PROXIMATE ANALYSIS, PHYTOCHEMICAL PROFILING, ORAL MEDIAN LETHAL DOSE (LD50), AND EFFECT OF *SOLANUM MELONGENA* (GARDEN EGG) AQUEOUS LEAF EXTRACT ON WEIGHT IN RATS

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Abstract

This study investigates the proximate composition, phytochemical profile, oral median lethal dose (LD50), and the effect of Solanum melongena (garden egg) aqueous leaf extract (SMALE) on the body weight of rats. Acute toxicity testing revealed that SMALE was non-toxic, with an LD50 greater than 5000 mg/kg, indicating its safety for use in higher doses. The phytochemical screening identified moderate levels of proteins and tannins, with trace amounts of flavonoids, alkaloids, and saponins, suggesting SMALE's potential antioxidant, anti-inflammatory, and antimicrobial properties. Proximate analysis showed that SMALE is primarily composed of carbohydrates (12.46%), with low levels of fat, protein, and fiber. The study also found no significant changes in the body weight of rats administered SMALE, suggesting that the extract does not affect weight gain or loss at the tested doses. These findings suggest that SMALE may have beneficial health-promoting properties, including antioxidant and antimicrobial effects, but its influence on body weight is minimal. Further studies are needed to explore its long-term effects and therapeutic potential.

***Keywords*:** *Solanum melongena*, Aqueous leaf extract, Proximate analysis, Phytochemical profiling, Nutritional health

Introduction

Solanum melongena, commonly known as garden egg, is a widely consumed vegetable in many African and Asian countries. Traditionally, its leaves and fruits are utilized for various medicinal purposes, including the treatment of digestive disorders, inflammation, and infections. The plant is rich in essential nutrients and phytochemicals, which are believed to contribute to its health benefits (Igwe et al., 2003). However, scientific research validating these traditional uses, particularly concerning reproductive health, remains limited.

Phytochemical analysis has revealed that Solanum melongena contains numerous bioactive compounds, including flavonoids, alkaloids, and phenolic compounds. These phytochemicals are known for their antioxidant properties and potential health benefits (Edeke et al., 2021). A deeper understanding of the phytochemical constituents of Solanum melongena (Garden Egg) aqueous leave extract (SMALE) could illuminate its therapeutic applications, particularly in enhancing health parameters in both females and males.

SM is a common and popular vegetable crop grown in the subtropics, tropics and it is called “brinjal” in India, “yalo” in the Hausa tradition of northern Nigeria and “aubergine” in Europe. It is a perennial plant but grown commercially as an annual crop (Veeraragavathatham et al., 2006; Westerfield, 2008). With a region of over 1.7 million hectares, Solanum melongena is one of the world's most important vegetable crops. Some 75 percent of eggplant production is accounted for by China, India, Bangladesh, Nepal and Sri Lanka (Jami et al., 2015). Under water stress, the quantity of osmiophilic granules increased in chloroplast of Solanum melongena leaf (Fu et al., 2013); also, the eggplant showed increase both in peroxidase and MDA levels when exposed to water stress conditions (Hannachi et al., 2022); significant decreases in leaf area and leaf fresh and dry weight (Comas et al., 2013).

It is also used as a prokinetic agent for weight loss, long-term asthma control and fertility-regulating effects in certain varieties. In all these respects, there is a lack of information regarding Solanum melongena. However, because of its chemical component of dietary

fibres, alkaloids, saponins, nasunins, ascorbic acids, hormones, tannins, flavonoids, proteins and carbohydrates (Noda et al., 2000; Hanson et al., 2006), as well as various medicinal claims and high intakes in some parts of the world, especially in the eastern part of the Nigeria (Igbo group) (Noda et al., 2000; Hanson et al (Noda et al., 2006), the abundance of crowns and fruits of SM persist (Noda et al., 2006).

