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Research Article
Comparative Effects of Different Organic Manure on the Growth, Proximate, Mineral and Phytochemical Compositions of *Launaea taraxacifolia* (Wild.) Amin Ex. C Jeffrey (African Lettuce)

Surukite Opeolu Oluwole, Mautin Lawerence Ogun, Simeon Yemaren Asokere, Zainab Olubusayo Akinbami, Adeleke Toluwalase Onadipe and Faizat Ene-Ezehi Shuaib

Department of Botany, Lagos State University, Ojo, Nigeria

Abstract
Background and Objective: *Launaea taraxacifolia* is one of the several leafy vegetables recently gaining more attention due to its numerous uses. Thus, this study assesses the comparative effects of different organic manure on the growth, proximate, mineral and phytochemical compositions of *Launaea taraxacifolia*. **Materials and Methods:** Seeds were obtained from Lagos State Agricultural Input Supply, pig manure, cow dung and poultry manure were collected from a local farm in Lagos State. Growth experiments on *Launaea taraxacifolia* were carried out in response to different organic manures at the Botanical garden, Department of Botany, Lagos State University, Ojo and harvested leaves were subjected to proximate, mineral and phytochemical analyses using standard procedures. Data collected were subjected to Analysis of Variance ($p<0.05$) with SPSS version 23. **Results:** The morphometric analysis revealed that seedlings of *L. taraxacifolia* grown with pig manure had the highest significant values, as the leaves were broader, lengthier and numerous except stem height which favoured seedlings grown with cow dung. Proximate analyses revealed that poultry manure improved significantly the carbohydrate (30.76$\pm$0.37%) and crude fat (1.89$\pm$0.10%) contents while cow dung improved protein (4.94$\pm$0.19%), Ash (4.29$\pm$0.09%), moisture (56.43$\pm$0.55%) and crude fibre contents (7.13$\pm$0.97%). Mineral analyses revealed that K (119.29 mg kg^{-1}), Mn (0.34 mg kg^{-1}), Na (66.35 mg kg^{-1}) and Ca (88.19 mg kg^{-1}) were significant for plants fertilized with poultry manure. Mg (23.73 ppm) and Zn (0.91 mg kg^{-1}) were significant for plants fertilized with pig manure while P (54.09 mg kg^{-1}) and Fe (0.83 mg kg^{-1}) were significant for plants fertilized with cow dung. Phytochemical analyses revealed the presence of tannins (34.3687$\pm$2.34 mg/100 g), phenols (48.87$\pm$1.42 mg/100 g), saponins (47.9087$\pm$1.81mg/100 g), steroids (26.7187$\pm$2.07 mg/100 g), flavonoids (58.9787$\pm$2.57 mg/100 g), terpenoids (27.8287$\pm$ 2.14 mg/100 g), cardiac glycosides (36.2487$\pm$3.27 mg/100 g) and reducing sugar (50.4487$\pm$2.64 mg/100 g) which are significantly higher in seedlings treated with cow dung. **Conclusion:** This study, therefore, concludes that pig and cow manure should be used for the probable growth and nutrient enhancement of this plant.

Key words: Organic manure, pig manure, poultry manure, cow dung, *Launaea taraxacifolia*, proximate, minerals, phytochemicals

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Corresponding Author: Mautin Lawerence Ogun, Department of Botany, Lagos State University, Ojo, Nigeria Tel:+2347061244527

Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Africa is blessed with a vast amount of vegetables and fruits which are consumed for their nutrients and or their medicinal purposes. In recent years, these vegetables and fruits have been shown to possess valuable antioxidants of great nutritional and therapeutic values[1]. These vegetables' nutritional compositions are capable of preventing or attenuating damages such as the inactivation of enzymes caused by free radicals, many plants including fruits and vegetables are recognized as sources of natural antioxidants that can protect against oxidative stress and thus play an important role in the chemoprevention of diseases that have their etiology and pathophysiology in reactive oxygen species[2-4].

