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ORIGINAL RESEARCH ARTICLE

Anti-Aging and Longevity Effects of *Terminalia catappa* Ripe Fruit Extract in in D-Galactose-Induced Aging in *Drosophila melanogaster* (Fruit Flies) Model

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ABSTRACT

Aging is a natural phenomenon brought on by the progressive decline of biological and physiological processes. This study aims to evaluate the anti-aging and longevity effects of *Terminalia catappa* ripe fruit aqueous extract on D-galactose-induced aging in a *Drosophila melanogaster* model. An acute toxicity study was carried out, and the flies were grouped into six (6) groups, each in triplicate, with 20 flies per vial for both sexes, and treated with 100, 250, 500, 750, and 1000 mg, and a Normal control/10g diet. The result shows that mortality recorded in the group of flies fed with 100, 250, 500, 750, and 1000 mg/10g of fortified diet was insignificant ($p<0.05$) compared to the normal control, indicating that the dosages are safe. The survival rate, negative geotaxis (locomotor activity), and eclosion (emergence) assays were carried out in triplicate with the vials containing 50 flies of both sexes. A notably high emergence rate was observed in the treated flies after 10 days, and high locomotor activity was also observed, suggesting the effectiveness of the extract. Biochemical markers of aging, such as telomerase and caspase 3 and 9 assays, were determined using colourimetric methods. There was a dose-dependent effect of the aqueous ripe fruit extract on lifespan, caspases 3 and 9, and telomerase, due to its ability to modulate the oxidative stress resistance pathway, thereby supporting its anti-aging and longevity effects. Therefore, the aqueous extract of ripe *T. catappa* fruits has anti-aging effects.

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INTRODUCTION

Aging is a natural biological process characterized by the progressive decline of physiological and cellular functions over time (Lopez-Otin et al., 2013; Sani et al., 2025). It occurs due to the accumulation of molecular and cellular damage, which gradually impairs normal body functions and increases vulnerability to diseases and death. According to Pyo et al. (2020), cellular degeneration contributes to reduced physical and cognitive performance, increased disease susceptibility, and mortality. Both intrinsic and extrinsic factors influence aging. Intrinsic factors include hormonal imbalance, inflammatory cellular changes, and genetic predisposition, while extrinsic factors include smoking, alcohol consumption, poor nutrition, and environmental stressors. Consequently, aging is strongly associated with chronic disorders such as hypertension, diabetes mellitus, neurodegenerative diseases, and increased mortality.

Several theories have been proposed to explain the mechanisms of aging. Among the most important are the genetic programming theory and the primary damage theory. The genetic programming theory suggests that lifespan and aging are genetically predetermined, whereas the primary damage theory proposes that aging results from cumulative cellular injuries caused by harmful factors. Related theories include the wear-and-tear theory, free radical theory, mitochondrial theory, DNA damage hypothesis, and error catastrophe theory (Sahabi et al., 2022). Physiologically, aging is associated with reduced tissue mass, decreased metabolic efficiency, impaired flexibility, and increased disease occurrence. These changes occur progressively at molecular, cellular, tissue, and organ levels, eventually reducing the organism's ability to maintain normal biological functions (Srivastava, 2019; Adav and Wang, 2021).

Lopez-Otin et al. (2013) further described the molecular and cellular hallmarks of aging, which include genomic instability, telomere attrition, epigenetic alterations, loss of proteostasis, deregulated nutrient sensing, mitochondrial dysfunction, cellular senescence, stem cell exhaustion, altered intercellular communication, disabled macroautophagy, chronic inflammation, and dysbiosis (Lopez-Otin et al., 2013). These hallmarks collectively

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contribute to the progressive deterioration of physiological integrity and development of age-related diseases. Among them, oxidative stress and chronic inflammation are considered major contributors to accelerated aging.

Natural products rich in antioxidants have attracted scientific attention because of their potential biological activities including anti-aging properties (Adamu et al., 2018, 2022; Dalhatu et al., 2024; Hamisu & Salisu, 2025; Isah et al., 2025; Mohammed et al., 2017; Mohammed et al., 2017; Mohammed et al., 2016a, 2016b; Muhammad et al., 2024; Salisu et al., 2019; Salisu et al., 2017; Salisu et al., 2017b, 2017a; Salisu & Shema, 2019; Usman et al., 2025). One such plant is *Terminalia catappa*, a tropical fruit-bearing plant of the family Combretaceae widely distributed in tropical and subtropical regions, including Nigeria. The plant is valued for both its nutritional and medicinal importance. Studies have shown that different parts of *T. catappa* contain diverse phytoconstituents with important biological activities. Gao et al. (2004) reported the presence of β-carotene, vitamin C, proteins, carbohydrates, tannins, oils, and phenolic compounds in the plant. The seeds contain fatty acids such as oleic acid, linoleic acid, palmitic acid, and stearic acid, while the bark contains glycosides, saponins, steroids, and volatile oils. Mininel et al. (2014) identified important polyphenols such as punicalagin and catappa derivatives, whereas Dukes (2008) reported the presence of ellagic acid, gallic acid, cyanidin-3-glucoside, and tannins in the fruit. Mandloi et al. (2013) also confirmed the presence of quercetin in the foliage of *T. catappa*. These phytochemicals, especially flavonoids, carotenoids, and phenolic compounds, possess antioxidant and anti-inflammatory properties that may contribute to the plant's traditional medicinal uses.

The anti-aging potential of medicinal plants is often investigated using suitable experimental models such as *Drosophila melanogaster*. *D. melanogaster*, a dipteran insect of the family Drosophilidae, has been extensively used in biological research for over a century (Sepel and Loreto, 2010). More recently, it has become an important model for toxicological and aging studies (Chifiriuc et al., 2016; Rand, 2019; Demir, 2020). The organism has a short life cycle, is easy to maintain, reproduces rapidly, and has a well-characterized genome, making it highly suitable for laboratory studies. Its lifespan ranges from 40 to 80 days depending on environmental conditions and diet (Hirth, 2010).