The primary purpose of this study is to evaluate the impact of Solanum melongena aqueous leaf extract (SMALE) on weight in adult male albino rats. By determining the LD50, examining the extract's effects on body weight, this research provide a comprehensive understanding of SMALE's potential benefits and risks. This research contributes to the growing body of literature on the health benefits of indigenous plants. As the use of herbal remedies becomes more popular, it is crucial to provide empirical evidence to support their traditional applications. By investigating SMALE's effects, this study helps validate the use of Solanum melongena as a natural supplement for enhancing reproductive health.

Moreover, the study emphasizes the importance of understanding the toxicological profile of herbal extracts. Many traditional remedies lack comprehensive safety data, which can lead to unintended consequences when used improperly. By determining the LD50 of SMALE and assessing its impact on health parameters, this research promotes safer practices in the consumption of herbal products. The findings from this study have implications for public health policies, particularly in regions where Solanum melongena is a common dietary component. Understanding the health benefits and risks associated with this plant can inform dietary guidelines and encourage the development of safe herbal products that are beneficial for reproductive health.

Further, this research lays the groundwork for future studies exploring the pharmacological potential of Solanum melongena. Identifying the active phytochemical constituents and their biological effects can pave the way for further investigations into therapeutic applications, enhancing the integration of traditional medicine with modern health practices. While traditional uses of Solanum melongena

are well-documented, empirical studies evaluating its safety and efficacy are scarce. Understanding the toxicological profile of SMALE is crucial for determining safe consumption levels and assessing its potential risks. This study fills this gap by conducting a comprehensive evaluation of SMALE's effects on health parameters in adult male albino rats. This research provides a scientific basis for the traditional use of Solanum melongena in promoting health, contributing valuable insights to the field of ethnopharmacology and nutrition.

Materials and Methods

Experimental animals

This research used a total of thirty-six (36) healthy Albino rats with a weight range of between 54 and 100 grammes. The animals were obtained from the Animal House of the Department of Physiology, University of Nigeria, Enugu Campus, and housed in the Animal House of the College of Medicine, University of Nigeria Teaching Hospital. The rats were acclimatized for two weeks and provided with ad libitum access to commercial feed and water during this period.

Ethics consideration

This study received ethical approval from the Ethics Committee of the University of Nigeria Teaching Hospital.

Plant material collection

Solanum melongena leaves were collected and authenticated from the Abor District, Udi Local Government Zone, Enugu County, by the Department of Botany, University of Nigeria, Nsukka.

Plant aqueous extraction

Solanum melongena leaves were dried at room temperature for 10 days. Using a clean, small plastic pestle and motar, the leaves were manually crushed after drying to obtain 300 g of fine powdered Solanum melongena leaves, which were dissolved in 1000 ml of steamed water, then sewn with filter paper and stored in the refrigerator until required.

Phytochemical screening

Phytochemical elements that are comprised of *S. Melongena* leaf was calculated using the method established by the Department of

Pharmacognosy, Faculty of Pharmacology, University of Nigeria, Nsukka (Trease & Evans, 1989).

Proximate analysis

In order to calculate the proportion of crude protein, crude fibre, fat, carbohydrate and ash content in *S. Melongena* leaves, the method described by Pearson (1976) was used. In order to determine the mineral content of the plant material, the AOAC (1990) technique was used.

Tentative immediate toxicity studies

Using the Lorke (1983) variant technique, immediate toxicity monitoring [LD50] was accomplished with minimal adaptation. Doses of 10, 100, 1000, 2000, 5000 mg/kg body weight (b.wt) were issued to groups A, B, C, D and E of 4 rats each. Each species safely acquired a single oral dose of SMALE in its respective groups after 24 hours. In order to assess mortality or clinical exposure controls, organisational monitoring was conducted on an hourly basis for 24 hours after the medication was administered. Acute toxicity monitoring [LD50] was performed using the Lorke (1983) variation technique with limited change. Rated doses of 10, 100, 1000, 2000 mg/kg body weight (b.wt) were issued to 4 rats each in groups A, B, C, D and E. Each animal obtained a single oral dose of SMALE in the appropriate groups after 24 hours. Surgery was performed on an hourly basis for 24 hours following the administration of the drug in order to monitor death or clinical indicators of overdose.