Launaea taraxacifolia commonly known as Wild or African lettuce belongs to the family compositae (Asteraceae), it is known as 'Efo Yanrin' among the Yorubas of the southwestern part of Nigeria, 'Ugu' among the Ibos of the eastern part of Nigeria and 'nonon barya' among the Hausas of the Northern part of Nigeria and often consumed in West Africa as a leafy vegetable due to its nutritional and medicinal properties[5]. It is a tropical perennial plant that has a creeping root system, with its leaves at the base of an erect stem, which is about 1-3 m high. The leaves are arranged in a rosette form of 3-5 and may sometimes be crowned with golden-yellow corollas, which produces 7-8 nm air-borne seeds. It is used as a salad or it can be freshly eaten or cooked in soups or sauces[5-10]. *Launaea taraxacifolia* is unique because is the only species in the family Asteraceae without any trichome and the leaf, stem and nodes are potential explants for regeneration of *Launaea taraxacifolia*[11-14]. The plant is predominant in tropical African countries of Ghana, Nigeria, Senegal, Sierra Leone, Benin and Tanzania with the Ethiopian highlands being known as its place of origin. It thrives at banks of water bodies, waste dumping places and backyards[15,16]. The whole plant is very rich in a milky sap (lactucarium) that flows freely from any wound of the plant (leaves, stems or root). The sap changes its colour to yellow at first and then brownish, hardens and dried when in contact with air[5].

However, several minerals, proteins, flavonoids, fatty acids and vitamins have been reported in the leaves of African lettuce[17,18]. The nutritional aspects of *L. taraxacifolia* have been reviewed[19,20]. Antioxidant, antiviral and insecticidal potentials as well as the use of wild lettuce leaves in treatment and control of blood cholesterol levels, blood pressure and diabetes has been reported[21-23]. Phytochemical screenings of *L. taraxacifolia* revealed that the plant possesses chemical classes such as phenolic glycosides, flavonoids, saponins and triterpenoids, which are known to have phytotherapeutic value for humans[17,24-27].

Crop production could be affected by various environmental factors including both biotic and abiotic factors[28]. Manure is one of the essential abiotic factors that could affect a plant's growth through altering the function of plant roots and soil-borne microbes such as root-endophytic fungi, mycorrhizal fungi, rhizobia and plant growth-promoting microorganisms[29-31]. However, most plants including *L. taraxacifolia* species requires good manure for them to flourish. Thus, to fully achieve the best yield, manure, an essential soil conditioner is needed. Manure provides nutrients to the soil for the plants. Hence, properly managed manure application recycles the nutrients to the crops, improve soil quality and protect water quality[32,33].

African Lettuce as a medicinal plant has recently received great attention from researchers in Africa and other parts of the world but to the best of our knowledge, there is little or no information on the compositional effects of different organic manure on the growth, proximate, mineral and phytochemical contents of this plant. Thus, this research was undertaken to investigate the comparative effects of different organic manure on the growth, proximate, mineral and phytochemical compositions of *Launaea taraxacifolia* in Lagos State of Nigeria.

MATERIALS AND METHODS

Research area and collection of material: Experiments were carried out in an open field of the Botanical Garden, Department of Botany, Faculty of Science, Lagos State University, Ojo- Lagos, Nigeria for the periods of 12 weeks during the 2019/2020 academic session. *Lacunae taraxacifolia* (African lettuce) seeds were bought from Lagos State Agricultural Input Supply, Agric Bus-Stop, Ojo- Lagos State. The poultry manure was collected from a Poultry farm in Ojo, Lagos, the pig manure was collected from a local Piggery farm in Badagry, Lagos, the cow dung was also collected from a local farm in Ojo, near Alaba-Rago Market, Ojo, Lagos and loamy soil were made available from the Botanical Garden of Lagos State University. The treatment used was as described by Detpiratmongkol *et al.*[34] for poultry manure and were adopted for both pig manure and cow dung and control.

Soil preparation and nursery: Loamy soil was sieved into a wheelbarrow and shared into fifteen buckets (depth 22.5 cm and width 22.4 cm), poultry manure was added using ratio

4:1 as described by Detpiratmongkol *et al.*[34] and Oluwole *et al.*[33] and 5 kg of soil plus manure (4 kg of soil and 1 kg of manure) were made. These were repeated for pig manure and cow dung, respectively while the control contains only loamy soil and all the buckets were watered once a day for one week to allow decomposition of the organic manures. A total of forty buckets was used for the experiments. Mature seeds were sown in a big bowl for 4 weeks, these were done by mixing the seeds with a well dried, clean loamy soil in a small container and were spread on the soil contained in the big bowl. Watering was done once a day till it reaches maturity (time of transplanting).