Importantly, *D. melanogaster* shares significant genetic and physiological similarities with humans. Approximately 65–70% of human disease-related genes and about 75% of genes implicated in human disorders have homologs in flies (Ugur et al., 2016). This high level of genetic conservation makes *Drosophila* a valuable model for studying aging, longevity, and disease mechanisms. In addition, the organism has contributed significantly to advances in genetics and developmental biology, including discoveries in chromosome inheritance and embryonic development (Wangler et al., 2017). Its short life cycle, consisting of embryo, larva, pupa, and adult stages, enables rapid experimental observations under laboratory conditions (Wolpert et al., 2015).

Given the growing burden of age-related diseases and the search for safer therapeutic alternatives, medicinal plants with antioxidant properties remain of significant research interest. Therefore, this study aims to evaluate the anti-aging and longevity effects of aqueous ripe fruit extract of *Terminalia catappa* against D-galactose-induced aging in the *Drosophila melanogaster* model.

MATERIALS AND METHODS

Materials/Equipment/Apparatus

These include Food Materials (Corn Meal, Yeast), Plant Material (*Terminalia catappa),* Model Organism **(***Drosophila* melanogaster), UV/VIS Spectrophotometer (Thermo Scientific, USA), Vortexer (Bio Teck, USA), Refrigerated Centrifuge (PEC-Medical, USA), Water Bath (Cole Medical Inst, England), Filter paper (Whatsman, plc, England), Analytical Balance (METLER TOLEDO, Switzerland), Micro-plate reader (BIO-RAD, Japan), test tube, measuring cylinder, beaker, culture vials, petri dish, spatula, masking tape, form plug, marker, foil paper, camp gas, vacuum flask, pot, stirrer rod and masking tape. Others include Nipagin (methyl paraben) (Central Drugs House, India), Agar Agar (Titan Biotch, India), Ethanol (Riedel-de Haën, Germany).

Plant Material

Terminalia catappa fruits were obtained from Kaduna State University main campus. The plant was identified and authenticated at the herbarium of the Department of Biological Science, Kaduna State University (KASU) by a botanist. A Boucher number (NO/KASU/BSH/049) was assigned to the sample.

Extract Preparation

The collected fruits were washed, cut into pieces, dried, and finely ground into a powder using a mortar and pestle. The fineness of the powdered form was achieved by sieving through a clean white muslin cloth, thereby completely removing the fibres. The powdered sample was soaked in distilled water for 48 hours. The extract obtained was filtered using No. 1. Whatsman filter paper. The extract was concentrated using a rotary evaporator. The crude concentrated extract was stored in a refrigerator (4 ^{o}C) until used for further analyses as reported by (Sultanna *et al.,* 2009).

Drosophila melanogaster Stock and Culture

Drosophila melanogaster was obtained from Department of Biochemistry *Drosophila* Laboratory, Biochemistry Department, Kaduna State University (KASU) Kaduna, Nigeria and were reared on cornmeal medium containing 1 % w/v brewer's yeast, 1 % w/v agar agar, and 0.08 % v/w nipangin at constant temperature and humidity (24–27 °C; 60–70 % relative humidity) under 12 h dark/light cycle conditions.

Acute Toxicity Study of *T. catappa* Ripe Fruit Extract.

As previously described by Azrul *et al.* (2013), aqueous ripe fruit extract of *Terminalia catappa* at concentrations of 100mg, 250mg, 500mg, 750mg, and 1000mg/10g diet was fed to 1-3 days old *Drosophila melanogaster* for a period of 7 days.

Induction of aging and Confirmation by Analysing Behavioural Assays

As previously described by Oyebode *et al.* (2019), a D-Galactose concentration of 250mg/10g diet (25mg/g) was fed to 1-day-old to 3-day-old *Drosophila melanogaster* for a period of 7 days.

Behavioural Assays

Eclosion Rate Assay

The flies were subjected to a reproduction performance assay; males and females (50 flies) in each treatment vial were left to mate for 10 days, and the number of offspring newly emerged from the empty pupal cases of the eggs laid was counted (Mesce & Fahrbach, 2002). Were counted and recorded.

Negative Geotaxis Assay

The flies were placed in a graduated vial, gently tapped down to the bottom of the vial, and allowed to climb to the 6cm mark in 6 seconds. Each vial was noted and recorded. Three repetitions were performed, and the data were expressed as the average of three trials per replicate, as reported by Farombi et al. (2018).

Survival Rate (Longevity)

This assay determines the mortality rate of flies by recording daily mortality, and the data were analyzed using the Kaplan-Meier survival curve, as described by Abolaji *et al.* (2015).

Bioassays for Bio-markers of Aging

3.4.1 Homogenization of Flies

For the homogenization of the flies, 50 flies per group (Normal Control (N), Disease Control (DC) and Treatment Group (TRX) were manually grounded and homogenized in phosphate buffer saline (0.1 M, pH 7.4) using a mini pestle and tube centrifuged at 10,000rpm for 10minutes and the supernatant was filtered. The resulting homogenate was kept at 4 °C for biochemical assessments: Telomerase and Caspases 3 and 9. Notably, all assays were performed in triplicate.

Procedures for Determination of Biochemical Parameters

Determination of Telomerase Activity

The activity was evaluated according to the procedure of Blackburn *et al.* (1989) as follows: Telomerase activity was determined using the Telomeric Repeat Amplification Protocol (TRAP) assay. The method is based on telomerase's ability to elongate oligonucleotides in the presence of dNTPs. If an oligonucleotide or one of the dNTPs (typically dGTP1, since telomerase-synthesized telomeres are enriched in guanine residues) contains a radioactive label, the oligonucleotide can be detected.

