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Effects of the Crude Water Extract of the Leaves of *Morinda lucida* on the Germination and Growth of *Amaranthus spinosus* and *Amaranthus hybridus*

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Authors' contributions

This work was carried out in collaboration between all authors. Authors CUO and CFI designed the study, wrote the protocol, managed the analyses of the study and wrote the first draft of the manuscript. Author CFI carried out the laboratory work under supervision of authors CUO and BLN. Authors NCO and CFI performed the statistical analysis, wrote the final draft and managed the Literature searches. All authors read and approved the final manuscript.

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ABSTRACT

The effect of crude leaf extract of *Morinda lucida* on germination and growth of *Amaranthus spinosus* and *Amaranthus hybridus* was studied. However, the aim was to use crude water extract from leave of *M. lucida* to germinate, nurture and compare the growth of *A. hybridus* and *A. spinosus*. The plants seeds selected were planted in polyethylene bags filled with loamy soil, different extract concentrations of 5%, 10% and 15% were obtained from the leaf of *M. lucida* using manual extraction method. The plants were well watered with the extracts of three different concentrations and allowed to grow under natural environmental condition. Parameters measured include: weekly height of plants, number of leaves produced by each plants at the end of the week, weekly stem girth and weekly leaf area of plant. The study showed that the extract of *M. lucida* had

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negative effect on the growth of *A. spinosus* and *A. hybridus*. The effect was significantly higher at higher concentrations of the extracts. *M. lucida* extract significantly reduced the leaf number, leaf area, stem height, fresh weight and dry weight in *A. spinosus* and *A. hybridus* when compared to those of the control. Additionally, the germination of *A. spinosus* and *A. hybridus* were delayed considerable to the fourth and fifth weeks and in some replicate no germination was observed. The study further showed that the sensitivity of *A. spinosus* and *A. hybridus* to plant extracts differ. From the study *M. lucida* had more negative effect on *A. spinosus*, hence, revealing more inhibitory activity on the growth of *A. spinosus* than on *A. hybridus.*

Keywords: Amaranthus; germination; growth; hybridus; Morinda lucida; spinosus.

1. INTRODUCTION

A. hybridus L. popularly called "Amaranth or pigweed" is an annual herbaceous plant of 1-6 feet high. The leaves are alternate, petiole 3–6 inches long, dull green in colour and rough, hairy, ovate or rhombic with wavy margins. The flowers are small, with greenish or red Terminal panicles. Taproot is long, fleshy red or pink. The seeds are small and lenticellular in shape; with each seed averaging 1–1.5 mm in diameter and 1000 seeds weighing 0.6–1.2 g. It is rather a common species in waste places, cultivated fields and barnyards. In Nigeria, *A. hybridus* leaves combined with condiments are used to prepare soup [1,2,3]. In Congo, their leaves are eaten as spinach or green vegetables [4]. These leaves boiled and mixed with a groundnut sauce are eaten as salad in Northern Nigeria and in Mozambique [5]. [6] Flowers tiny green flowers are borne in dense, elongated clusters, usually on the tip of the branches. They are borne in spikes or plumes and are white, green, pink or purplish in colour.

Spiny amaranth, *A. spinosus* sometimes called spiny pigweed, is a troublesome weed of vegetables, row crops, and pasture in warm climates. Native to the lowland tropics in the Americas, spiny amaranth has spread through tropical and subtropical latitudes around the world [7]. It has become a major weed of rice in the Philippines and is moving into temperate regions in the United States. Its widespread distribution and its sharp spines, which deter grazing and interfere with manual weeding and harvest, have earned spiny amaranth designation as the world's 15th worst agricultural weed [7]. Spiny amaranth is an erect, often bushy, much-branched summer annual, growing to heights of 2–5 feet. Stems and leaves are smooth and hairless, sometimes shiny in appearance. Each leaf node along the stem bears a pair of rigid, sharp spines 0.5 inch long. Leaf blades are egg-shaped to diamond-shaped, with the broader end closest to the stem, 1–4 inches long by 0.5–2.5 inches wide. The petiole is approximately as long as the blade. Leaves may be variegated with a v-shaped watermark or area of lighter colour although this is not a definitive characteristic of this species, since some other amaranths can show a similar watermark. Like other pigweeds, spiny amaranth develops a strong taproot with a network of fibrous feeder roots. The taproot may or may not be distinctly reddish in color. Male and female flowers are borne on different regions of the same plant; linear or branched terminal spikes with mostly male flowers and globular axillary clusters of mostly female flowers [8].