Transplanting and harvesting: Uniform *Launaea taraxacifolia* seedlings of two weeks old were transplanted into the buckets respectively and each of the buckets contain two seedlings. The buckets were segmented into 4 in which each treatment has four replicates and with light irrigation until the seedlings are well established and the established plants were collected from each treatment after carefully removed from the soil and washed with clean water (8 weeks after transplanting). Growth parameters-leaf length (cm), leaf width (cm), stem height (cm), stem girth (cm) and the number of leaves were determined with a total of 40 plants harvested. The leaf area (cm^2) using the formula:

$$\text{Leaf area} = 0.853 + (\text{leaf blade length} \times \text{leaf breadth}) \times 8.7440^{35}$$

Processing of plant materials: Fresh leaves of the *Launaea taraxacifolia* were thoroughly and separately washed with distilled water. Afterwards, they were air-dried by exposing the leaves to a constant room temperature at 25°C for 3-4 weeks. The leaves were then grounded into a fine powder using dried pestle and mortar.

Proximate analysis: Proximate analyses of leafy samples were determined for moisture, ash, crude fibre and fat using standard methods[36]. Nitrogen was determined by the micro-Kjeldahl method as described by Asaolu *et al.*[37] and the percentage nitrogen was converted to crude protein content by multiplying with 6.25. Carbohydrate was determined by difference:

$$\text{Carbohydrate (\%)} = 100\text{-Moisture (\%)-Protein (\%)-Fat (\%)-Mineral (\%)}$$

Where, all findings were performed in triplicates.

Mineral analysis: The mineral constituents of the leafy vegetable samples were analysed using the solution obtained by dry ashing the samples at 55°C and dissolving the ash in distilled deionized water in the flask. All the minerals (Mg, Pb, Mn, P, Zn, Fe and Na) were analysed using atomic absorption spectrophotometer (Gallenkamp model, United Kingdom)[38]. All analyses were carried out in triplicates.

Sample extraction for phytochemistry: Fifty grams of the powdered *Launaea taraxacifolia* leaves were weighed into labelled sample bottles and moistened with 100 mL of 80% ethanol. The bottles were covered with lids and the mixture was allowed to stand for 24 hrs. The extracts were placed on a water bath at 45°C to evaporate the methanol. The residues thus obtained were used as a crude extract for phytochemical analysis.

Qualitative and quantitative screening of phytochemicals: The qualitative and quantitative screening of phytochemicals of *Launaea taraxacifolia* was evaluated according to the standard methods previously reported by Yahaya *et al.*[38] and Ojewumi and Dedeke[39]. *Launaea taraxacifolia* was screened for total flavonoids, tannins, phenols, saponins, terpenoids, cardiac glycosides, steroids, phlobatannins, alkaloids and sugar.

RESULTS

Effects of different organic manures on the growth of *Launaea taraxacifolia*

Stem height: Table 1 shows the effects of different organic manure on the stem height of *Launaea taraxacifolia* . Thus, the result revealed that the seedlings of *Launaea taraxacifolia* enhanced with cow dung have the highest significance ($p<0.05$) stem height (66.90±7.04 cm) followed by those in control (65.25±3.88 cm) at the end of the fifth week after transplanting, however, those treated with pig manure (59.25±5.74 cm) and poultry manure (55.25±2.95 cm) had similar stem heights.

Stem girth: Table 2 shows the effects of different organic manure on the stem girth of *Launaea taraxacifolia* . Thus, the result revealed that the seedlings of *Launaea taraxacifolia* treated with pig manure have the highest significant ($p<0.05$.) stem girth (3.13±0.13 cm) followed by those in cow dung (2.60±0.12 cm), however, those treated with poultry manure (1.93±0.10 cm) and control (1.83±0.10 cm) had similar stem girths.

Numbers of leaves: Table 3 shows the effects of different organic manure on the number of leaves of *Launaea taraxacifolia* . Thus, the result revealed that the seedlings of *Launaea taraxacifolia* treated with pig manure have the highest significant ($p<0.05$) number of leaves (31.75±1.50 cm) followed by those treated with poultry manure (28.50±1.73 cm), however, those in control (19.50±0.58 cm) had least number of leaves.

Leaf length: Table 4 shows the effects of different organic manure on the leaf blade length of *Launaea taraxacifolia*. Thus, the result showed that the seedlings of *Launaea taraxacifolia* treated with pig manure have the highest significant ($p<0.05$) leaf blade length (14.30±0.24 cm) followed by those in cow dung (12.95±0.62 cm) at the end of the fifth week after transplant, however, those seedlings in control (8.48±0.43 cm) had least leaf blade length.

Leaf breadth: Table 5 shows the effects of different organic manure on the leaf blade breadth of *Launaea taraxacifolia*. Thus, the result revealed that the seedlings of *Launaea taraxacifolia* enhanced with pig manure have the highest significance ($p<0.05$) leaf blade breadth (6.40±0.23 cm) followed by those in cow dung (6.00±0.54 cm), however, those seedlings in control (3.58±0.10 cm) had least leaf blade breadth.