The TRAP reaction mixture was prepared by combining 2 µL of supernatant, 1 µL of telomerase substrate, 1 µL of reverse primer, 1 µL of dNTPs, 1 µL of Taq polymerase, and 1 µL of PCR buffer, and adding distilled water to make a final volume of 20 µL.

The reaction mixture was incubated at 25°C for 30 minutes to allow for the primer extension. The extended products were amplified by Polymerase Chain Reaction (PCR), and telomerase activity was analyzed by electrophoresis.

Telomerase activity was calculated using the formula below;

$$\text{Telomerase activity (umol/min/mgprotein)} = \frac{intensity\ of\ telomerase - dependent\ products}{intensity\ of\ internal\ control} \times Dilution\ Factor$$

Where internal control is a PCR product of known concentration.

Determination of Caspases Activity

Caspase activity was determined using the method reported by Gaurav et al. (2014) as follows: The flies were washed with cold 1× PBS and resuspended in 50 µL of cold lysis buffer, vortexed, and kept on ice for 30 min. The flies were centrifuged at 10,000 rpm for 10 min at 4 °C; the supernatant was collected into fresh tubes, and the protein concentration was measured for each sample, which was then kept on ice. To a 96-well plate, 1 mL of reaction buffer was added, followed by 50 µL of caspase substrate, 20–50 µL of supernatant, and 2 µL of Dithiothreitol (DTT). The contents were mixed gently, incubated at 37°C for 1–2 hours, and the enzyme-catalyzed release of p-NA was monitored at 405 nm using a microplate reader. Caspase activity was expressed as units per milligram of protein.

Caspase activity (OD) = ($\triangle$ A405 per minute) X (dilution factor) X (protein concentration)

Where: $\triangle$ A405/min is the change in absorbance per minute; the dilution factor and protein concentration are used to normalize the activity.

RESULTS

Identification of Collected Plant Sample

The ripe fruit of the *T. catappa* plant was collected from Kaduna State University's main campus located at Tafawa Balewa Way, Kaduna State. The plant specifications are presented in Table 1.

Table 1: Identification of the collected plant part

Plant Material	Plant Part	Local Name (Hausa)	English Name	Bio Nomenclature	Voucher Number
T. catappa	Ripe fruit	Baushe	Almond	*Terminalia catappa*	V/NO/KASU/BSH/049

Table 2 Acute Toxicity of *T. catappa* Ripe Fruit Aqueous Extract on *D. melanogaster* flies.

S/N	GROUPS	*T. catappa* Conc in mg/10g diet.	NO. OF FLIES	MORTALITY	ECLOSION
1	Group A	100	20	0.667 ± 1.155^{a}	47.333 ± 9.292^{a}
2	Group B	250	20	0.667 ± 1.155^{b}	$84.000\pm7.211^{a,b}$
3	Group C	500	20	0.667 ± 0.577^{c}	65.333 ± 17.502
4	Group D	750	20	0.333 ± 0.577^{d}	63.333 ± 29.834
5	Group E	1000	20	0.333 ± 0.577^{e}	53.000 ± 7.000^{b}
6	Normal Control	Diet only	20	$6.000\pm3.000^{a,b,c,d,e}$	65.000 ± 2.000

Values are expressed as mean ± standard deviation (SD), and those bearing the same superscripts are significantly different ($P< 0.05$) under the same column using the LSD comparison.

Table 3: Shows Induction of Aging and Treatment Groups

Group (S)	D–gal(mg/10g) diets)	*Catappa* (mg /10g/diet)	Remarks	Number of flies
1	-	00	Normal Control	50
2	250	-	Disease Control	50
3	250	250	Treatment	50

Note: All experiments were set in triplicate.