Amaranth consists of 60-70 species, 40 of which are considered native to the Americas. They are grown in the temperate and tropical climates, and are used as grain or vegetable. They are highly nutritious, contain vitamins and minerals. The leaves, shoots, tender stems and grains are eaten as pot herb in sauces or soups, cooked with other vegetables, with a main dish or by itself. The plants are used as forage for livestock. Traditionally, the boiled leaves and roots are used as: laxative, diuretic, anti-diabetic, antipyretic, anti-snake venom, anti-leprotic, anti-gonorrheal, expectorant, to relieve breathing in acute bronchitis. It also has anti-inflammatory properties, immune modulatory activity, anti-androgenic activity and anthelmintic properties.

Morinda comprises about 80 species and occurs throughout the tropics. In Africa 5 species are found. *M. lucida* is a tree of 18 m high bearing a dense crown of slender crooked branches and it is 20-30 cm in diameter. It belongs to the family Rubiaceae and is commonly known as noni or nonu, *M. lucida* is abundant in northern and southern Nigeria and Fernando po and over the Congo basin. The plant is a dicotyledonous plant, the comparatively small flowering and fruiting heads on long slender peduncles are distinctive characteristics of *M. lucida*. Other *Morinda* species also yield yellow and red dyes, but they

usually have other more important uses. Many species, including those from Africa, are important medicinal plants, widely applied against various kinds of fevers and infections. The powerful dye from bark and roots of *M. citrifolia* L. is used where traditional textile dyeing is practised in Africa [9,10]. However, crude water extract from leave of *M. lucida* was used to germinate, nurture and compare the growth of *A. hybridus* and *A. spinosus*.

2. MATERIALS AND METHODS

2.1 Preparation of Crude Extract

The *M. lucida* leaves were from Enugo village Ojoto in Idemili South Local Government Area, Anambra State. The leave sample was then dried in the oven at the temperature of 70°C. After drying, the leaves were ground into powder form using mortar and pestle. The powdered leave sample was boiled in water and later diluted to varying concentrations.

2.2 Planting

Loamy soil was used in the planting of the two *Amaranthus* species. Measured quantity of the soil was weighed 10 g each and then placed inside the plastic poly bags for seed planting.

2.3 Experimental Design

In the experimental design, *M. lucida* had three concentrations; 5%, 10% and 15%, each concentration had three replicate.

2.4 Seed Viability Test

The seeds of *A. hybridus* were from Gbarimgba market in Awka South Local Government Area. Before planting, seed viability test was carried out to know if the seeds will germinate, this was done manually by placing all the seeds in water; however, the ones that dropped to the bottom of the Petri dish were viable while those at the top of the Petri dish were not viable.

2.5 Sowing of Seeds

After the viability test seeds were sown by broadcasting method in the poly bag and then left for three days before applying the crude water extracts of *M. lucida* in their concentration to *A. hybridus* and *A. spinosus*. However, the plants were treated with the extract morning and evening for six weeks based on the experimental design highlighted in 2.3 above [3].

3. RESULTS

3.1 Effect of Leaf Extract of *M. lucida* on the Productivity of *A. spinosus* and *A. hybridus*

Table 1 shows the weekly mean height of *A. spinosus* cultivated with extract of *M. lucida* at various concentrations. The table indicates that comparatively, *A. spinosus* in the control (% extract) reported the highest height from the first week (2.6±0.007) to the fifth week (12.7±0.577). Samples treated with 5% concentration of the extract only reported a mean height of 4.2±0.764 in the fourth week and 6.0±1.000 in the fifth week. Similarly, samples treated with 10% of the extract only reported a mean height of 2.3±0.577 in the fifth week. No height reading was observed for samples treated with 15% of the extract. The analysis of variance further indicates a significant difference in the mean height of *A. spinosus* between concentrations of extract (P=0.05).