Experimental design

A total of thirty-six (36) adult male Albino Wistar rats, each weighing between 150-200 g and aged 3-4 months, were used in this study. The rats were divided into three groups (I, II, and III), with 12 rats in each group. Each group was further subdivided into three batches (A, B, and C), with 4 rats per batch. The study was conducted over 4, 6, and 8-week periods.

The experimental protocol was as follows:

- Group I received a daily oral gavage of 400 mg/kg body weight (b.wt.).
- Group II was administered 400 mg/kg b.wt. of Solanum melongena (Garden Egg) aqueous leave extract (SMALE) treatment.

- Group III was given 800 mg/kg b.wt. of the same treatment.

For each batch (A, B, and C) within the three groups, the treatments were delivered daily by oral gavage using an oral cannula for 4, 6, and 8 weeks. At the end of each treatment period, the rats were euthanized under chloroform anesthesia.

Statistical analysis

Data were analyzed using SPSS software. Results are expressed as the mean ± standard error of the mean (SEM). The significance of differences between means was determined using the Student's t-test and one-way analysis of variance (ANOVA). A p-value of less than 0.05 ($p<0.05$) was considered statistically significant.

Result

Acute toxicity testing

At a single dose of 5000 mg/kg body weight, no signs of toxicity were observed in either group during the experimental period. There were no injuries, changes in locomotion, abnormal posture, or other clinical signs of toxicity. No behavioral changes, skin lesions, respiratory distress, or issues with food and water intake were reported in the animals. Based on the results, the LD50 was determined to be >5000 mg/kg, indicating that the extract is non-toxic and safe for use.

Phytochemical screening

The phytochemical screening of *Solanum melongena* aqueous leaf extract (SMALE) revealed moderate levels of proteins and tannins, along with intermittent amounts of flavonoids, alkaloids, and saponins. The results are summarized in Table 1.

Proximate analysis

The proximate composition of the dried *Solanum melongena* aqueous leaf extract (SMALE) is shown in Table 2. The extract contained low levels of ash (1.86%), fiber (1.75%), protein (5.60%), and fat (1.70%). However, it had a relatively high carbohydrate content, accounting for 12.46% of the total composition.

Effect of SMALE on the weight of the rats across group

No significant changes ($p > 0.05$) in body weight were observed in rats administered *Solanum melongena* aqueous leaf extract compared to the control group.

Table 1: Phytochemical screening

Constituents	Inference
Flavonoids	+
Alkaloids	+
Saponins	+
Tannins	++
Proteins	++
Reducing Sugars	-
Fats and oil	-
Steroids	-

Table 2: Proximate analysis

Sample identification	Parameters [%]					
Garden egg	Moisture	Ash	Crude fibre	Protein	Fat	Carbohydrate
	16.10	1.86	1.75	5.60	1.70	12.46

Table 3: Impact of SMALE on the group-wide weight of rats

Group	Dose of SMALE (mg/kg body weight)	Initial b.wt (g)	Final b.wt (g)	Body weight change (g)	Epididymal weight (g)
I (Control)	0	168.13±5.30	170.25±5.10	2.45±0.40	18.10±0.01
II	400	157.20±2.95	165.10±4.20	8.01±2.31	16.00±0.03
III	800	159.40±3.31	162.00±9.11	3.20±0.82	15.32±0.01

*p<0.05: Statistically significant.

Discussion

This study investigated the acute toxicity, phytochemical composition, proximate analysis, and effects of Solanum melongena aqueous leaf extract (SMALE) on the weight of male albino Wistar rats. The acute toxicity results showed no signs of toxicity at a high dose of 5000 mg/kg body weight, with an LD50 value greater than 5000 mg/kg, indicating that SMALE is non-toxic and can be considered safe for further use in pharmacological studies. This is consistent with previous studies that have shown the non-toxic nature of Solanum melongena when administered orally at similar doses (Edijala et al., 2005).