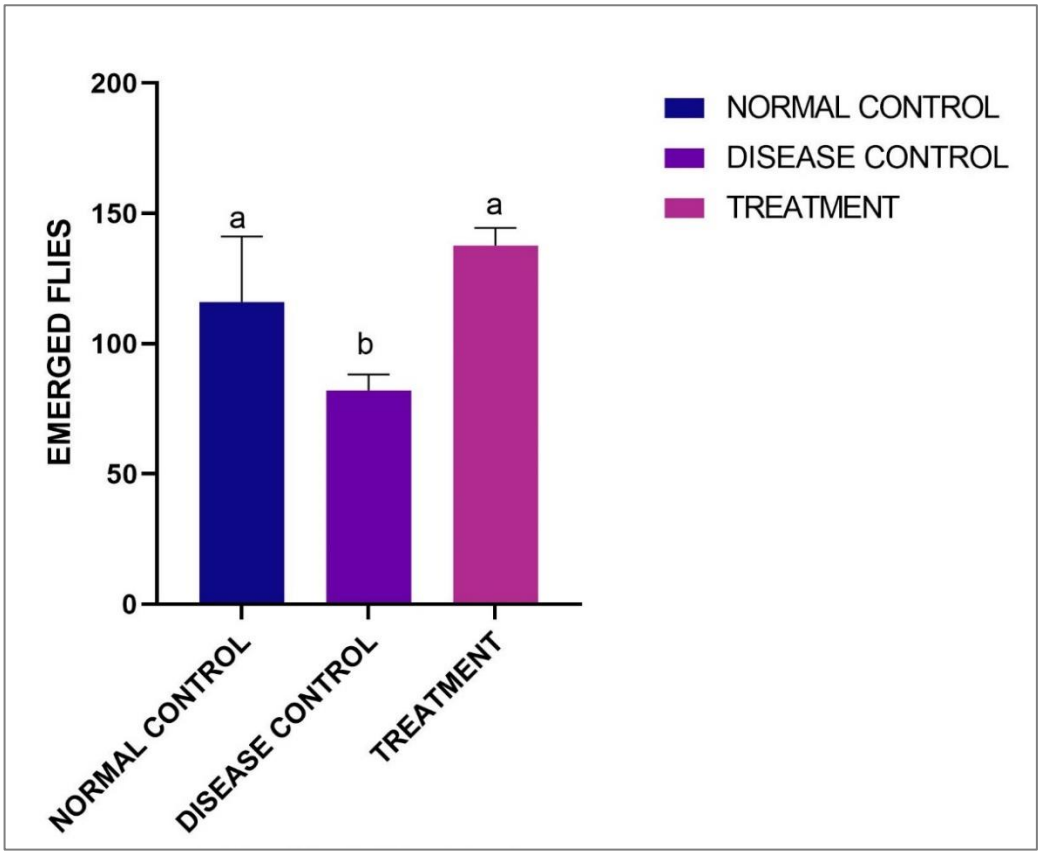

Figure 1: Emergence of flies fed with *T. catappa* ripe fruit extract.
Values are presented as means +/- SEM (n=3). Values with different superscripts are statistically different from one another (P< 0.05)

Percentage Yield of *T. catappa* Ripped Fruit Extract

The percentage yield of the aqueous extract of *T. catappa* ripe fruit. From the initial powdered sample weight of 150g and the crude extract weight of 9.34g, the percentage yield was determined to be 6.2%, and the extract had a brownish, gummy texture.

Acute Toxicity Study of *T. catappa* Ripped Fruit Extract.

Acute toxicity of *T. catappa* ripe fruit aqueous extract at varying concentrations of 100mg, 250mg, 500mg, 750mg and 1000mg/10g diet on newly emerged *D. melanogaster* flies (1-3 days old) of both sexes (20 flies) per vial was carried out in triplicate for seven days (Table 2).

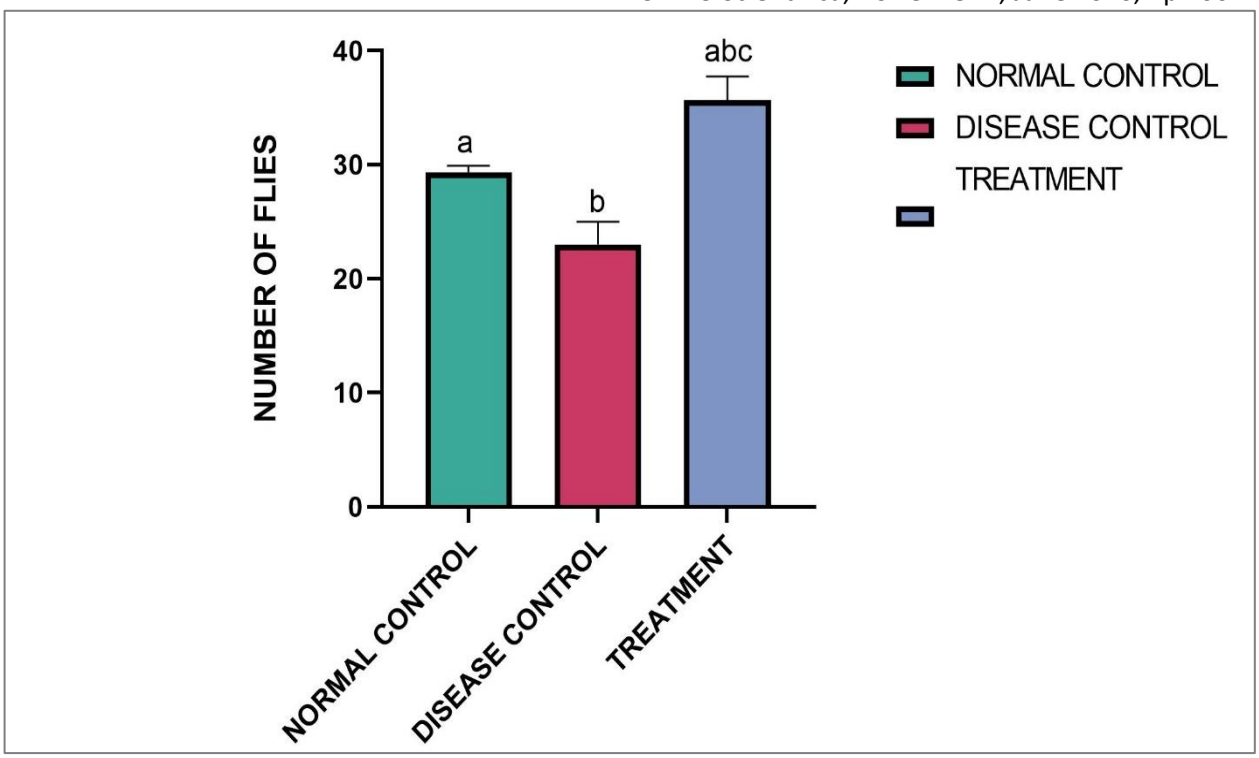

Figure 2: Climbing activities of flies after seven days of treatment with *T. catappa* extract
Values are presented as means +/- SEM (n=3). Values with different superscripts are statistically different from one another (P< 0.05)