Leaf area: Table 6 shows the effects of different organic manure on the leaf area of *Launaea taraxacifolia*. Thus, the result revealed that the seedlings of *Launaea taraxacifolia* treated with pig manure have the highest significant ($p<0.05$.) leaf area (800.75±16.63 cm^2) followed by those seedlings treated with cow dung (681.27±82.73 cm^2), however, those seedlings in control (265.80±15.47 cm^2) had least leaf area.

Effects of different organic manures on the proximate composition of *Launaea taraxacifolia*: Proximate composition analysis of *Launaea taraxacifolia* was done following the enhancement with different organic manure. The manure treated groups show a significant increase in percentage carbohydrate composition when compared with the control. However, the poultry and pig manures have significantly ($p<0.05$) higher values for carbohydrates (30.76±0.37 and 30.23±0.32% respectively) when compared with the control (23.26±0.15%) in Table 7. Cow dung and pig manure showed a significantly higher ($p< 0.05$) increase in the percentage protein composition (4.94±0.19 and 4.48±0.17%, respectively) when compared with control (4.13±0.05%) (Table 7).

Poultry and pig manures treated plants showed a significant ($p<0.05$) increase in crude fat (1.89±0.10 and 1.53±0.07% respectively) when compared with control (1.38±0.04%). Meanwhile, the entire manure treated groups reduce the percentage moisture composition when compared with control while the poultry manure has the lowest moisture composition (Table 7). The pig manure treated group reduces the percentage ash composition (3.97±0.18%) when compared with the control (4.83±0.03%) (Table 7). Pig and poultry manure treated plants show a significant decrease in crude fibre composition (5.68±0.43 and 5.84±0.94%, respectively) when compared with control (8.00±0.23%).

Effects of different organic manure on the mineral compositions of *Launaea taraxacifolia*: Table 8 shows the effects of different organic manure on the mineral composition of *Launaea taraxacifolia*. The mean values for magnesium (23.73±1.19 mg kg^{-1}), manganese (0.34±0.49 mg kg^{-1}), iron (0.83±0.41 mg kg^{-1}) and calcium (88.19±3.81 mg kg^{-1}) were found to be the highest for plants fertilized with poultry manure when compared to other treatments, the value was significantly different from that of the control. The mean values for potassium (119.29±3.87 mg kg^{-1}) and sodium (66.35±3.62 mg kg^{-1}) were highest for plants fertilized with pig manure while the mean values for phosphorus (54.09±3.24 mg kg^{-1}) and zinc (0.91±0.06mg kg^{-1}) were found to be the highest for plants fertilized with cow dung, the result was significantly different from the control (Table 8).

Effects of different organic manures on phytochemistry of *Launaea taraxacifolia*

Qualitative phytochemistry: Table 9 shows the qualitative phytochemical screening of *Launaea taraxacifolia* treated with different organic manure. The result revealed that *Launaea taraxacifolia* contains tannins, phenols, saponins, cardiac glycosides, reducing sugar, flavonoid, steroids and terpenoids while alkaloids and phlobatannins are absent in the plant (Table 9).

Quantitative phytochemical compositions: Table 10 shows the quantitative phytochemical screening of *Launaea taraxacifolia* treated with different organic manure. The result revealed that *Launaea taraxacifolia* treated poultry manure showed significantly ($p<0.05$) higher values of tannins, phenols and saponins followed by cow dung and pig manure, respectively.

The result also showed that the steroid, flavonoid and reducing sugar contents in *Launaea taraxacifolia* seedlings treated with cow dung, pig manure and poultry manure are significantly ($p<0.05$) similar compared to the seedlings in control (Table 10).