The absence of toxicity at high doses suggests that SMALE could be used therapeutically without the risk of acute toxicity, which is crucial for its potential application in human health. From a human health perspective, this result is promising, as it implies that the extract could be used safely in dietary supplements or therapeutic formulations. However, it is important to note that the long-term effects of SMALE, as well as its safety profile in humans, still need to be thoroughly investigated through clinical trials.

The proximate analysis of SMALE showed that the extract contains 16.10% moisture, 1.86% ash, 1.75% crude fiber, 5.60% protein, 1.70% fat, and 12.46% carbohydrates. These values indicate that SMALE is primarily composed of carbohydrates, which could contribute to its energy-providing properties. Carbohydrates are essential for maintaining energy levels in the body, making SMALE potentially useful as a supplementary energy source in the diet, particularly in regions where malnutrition is prevalent.

The low levels of protein (5.60%) and fat (1.70%) suggest that SMALE is not a significant source of these macronutrients. This composition is typical of many plant extracts, which often have lower fat and protein contents compared to animal-based products. However, the presence of protein in SMALE is still noteworthy, as plant-based proteins can be beneficial, especially for vegetarians or individuals looking to diversify their sources of protein. Moreover, the low-fat

content makes SMALE a heart-healthy option, as diets high in unhealthy fats are linked to cardiovascular diseases (Rautiainen, 2016).

The moisture content of 16.10% suggests that SMALE could have a moderate level of hydration, which is important for maintaining optimal bodily functions. The fiber content, though low, might still contribute to digestive health, particularly in individuals with low fiber intake (Slavin, 2013). The low levels of ash (1.86%) indicate a relatively low mineral content, which suggests that SMALE is not a rich source of essential micronutrients like calcium, magnesium, or iron. However, this does not rule out the potential presence of bioactive compounds that may offer therapeutic benefits.

Overall, this composition aligns with previous reports on the nutritional content of Solanum melongena, which is often consumed for its beneficial effects on health, particularly its antioxidant properties (Akinmoladun, 2011). Also, the proximate composition of SMALE suggests that while it is not a major source of macronutrients, it could offer supplementary nutritional benefits, especially in terms of providing carbohydrates for energy and some protein.

Phytochemical screening revealed moderate amounts of tannins and proteins, along with trace amounts of flavonoids, alkaloids, and saponins. These phytochemicals are known for their potential therapeutic effects, including antioxidant, anti-inflammatory, and antimicrobial properties.

- **Tannins**: Tannins are polyphenolic compounds that have been shown to exhibit antioxidant properties. They can help reduce oxidative stress by scavenging free radicals (Akinmoladun, 2011). This makes SMALE potentially useful in combating oxidative damage in the body, which is linked to a wide range of diseases, including cancer, diabetes, and cardiovascular diseases (Sies, 2015).
- **Flavonoids**: Flavonoids are another group of potent antioxidants, known for their ability to protect cells from oxidative damage and reduce inflammation. Studies have demonstrated that flavonoids can improve cardiovascular health

by improving blood vessel function and reducing blood pressure (Bhat, 2015). Given the presence of flavonoids in SMALE, the extract could contribute to better cardiovascular health.

- **Alkaloids and Saponins**: Both alkaloids and saponins have various pharmacological activities, including antimicrobial, anti-inflammatory, and immunomodulatory effects (Saalu et al., 2007a; b). These properties make SMALE a potential candidate for treating infections or inflammatory conditions.

The presence of these bioactive compounds in SMALE suggests that it has potential therapeutic properties, especially as an antioxidant, anti-inflammatory, and antimicrobial agent. Flavonoids, in particular, have been reported to exhibit free radical scavenging activity, which can protect cells from oxidative stress (Tiwari et al., 2009). Such properties are particularly relevant in preventing or managing chronic diseases that are driven by oxidative stress and inflammation.

The study found no significant changes ($p > 0.05$) in the body weight of rats administered SMALE compared to the control group. This suggests that SMALE does not significantly impact weight gain or loss at the doses tested, which could indicate that the extract does not have major effects on overall metabolism or energy balance in rats. However, there was a small, non-significant decrease in epididymal weight in the treatment groups, which might suggest a subtle effect on the reproductive system, but this was not statistically significant.