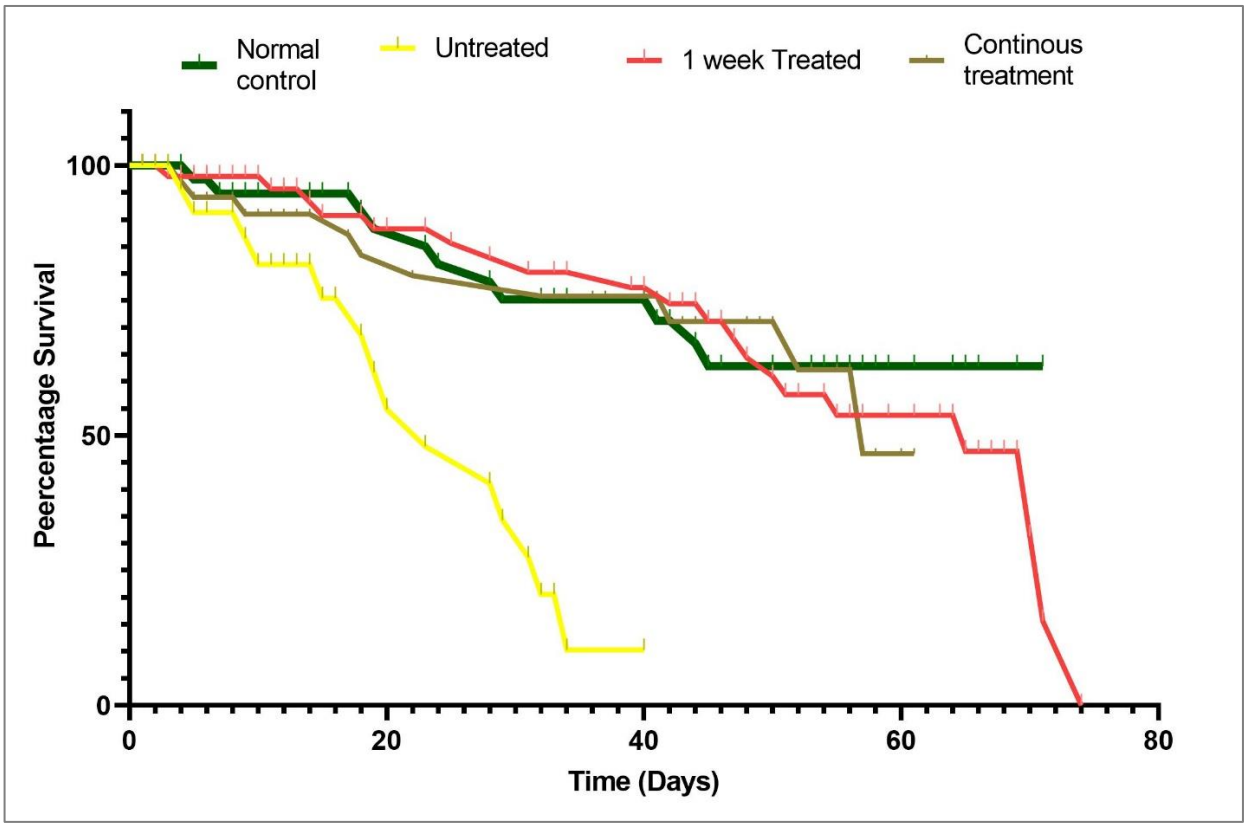

Figure 3: Kaplan-Meier survival curve for *Drosophila melanogaster*.

The results show that mortality recorded in the group fed the 100 mg, 250 mg, 500 mg, 750, and 1000 mg/10 g diet was insignificant ($p<0.05$) compared to the normal control, indicating that the dosages are safe. However, there is a significant difference in the concentration between the 100mg/10g diet and the normal control group ($P < 0.05$).

Induction of Aging and Was Confirmed By Analysing Behavioural Assays

As previously described by Oyebode *et al.* (2019), a concentration of D-Galactose of 250mg/10g diet (25mg/g) was fed to 1 - 3days old *Drosophila melanogaster* of both sexes for a period of 7days (Table 3).