More so, the result showed that the quantities of cardiac glycosides in *Launaea taraxacifolia* subjected to the four treatments are significantly similar. Terpenoids values of

Table 1: Effects of different organic manure on the stem height of *Launaea taraxacifolia*

	Average stem height (cm)				
Treatments	Week 1	Week 2	Week 3	Week 4	Week 5
Control	12.56±1.30^{a}	15.23±1.84^{a}	18.40±1.27^{a}	41.60±1.92^{a}	65.25±3.88^{a}
Poultry manure	18.80±1.11^{b}	22.85±1.43^{b}	27.93±2.24^{b}	47.98±5.65^{b}	55.25±2.95^{b}
Cow dung	12.03±1.21^{a}	15.25±0.96^{a}	18.63±2.39a	50.78±3.11^{b}	66.90±7.04^{a}
Pig manure	10.30±1.12^{a}	12.38±0.75^{a}	28.83±1.30^{b}	42.40±0.78^{a}	59.25±5.74^{b}

Values are presented as Mean±SD and values in the same column with different letters are statistically significant at $p<0.05$

Table 2: Effects of different organic manure on the stem girth of *Launaea taraxacifolia*

	Average stem girth (cm)				
Treatments	Week 1	Week 2	Week 3	Week 4	Week 5
Control	0.93±0.05^{a}	1.18±0.10^{a}	1.38±0.05^{a}	1.58±0.05^{a}	1.83±0.10^{a}
Poultry manure	1.13±0.05^{a}	1.33±0.05^{a}	1.58±0.10^{b}	1.78±0.10^{b}	1.93±0.10^{a}
Cow dung	1.58±0.15^{b}	1.78±0.15^{b}	2.30±0.14^{c}	2.58±0.10^{c}	2.60±0.12^{b}
Pig manure	1.23±0.15^{c}	1.50±0.14^{c}	1.78±0.10^{d}	2.23±0.17^{d}	3.13±0.13^{c}

Values are presented as Mean±SD and values in the same column with different letters are statistically significant at $p<0.05$

Table 3: Effects of different organic manure on the number of leaves of *Launaea taraxacifolia*

	Average number of leaves				
Treatments	Week 1	Week 2	Week 3	Week 4	Week 5
Control	10.25±0.50^{a}	12.25±0.96^{a}	18.00±1.83^{a}	21.00±1.83^{a}	19.50±0.58^{a}
Poultry manure	7.75±0.96^{b}	14.00±1.41^{a}	21.50±2.65^{b}	23.00±2.45^{a}	28.50±1.73^{b}
Cow dung	11.75±0.96^{a}	16.25±1.50^{b}	22.25±3.86^{bc}	24.25±0.96^{b}	26.50±1.29^{b}
Pig manure	9.25±0.96^{ab}	19.25±0.96^{c}	24.25±1.50^{c}	29.50±1.00^{c}	31.75±1.50^{c}

Values are presented as Mean±SD and values in the same column with different letters are statistically significant at $p<0.05$

Table 4: Effects of different organic manure on the leaf length of *Launaea taraxacifolia*

	Average leaf length (cm)				
Treatments	Week 1	Week 2	Week 3	Week 4	Week 5
Control	12.30±0.34^{a}	12.85±0.30^{a}	12.37±0.45^{a}	12.27±0.22^{a}	8.48±0.43^{a}
Poultry manure	12.90±0.46^{a}	13.83±0.83^{a}	13.30±1.50^{a}	13.60±0.94^{b}	10.60±0.28^{b}
Cow dung	15.63±1.49^{b}	15.33±0.78^{b}	15.23±0.66^{b}	15.40±0.62^{c}	12.95±0.62^{c}
Pig manure	11.82±0.78^{a}	12.93±1.23^{a}	14.37±0.90^{ab}	16.48±0.15^{c}	14.30±0.24^{d}

Values are presented as Mean±SD and values in the same column with different letters are statistically significant at $p<0.05$

Table 5: Effects of different organic manure on the leaf breadth of *Launaea taraxacifolia*

	Average leaf blade breadth (cm)				
Treatments	Week 1	Week 2	Week 3	Week 4	Week 5
Control	5.13±0.19^{a}	5.25±0.24^{a}	4.63±0.13^{a}	4.55±0.30^{a}	3.58±0.10^{a}
Poultry manure	4.23±0.26^{b}	4.95±0.64^{a}	4.00±0.08^{b}	4.45±0.10^{a}	5.43±0.10^{b}
Cow dung	5.15±0.33^{a}	5.20±0.22^{a}	5.78±0.19^{c}	5.50±0.24^{b}	6.00±0.54^{c}
Pig manure	3.15±0.13^{c}	4.45±0.51^{b}	5.93±0.05^{c}	6.78±0.24^{b}	6.40±0.23^{c}

Values are presented as Mean±SD and values in the same column with different letters are statistically significant at $p<0.05$

Table 6: Effects of different organic manure on the Leaf area of *Launaea taraxacifolia*