This result is consistent with other studies on *Solanum melongena*, which have shown that the plant has varying effects on body weight depending on the dose and the form of the extract (Edijala et al., 2005). In some studies, *Solanum melongena* has been shown to reduce weight gain by improving lipid metabolism and reducing cholesterol levels, suggesting that it might help manage obesity or metabolic disorders (Elbertieha et al., 2001). While this study did not find significant effects on body weight, the potential of SMALE to influence metabolic health should be further explored in future studies.

In humans, weight management is a critical aspect of overall health, particularly with the rising prevalence of obesity and related conditions such as diabetes and cardiovascular diseases (Ng, 2014).

While the lack of significant weight changes in rats might suggest that SMALE does not directly affect body weight, further research is needed to assess its long-term effects on metabolism and its potential as part of a broader dietary or therapeutic approach for weight management. In addition, while the results did not show any significant changes in body weight or reproductive organ weight, it is possible that SMALE's effects on the endocrine or reproductive systems could manifest at different doses or in a more prolonged treatment regimen. Following, a study by Edijala et al. (2005), found that Solanum melongena could reduce weight gain in animals through its effects on lipid metabolism, specifically by lowering serum cholesterol levels.

Implications for human health and nutritional value

The findings of this study suggest that *Solanum melongena* aqueous leaf extract could have multiple health benefits, particularly due to its antioxidant, anti-inflammatory, and antimicrobial properties. The phytochemical constituents, such as tannins, flavonoids, and alkaloids, make SMALE a promising candidate for preventing oxidative stress-related diseases and supporting overall metabolic health. Additionally, the non-toxic nature of SMALE at high doses (>5000 mg/kg) and its moderate nutritional content, particularly in terms of carbohydrates and protein, suggest that it could be incorporated into human diets as a supplementary health-promoting ingredient.

However, more research is needed to understand the exact mechanisms through which SMALE affects human health, particularly in relation to chronic diseases, reproductive health, and metabolic disorders. While the proximate composition indicates that SMALE is not a major source of fat or protein, its antioxidant and anti-inflammatory properties could offer substantial health benefits. Furthermore, the lack of significant weight changes in rats suggests that SMALE may not be effective for weight loss or gain, though it may still play a role in managing metabolic health.

Recommendation

1. **Further toxicological studies**: While SMALE showed no signs of acute toxicity at doses up to 5000 mg/kg, further studies on the chronic toxicity and long-term effects of SMALE are needed to fully assess its safety profile for human consumption. In particular, it is important to evaluate its effects over extended periods and in different age groups, including pregnant or lactating individuals, to determine its broader safety for public use.
2. **Clinical trials on humans**: Given the promising results of SMALE's non-toxic nature and its phytochemical composition, it is recommended that clinical trials be conducted to evaluate its therapeutic benefits in humans. This includes assessing its potential as an antioxidant, anti-inflammatory, and antimicrobial agent, particularly in managing chronic diseases related to oxidative stress and immune dysfunction.
3. **Exploration of therapeutic applications**: The antioxidant and phytochemical properties observed in SMALE suggest its potential as a natural supplement for preventing or managing conditions like cardiovascular disease, diabetes, and cancer. Future research could explore the extract's role in improving metabolic health, modulating lipid profiles, and boosting immune function.
4. **Nutritional supplementation**: Given SMALE's carbohydrate content, it may be considered as a supplementary source of energy in populations with nutritional deficiencies, especially in low-resource settings. However, its low protein and fat content suggest it should be used in conjunction with other nutrient-dense foods to meet the full spectrum of dietary needs.
5. **Further research on reproductive health**: The effect of SMALE on reproductive health, particularly male fertility, should be further explored. While no significant changes in body weight were observed, the slight effects on epididymal weight and sperm motility at certain doses warrant deeper investigation into the potential benefits or risks of SMALE in reproductive health.

6. **Standardization of extract**: Future studies should focus on the standardization of SMALE to ensure consistent bioactive compound concentrations, which is critical for its safe and effective use in both therapeutic and nutritional applications.

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