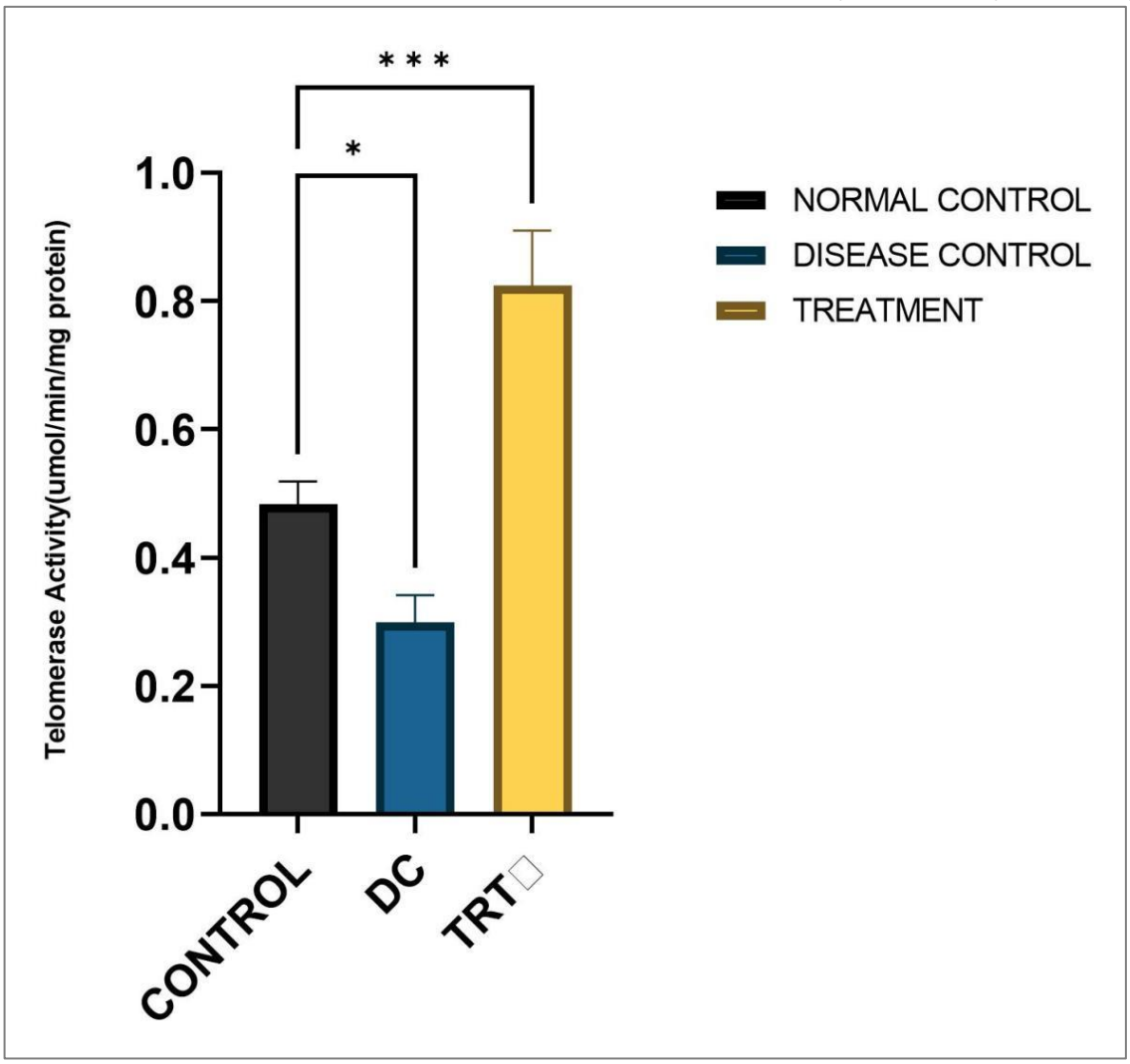

Figure 4: Telomerase activity of the control, disease and treated flies.

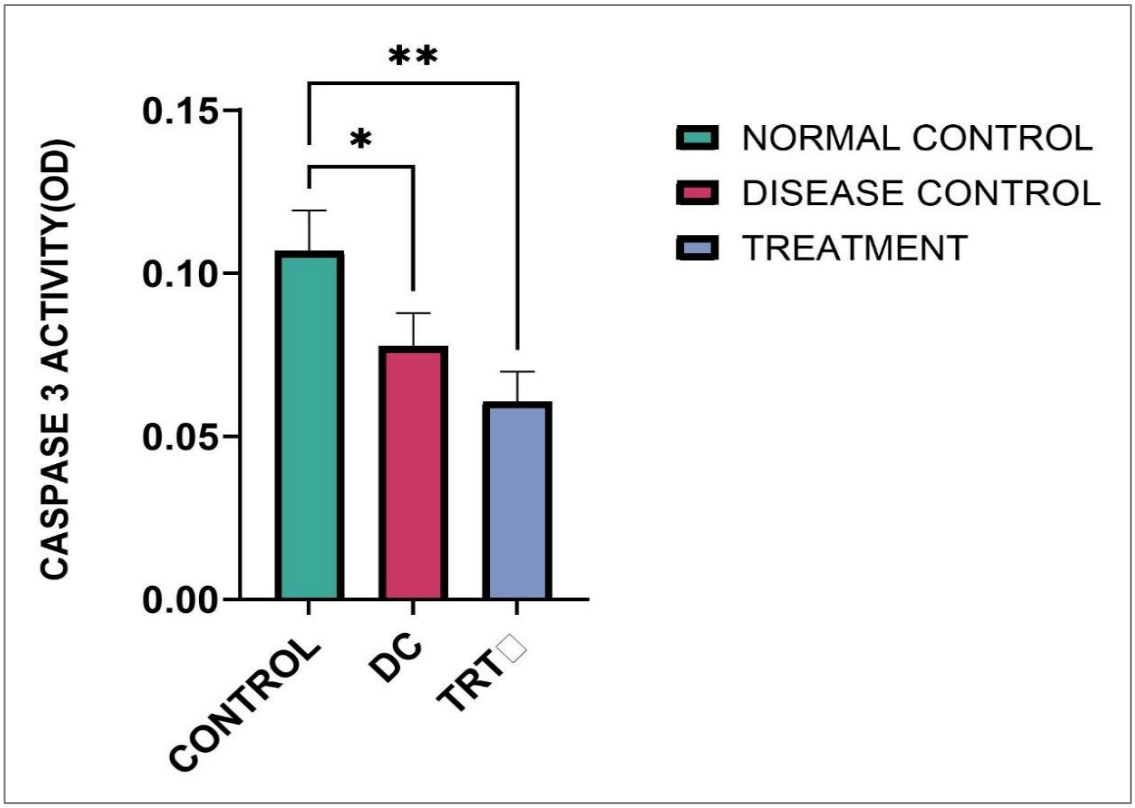

Figure 5: Caspase 3 activity of control, disease and treated flies.

