group 5) resulted in an intermediate ESR of 25.00 mm/hour, consistent with its known anti-inflammatory effects though less pronounced than higher doses of Luffa cylindrica. The control (Group 1) White Blood Cell Count **(**WBC) was 9.00×10^9/L, within normal range for rats. Yeast treatment alone (Group 2) slightly reduced WBC to 8.30×10^9/L, possibly due to leukocyte redistribution during acute inflammation. 800 mg/kg Luffa cylindrica (Group 3) increased WBC to 9.90×10^9/L, suggesting immune stimulation. 1600 mg/kg dose (Group 4) decreased WBC to 6.90×10^9/L, indicating potential immunosuppressive or regulatory effects at higher doses. Paracetamol (Group 5) increased WBC significantly to 12.55×10^9/L, possibly reflecting its immunomodulatory activity beyond antipyretic action. Neutrophils in control rats were 40%, and yeast alone did not significantly alter this (39.5%). Both Luffa cylindrica doses increased neutrophils considerably (54.0% and 53.25%), indicating enhanced innate immune response and neutrophil mobilization, critical in early inflammation (Niemietz, et al., 2020). Paracetamol also elevated neutrophils (45.75%) but less than the extract. Control rats had lymphocytes at 48.5%, which dropped to 39.5% after yeast treatment, consistent with stress or inflammatory-induced lymphocyte redistribution. Both doses of Luffa cylindrica reduced lymphocytes further (~33%), indicating a shift in leukocyte profile, possibly balancing the immune response between innate and adaptive arms. Paracetamol-treated rats maintained higher lymphocyte levels (42.25%) compared to extract-treated groups. Yeast caused a marked increase in monocytes from 5.0% (control) to 14.0%, reflecting monocytosis typical in inflammation (Davies et al., 2013). Both Luffa cylindrica doses significantly lowered

monocytes (~7.5–7.75%), suggesting a modulatory effect reducing monocyte-driven inflammation. Paracetamol showed similar monocyte suppression (6.5%). Eosinophils increased notably with yeast treatment (5.25%) compared to control (1.5%). Luffa cylindrica doses further elevated eosinophils (7.0% and 5.5%), potentially reflecting anti-parasitic or immunoregulatory effects, as eosinophils are involved in immune regulation and tissue repair (Rothenberg & Hogan, 2006). Paracetamol showed a moderate increase (4.0%). Basophils remained low across all groups (0.0–1.5%) with no significant differences, indicating minimal basophil involvement in this pyrexia model. The hematological changes induced by yeast confirm an inflammatory response characterized by increased ESR, monocytes, and eosinophils with a relative decrease in lymphocytes. Administration of Luffa cylindrica leaf extract modulated these parameters dose-dependently: the lower dose heightened neutrophil counts and ESR (potentially indicating immune activation), while the higher dose tended to normalize these markers, suggesting anti-inflammatory or immunoregulatory properties. Paracetamol showed typical anti-inflammatory hematological profiles. These findings highlight the dual immunomodulatory potential of Luffa cylindrica, supporting its traditional use and warranting further studies into its mechanisms and active compounds.

CONCLUSION

Baker's yeast induced characteristic pyrexia response on rat. There was a significant rise in rectal temperature in comparison with the controlled group. There was increased effect on inflammatory markers and hematological indices. After treatment with aqueous leaf extract of Luffa cylindrica and paracetamol demonstrates significant anti-pyretic effects in a dose-dependent manner. These findings suggest that Luffa cylindrica contains bioactive compounds with antipyretic properties, potentially useful as an alternative or complementary therapy.

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