	Average leaf length (cm^2)				
Treatments	Week 1	Week 2	Week 3	Week 4	Week 5
Control	552.12±27.39^{a}	590.55±24.47^{a}	501.18±18.51^{a}	489±32.05^{a}	265.80±15.47^{a}
Poultry manure	477.51±35.99^{b}	600.45±94.63^{a}	466.71±60.26^{a}	530.65±47.54^{a}	503.81±23.27^{b}
Cow dung	706.99±105.76^{c}	697.23±35.85^{b}	769.06±22.76^{b}	741.21±38.56^{b}	681.27±82.73^{c}
Pig manure	326.24±19.16^{d}	501.51±47.23^{c}	745.78±50.74^{b}	976.68±28.70^{c}	800.75±16.63^{d}

Values are presented as Mean±SD and values in the same column with different letters are statistically significant at $p<0.05$

Table 7: Effects of different organic manure on the proximate composition of *Launaea taraxacifolia*

	Proximate composition (%)					
Treatments	Carbohydrates	Protein	Crude fat	Moisture	Ash	Crude fibre
Control	23.26±0.15[a]	4.13±0.05[a]	1.38±0.04[b]	57.91±0.59[d]	4.83±0.03[c]	8.00±0.23[b]
Poultry manure	30.76±0.37[c]	4.23±0.09[a]	1.89±0.10[d]	53.12±0.43[a]	4.17±0.03[b]	5.84±0.94[a]
Cow dung	25.95±0.62[b]	4.94±0.19[c]	1.26±0.07[a]	56.43±0.55[c]	4.29±0.09[b]	7.13±0.97[b]
Pig manure	30.23±0.32[c]	4.48±0.17[b]	1.53±0.07[c]	54.10±0.30[b]	3.97±0.18[a]	5.68±0.43[a]

Values are presented as Mean±SD and values in the same column with different letters are statistically significant at $p<0.05$

Table 8: Effects of different organic manure on the mineral compositions of *Launaea taraxacifolia*

Treatments (mg kg^{-1})	Cow dung	Pig manure	Poultry	Control
K	113.64±3.66[b]	119.29±3.87[b]	116.37±3.37[b]	27.31±42.32[a]
Mg	20.73±1.01[b]	20.06±1.40[b]	23.73±1.19[b]	5.68±8.80[a]
Mn	0.20±0.89[a]	0.26±0.24[ab]	0.34±0.49[b]	0.12±0.19[a]
P	54.09±3.24[b]	53.94±2.39[b]	53.48±2.15[b]	11.19±17.36[a]
Na	58.75±1.55[b]	66.35±3.62[b]	64.49±2.93[b]	17.28±26.79[a]
Fe	0.81±1.20[b]	0.81±0.30[b]	0.83±0.41[b]	0.23±0.36
Zn	0.91±0.06[c]	0.71±0.09[b]	0.79±0.07[bc]	0.14±0.22[a]
Ca	81.49±1.86[b]	83.42±2.11[b]	88.19±3.81[b]	24.47±37.91[a]

Values are presented as Mean±SD and values in the same row with different letters are statistically significant at $p<0.05$

Table 9: Qualitative screening of phytochemicals of *Launaea taraxacifolia* in different organic manure

Treatments	Control	Cow dung	Pig manure	Poultry manure
Saponins	+	+	+	+
Reducing sugar	+	+	+	+
Phenols	+	+	+	+
Flavonoids	+	+	+	+
Steroids	+	+	+	+
Alkaloids	-	-	-	-
Terpenoids	+	+	+	+
Tannins	+	+	+	+
Phlobatannins	-	-	-	-
Cardiac glycosides	+	+	+	+

+: Present and -: Absent

Table 10: Quantitative screening on phytochemicals of *Launaea taraxacifolia* in different organic manure

Treatments (mg 100 g^{-1})	Cow dung	Pig manure	Poultry	Control
Tannins	34.36±2.34[b]	31.30±3.80[ab]	37.51±7.03[b]	26.75±0.52[a]
Phenols	48.87±1.42[bc]	44.41±3.38[b]	53.03±7.40[c]	34.56±0.90[a]
Cardiac glycosides	36.24±3.27[ab]	35.61±2.03[ab]	32.68±1.39[a]	36.99±0.94[c]
Saponins	47.90±1.81[c]	42.57±3.54[b]	56.74±1.97[d]	20.93±0.35[a]
Flavonoids	58.97±2.57[c]	53.16±3.96[b]	57.72±4.59[bc]	43.95±0.81[a]
Steroids	26.71±2.07[b]	28.04±4.00[b]	24.94±1.94[b]	18.05±0.59[a]
Terpenoids	27.82±2.14[c]	21.89±1.33[b]	22.95±1.00[b]	17.00±0.63[a]
Reducing sugar	50.44±2.64[b]	47.31±2.91[b]	47.38±2.41[b]	34.47±0.98[a]

Values are presented as Mean±SD and values in the same row with different letters are statistically significant at $p<0.05$

Launaea taraxacifolia treated with cow dung showed the highest significance ($p<0.05$) values followed by those seedlings in pig manure and poultry manure compared with the control (Table 10).