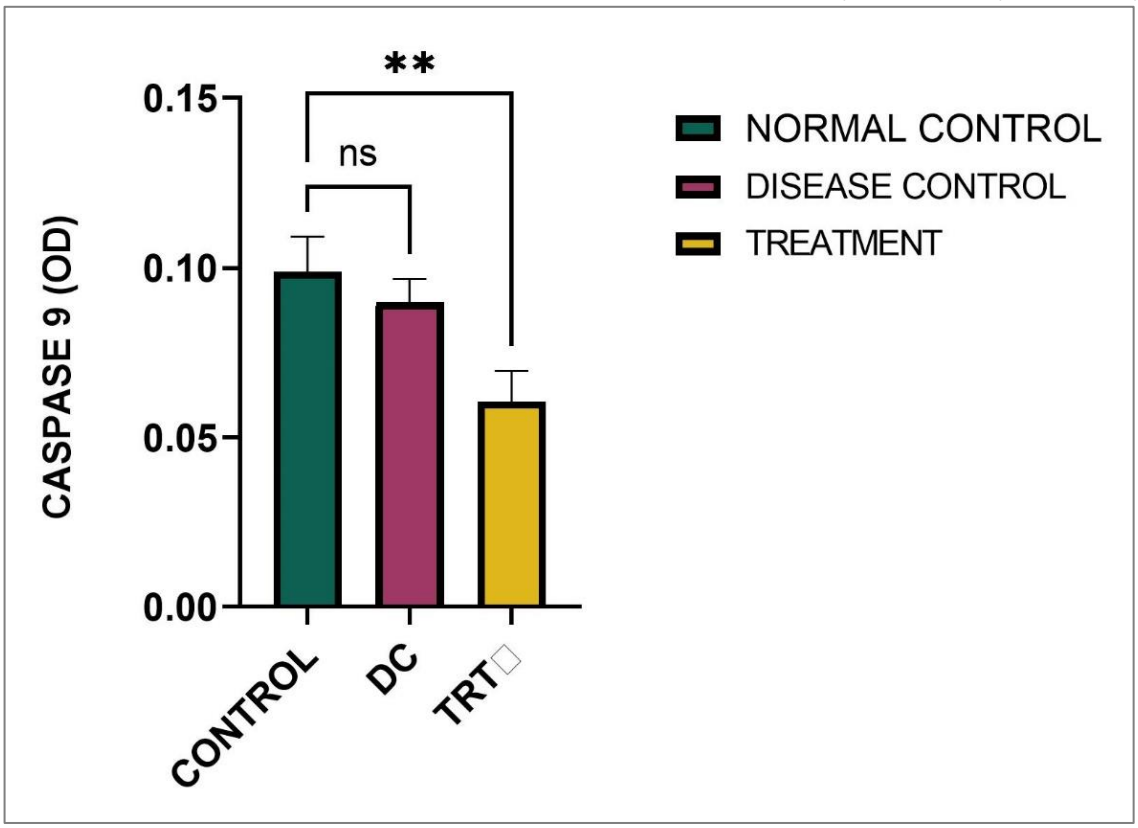

Figure 6: Caspase 9 activity of control, disease and treated flies.

Induction of Aging and Treatment

Behavioural Assays

Eclosion of Flies Fed with *T. catappa* Ripe Fruit Extract.

This assay is used to count the number of emerged flies after seven days of exposure to *T. catappa* extract at concentration (250mg/10g) diet alongside a disease control (DC) and normal control (NC). The result was obtained after 10 days of treatment (Figure 1); it reveals that there is a significant difference between the treated group and the disease control group, and also between the normal group and the disease control group.

Negative Geotaxis Assay on Flies Fed with *T. catappa* Ripe Fruit Extract.

The climbing activities of flies after seven days of treatment with *T. catappa* extract at concentrations of 250mg/10g diet alongside a disease control (DC) and normal control (NC). The result, as shown in Figure 2, reveals that the treatment group with fly extract was statistically significant compared to the disease control group (indicating higher climbing activity).

Survival Rate (Longevity) Assay on Flies Fed with *T. catappa* Ripe Fruit Extract.

Kaplan Meier Survival Curve

From the Kaplan-Meier survival curve, the groups treated for 1 week have the highest survival rate compared with those treated continuously (Figure 3). Also, the untreated groups have the shortest survival rate compared to the normal control groups.

Results for Bioassays

4.6.1 Telomerase activities.

This assay describes the effect of *T. catappa* telomerase activity. It is clear that telomerase activity is high in the treated flies, with a significant difference between the normal and disease groups (Figure 4). Therefore, there is a significant difference among groups ($p < 0.05$).

Caspase 3 and 9 activities

Low caspase-3 activity was clearly observed in the treated groups, showing significant differences between the treated group and the normal control and between the normal and disease control groups (Figure 5). The significance difference among groups is ($p < 0.05$) in Caspase 3 activity as shown in Figure 4.6. Caspase 9 activity was found to be below the significance threshold for the normal control vs disease group, but not for the normal control vs treated groups (Figure 6). Therefore, p value is not significant.

Statistical Analysis

The data were statistically analyzed using a one-way ANOVA and multiple T-tests in GraphPad Prism version 9, and the results were presented as mean ± standard deviation. A 95% confidence interval was used to determine the statistical difference between the control, disease control and treated groups.

DISCUSSION

The effect of *T. catappa* on aging and longevity in Drosophila melanogaster was evaluated via behavioural and biochemical assays in the current study. First, it was

found that the extract of *T catappa* contained significant amounts of polyphenols which was found to be 0.85mg/ml gallic acid equivalent which is far lower than the amount reported by Abdulkadir, (2015) and Uchida et al. (2023) from 100% water ripe fruit extract but almost similar with aqueous stem bark reported by (Oyeleye *et al.*, 2017) which we presume may have contributed to the therapeutic effect of the fruit of *T catappa*. Also, the extract inhibited the free radical chain reaction induced by the DPPH free radical in a concentration-dependent manner, which is in line with previous studies showing the significant free radical-scavenging effect of *T. catappa* extract (Wen *et al.,* 2011). Similar studies have reported high DPPH scavenging activity in the fruit, leaves, and stem of *T. catappa* (Gao et al., 2004).

While the use of plant extracts has been documented to have diverse pharmacological effects through various mechanisms, evidence suggests that some extracts may induce toxicity. Thus, acute toxicity studies on the plant revealed that the LD_{50} of T. catappa aqueous extract on newly emerged (1-3 days old) *D. melanogaster* flies of both sexes was 250mg/10g diet. This suggests that *T. catappa* aqueous ripe fruit extract was non-toxic and well tolerated at the lower doses employed in this study, suggesting it is relatively safe. The LD_{50} is, however, lower than the LD_{50} of *T. catappa* aqueous leaf extract in juvenile fish *Colossomamacropomum* reported by Meneses *et al.* (2020) to be 0.41g/L also lower than the LD_{50} in rats on *T. catappa* seed oil extract reported by Halilu *et al.* (2023) to be greater than 5g/kg.