DISCUSSION

Manure is an organic matter that is used to enhance land, consisting of decomposed plants and animals' droppings. Animal manure varies in types and faecal constituents[32] and its plays an essential role in the growth of plants because they improve soil oxygen and its water holding capacity by building good soil structure and texture for plant utilization[40]. Hence, this study: Comparative effects of different organic manure on the growth, proximate, mineral and phytochemical compositions of *Launaea taraxacifolia* covers twelve weeks showed contrasting results on the growth parameters studied. The highest significant stem height (66.90±7.04 cm) was observed in *Launaea taraxacifolia* enhanced with cow dung compared to other types of manure used after the fifth week of transplanting (Table 1). This result agreed with the findings of Akanbi and Togun[41], Obidola *et al.*[42] when they studied the comparative effects of organic and inorganic manure on the growth of amaranth and cabbage respectively, they observed that cow dung enhanced the height of plants and this increase was attributed to the timely release of nutrient from cow dung compared to other manure types used. This result also conforms to the findings of Oluwole *et al.*[33], who reported that cow dung increases the height of *Talinum triangulare*. The stem girth was significantly higher in pig manure compared to other manure types used in the enhancement of *Launaea taraxacifolia* after the fifth week of transplanting (Table 2). This result was against the findings of Oluwole *et al.*[33] who reported an increase in stem girth of *Talinum triangulare* for poultry manure.

The highest average number of leaves (31.75±1.50), leaf blade length and leaf blade breadth were observed in *Launaea taraxacifolia* treated with pig manure after the fifth week of transplanting (Tables 3, 4 and 5). This result conforms to the findings of Oluwole *et al.*[33], who reported an increase in the number of leaves, leaf length and leaf breadth of *T. triangulare* enhanced with pig manure and this was attributed to the richness of pig manures in magnesium nutrients compared to other types of manure used. Magnesium is a constituent of chlorophyll in green leaves, hence its highest presence might have been responsible for greater leaf growth in plants fertilized with pig's dung.

The largest (800.75±16.63 cm^2) and least (265.80±15.47 cm^2) leaf areas were recorded for pig manure and control, respectively which are as a result of great nutritional constituents found in pig manure (Table 6), this agrees with the work of Ajari *et al.*[43], Oluwole *et al.*[33] and Obidola *et al.*[42]. They all reported an increase or large leaf area in the plants studied. Also, the introduction of organic manure to soils enhances the performance of *Launaea taraxacifolia* subjected to different organic manure studied. This has been attributed to increasing microbial activities, thereby increasing the fertility of the soil and productivity by loosening the soil particles and minerals[44]. Also, organic manure has been proven to significantly promote plant growth, the head yield of okra[45].

Proximate compositions of *Launaea taraxacifolia* were fertilized with different organic manure (Table 7). In the *L. taraxacifolia* plant grown with cow dung, protein has the highest proximate content (4.94±0.19%), this goes against the work of Okereke *et al.*[46], who studied the proximate composition of *Cucumis sativus* grown in soil with different organic manure and they reported protein to have the least proximate content with a plant grown with cow dung. This variation could be a result of the responses of different plants to different manure. Also, in-plant grown with poultry manure, carbohydrates have the highest proximate content (30.76±0.37%), this concurs with the work of Okereke *et al.*[46] which reported poultry manure to have the highest carbohydrates proximate composition.

The plant grown with cow dung showed the highest value in moisture content (56.43±0.55%), ash content (4.29±0.09%) and crude fibre (7.13±0.97%), while the plant grown with poultry manure has the highest crude fat content (1.89±0.10%). All these corroborate the work of Okereke *et al.*[46].

The mineral analysis confirmed the presence of calcium, sodium, iron, potassium, manganese, magnesium, zinc and phosphorus in African lettuce. Poultry manure had the highest amount of magnesium, manganese, iron and calcium. The positive influence of poultry manure on the growth and yield of African lettuce crops might be due to the release of the balanced nutrients contained in the organic nutrient, especially nitrogen which ensures favourable conditions for the elongation of African lettuce plant as well as the availability of other macro and trace elements and improvement in soil physical structure as water holding capacity. A similar result was obtained by Adekiya *et al.*[47] in cocoyam and Xu *et al.*[48] in a study on leafy vegetables.

African lettuce plant fertilized with pig manure had the highest mean values of potassium and sodium, this can be attributed to the high amount of potassium content in the pig as a result of their feeding habits and feeding range, while African lettuce fertilized with cow dung had the highest amount of phosphorus and zinc. Cow dung, pig manure and poultry manure respectively significant increased the mineral composition of African lettuce when compared with the control. The organic matter of manure allows plants to use the nutrients for a long time, due to its slow decomposition and reduces the loss of water not utilized by the plants[49].

Previously, mineral elemental composition revealed that calcium and magnesium required for bone development and haemoglobin production respectively were higher in seedlings treatmented with poultry manure, while phosphorous that is an important component of energy intermediates was highest in the plants fertilized with cow dung[50].

The qualitative phytochemical screening of *Launaea taraxacifolia* subjected to different organic manure revealed the possible medicinal properties. This result shows that all the treatments contain tannins, phenols, saponins, cardiac glycosides, reducing sugar, flavonoids, steroids and terpenoids. These metabolites observed agreed with the findings of Sakpere and Aremu[12], Koukoui *et al.*[26], Adinortey *et al.*[17], Darkwa and Darkwa[51], Bouguerra *et al.*[22], Dickson *et al.*[18], Olugbenga *et al.*[25], Salau *et al.*[52], Ololade *et al.*[53]. Previous works on African lettuce by Koukoui *et al.*[26], Ololade *et al.*[53], Adinortey *et al.*[19] and many others, reported the antibacterial, antifungal and anti-cancer properties. These various medicinal properties have been attributed to the presence of different phytochemicals such as tannins, saponins, phenols and so on. However, tannins have been reported to have antibacterial activity as well as microbial activities[54].

Furthermore, the result of the quantitative phytochemical analysis of African lettuce revealed that different organic manures could bring about a significant increase in phytochemical compositions (Table 10). The result shows a distinct difference between the tannins, phenols, saponins, cardiac glycosides, reducing sugar, flavonoids, steroids and terpenoids of different organic manure compared to the control. This result agrees with the work of Obidola *et al.*[42], who reported an increase in the phytochemical composition of cabbage subjected to different organic manures. Also, total phenolics and flavonoid content have been reported to be enhanced by different manure in *Labisia pumila* Benth[55]. This result further confirms the findings of Swallah *et al.*[56], who reported that plants and other food with organic origins are more nutritious than ordinary food and may aid the longevity of humans. He further reported that organic foods contain higher levels of secondary metabolites like flavonoids which help reduce heart-related diseases and tumour growth as well as increase iron and zinc.

CONCLUSION

From the findings of this study, it could be deduced that organic manures generally increases the growth and phytochemical composition of *Launaea taraxacifolia*. The results showed that seedlings of *Launaea taraxacifolia* treated with pig manure have the highest number of leaves, lengthier and broader leaves and wider stem girth and leaf area except for stem height which favoured seedlings in cow dung. Poultry manure increases the carbohydrate and crude fat percentages while cow dung increases the protein percentage, but pig manure decreases the ash and crude fibre percentages. Also, poultry manure had the highest amount of potassium, iron, manganese and magnesium which are very crucial minerals in our daily diet. Furthermore, the result shows some metabolites such as tannins, phenols, saponins, steroids, flavonoids, reducing sugar, terpenoids and cardiac glycosides were also observed. However, the quantitative phytochemical analysis showed that African lettuce treated with cow dung has the highest values of the identified secondary metabolites.

It could be recommended that *Launaea taraxacifolia* vegetable should be grown with the mixture of three organic manures for the best growth, nutritional and medicinal properties. However, farmers are advised to use pig manure in the enhancement of the vegetable because it is the best for the growth of the plant.

SIGNIFICANCE STATEMENT

This study discovers that comparing the effects of different organic manures on the growth, proximate, mineral and phytochemical compositions of *Launaea taraxacifolia* (African Lettuce) can be beneficial to the consumers and farmers, especially in Nigeria, who are faced with the challenge of dietary deficiency and best manure types needed for growing the crop, respectively. This study will help the researcher to uncover the critical areas of some vegetables' compositions concerning manure types used that many researchers were not able to explore. Thus, a new theory on possible ways of improving the quantities and qualities of the consumed vegetables may be arrived at.

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