In the behavioural assays, the effect of *T catappa* extract on the climbing capacity of the flies was evaluated. It was observed that locomotor activity decreased with increasing age in the flies. The extract had a significant effect ($p<0.05$) on lifespan, climbing activity, and reproductive performance. The lifespan-extending effect of *T. catappa* was evaluated using a Kaplan-Meier curve, which shows that flies treated for 1 week with the extract had higher longevity than the control groups and those treated continuously. This may be attributed to its nutritional and antioxidant properties and to its ability to increase oxidative stress resistance, a property peculiar to most anti-aging compounds, as reported in previous studies (Im *et al.,* 2016). The results of this study are consistent with previous findings showing that *T. catappa* extends lifespan in *C. elegans* via the oxidative stress resistance pathway (Im *et al.,* 2016). This may be due to the presence of polyphenolic compounds in the fruit extract, which act as cofactors in antioxidant reaction pathways. These compounds were reported to boost the endogenous antioxidant defence system in organisms and improve lifespan-extending effects (Salehi *et al.,* 2020). These findings are in line with a recent study reporting the antioxidant-boosting and memory-enhancing effects of *T. catappa* (Jamari *et al.,* 2020).

Collectively, the behavioural assays employed in this study demonstrate that *T. catappa* ripe fruit aqueous extract is largely non-toxic at moderate to high dietary concentrations, enhances locomotor performance, and improves survival when administered for a defined duration. Given that T. catappa is a rich source of bioactive phenolics and flavonoids (Yakubu *et al.,* 2022; Abdulkadir, 2015), the observed behavioural benefits may reflect improved physiological resilience and neuromuscular function rather than direct biochemical modulation. These findings support the utility of behavioural endpoints in *D. melanogaster* as sensitive indicators for evaluating the safety and functional effects of phenolic-rich dietary interventions.

In bioassays, the finding that the *T. catappa* extract decreases the expression of caspases 3 and 9 suggests its potential as an anti-apoptotic agent. The enzyme showed low activity, with the treated groups showing significant differences between the treated group and the normal control and between the normal and disease control groups. Several studies have investigated the effects of natural compounds on caspase expression and their potential implications for aging. A study by Mihailović *et al.* (2021) demonstrated that resveratrol, a polyphenolic compound found in red grapes and wine, reduced caspase 3 expression in aged mice, leading to improved cognitive function and increased lifespan. Similarly, Curcumin, a bioactive compound found in turmeric, has been shown to inhibit caspase 9 activation in neuronal cells, providing neuroprotective effects against age-related neurodegenerative diseases (Liu *et al.,* 2017). The decrease in caspase expression observed in the *T. catappa* extract aligns with findings from other studies investigating the potential anti-aging effects of natural extracts. A study by Wang *et al.* (2020) demonstrated that the Ginkgo biloba extract decreased caspase-3 expression in aged rats, leading to improved memory and cognitive function. Another study by Park *et al.* (2018) showed that the Polygonum cuspidatum extract, containing the active compound resveratrol, decreased caspase-9 expression in human fibroblasts, suggesting its potential as an anti-aging agent.

The extract of *T. catappa* has shown an effect on telomerase expression; it was clearly observed that telomerase activity is higher in the treated flies, with a significant difference between the normal and disease groups. Therefore, there is a significant difference among groups ($p < 0.05$). Other studies have also explored the relationship between *T. catappa* extract and telomerase expression. One such study, conducted by Ganesan and Xu (2018), investigated the effects of *T. catappa* extract on telomerase activity in human fibroblast cells. The study reported that treatment with the extract resulted in a significant increase in telomerase expression compared to the control group; this suggests that *T. catappa* extract has the potential to slow down cellular aging by maintaining telomere length. Another study by Proshkina *et al.* (2020) examined the effects of *T. catappa* extract on telomere length in a mouse model of aging. It was observed that mice treated with the extract had longer telomeres compared to the untreated group. This finding further supports the notion that *T. catappa* extract may have anti-aging effects by influencing telomerase expression. Another study by Tsoukalas *et al.* (2019) examined the effects of various natural compounds on telomerase

expression. It has been reported that certain compounds, including resveratrol and curcumin, can increase telomerase expression in human cells.

Therefore, the findings of this study suggest that the extract of *T. catappa* ripe fruit has an anti-aging and longevity effect in *D. melanogaster*.

CONCLUSION

T catappa fruit extract possesses anti-aging bioactivity, as evidenced by its ability to enhance biomarkers of aging in *Drosophila melanogaster*. It demonstrates remarkable effects on lifespan extension, climbing activity, reproductive performance, and some biochemical markers of aging in *D. melanogaster*. These effects are attributed to its nutritional content, antioxidant properties, and ability to modulate pathways involved in oxidative stress resistance. Behavioural assays confirm the safety and effectiveness of *T. catappa* extract, with higher doses demonstrating increased longevity and emergence rate, while biochemical assays reveal its impact on telomerase and caspase 3 and 9 activities, supporting its anti-aging and longevity effects.

Further investigations into molecular and biochemical mechanisms are recommended to fully elucidate the pathways underlying *T. catappa*'s anti-aging potential and to establish optimal dosing strategies for future translational applications.

CONSENT FOR PUBLICATION

All authors have read and consented to the submission of the manuscript.

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DECLARATION OF COMPETING INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have influenced the work reported in this paper.

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