Table 2 shows the weekly mean height of *A. hybridus* cultivated with extract of *M. lucida* at various concentrations. The table indicates that comparatively, *A. hybridus* in the control (% extract) reported the highest height from the first week (4.3±0.073) to the fifth week (15.4±0.917). Samples treated with 5% concentration of the extract only reported a mean height of 7.5±1.418 in the fourth week and 11.0±0.000 in the fifth week. No height reading was observed for samples treated with 15% of the extract. The analysis of variance further indicates a significant difference in the mean height of *A. hybridus* between concentrations of extract (P=0.05).

Table 3 shows the weekly mean number of leaves of *A. spinosus* cultivated with crude water extract of *M. lucida* at various concentrations. The table indicates that comparatively, *A. spinosus* in the control (% extract) reported the highest number of leaf from the first week (2.7±0.567) to the fifth week (7.7±0.577). Samples treated with 5% concentration of the extract only reported a mean number of leaves of 2.3±0.577 in the fourth week and 4.3±0.000 in the fifth week. Similarly, samples treated with 10% of the extract only reported a mean number of leaves of 2.3±0.577 in the fifth week. No leaf number reading was observed for samples treated with 15% of the extract. The analysis of variance further indicates a significant difference in the number of leaves of *A. spinosus* between concentrations of extract (P=0.05).

Table 4 shows the weekly mean number of leaves of *A. hybridus* cultivated with crude water extract of *M. lucida* at various concentrations. The table indicates that comparatively, *A. hybridus* in the control (% extract) reported the highest number of leaf from the first week (5.3±0.577) to the fifth week (9.3±0.577). Samples treated with 5% concentration of the extract only reported a mean number of leaves of 4.7±0.577 in the fourth week and 6.3±0.155 in the fifth week. No leaf number reading was observed for samples treated with 10% and 15% of the extract. The analysis of variance further indicates a significant difference in the number of leaves of *A. hybridus* between concentrations of extract (*P*=0.05).

Table 5 shows the weekly mean leaf area of *A. spinosus* cultivated with crude water extract of *M. lucida* at various concentrations. The table indicates that comparatively, *A. spinosus* in the control (% extract) reported the highest leaf area of 4.1±0.569 in the first week to 9.2±0.387 in the fifth week. Samples treated with 5% concentration of the extract only reported mean leaf area of 3.1±0.461 in the fourth week and 4.2±0.252 in the fifth week. Similarly, samples treated with 10% of the extract only reported a leaf area of 2.4±0.482 in the fifth week. No leaf area reading was observed for samples treated with 15% of the extract. The analysis of variance further indicates a significant difference in the leaf area of *A. spinosus* between concentrations of extract (P=0.05).

Table 6 shows the weekly leaf area of *A. hybridus* cultivated with crude water extract of *M. lucida* at various concentrations. The table indicates that comparatively, *A. hybridus* in the control (% extract) reported the highest leaf area of 3.3±0.173 in the first week to 8.3±0.054 in the fifth week. Samples treated with 5% concentration of the extract only reported mean leaf area of 3.4±0.161 in the fourth week and 4.5±0.304 in the fifth week. No leaf area reading was observed for samples treated with 10% and 15% of the extract. The analysis of variance further indicates a significant difference in the leaf area of *A. hybridus* between concentrations of extract (*P*=0.05).

Fig. 1. depicts that height of both *A. spinosus* and *A. hybridus* decreased with increasing concentration of the extract. In comparison, the height of *A. spinosus* was higher at 0% and 5% concentration while the height *A. hybridus* was higher at 10%. Analysis of variance further indicates a significant difference between the mean height of *A. spinosus* and *A. hybridus* in various concentrations of *M. lucida* extract (P = 0.05).

Fig. 2. depicts that number of leaf in both *A. spinosus* and *A. hybridus* decreased with increasing concentration of the extract. In comparison, the number of leaf of *A. spinosus* was higher at 0% and 5% concentration while the number of leaf *A. hybridus* was higher at 10%. Analysis of variance further indicates a significant difference between the number of leaf *A. spinosus* and *A. hybridus* in various concentrations of *M. lucida* extract (*P* = 0.05).

Table 1. Weekly mean height of *A. spinosus* grown with crude water extract of *M. lucida*

	Weekly Plant Height (cm) of *A. spinosus*				
Concentration*	**Wk1**	**Wk2**	**Wk3**	**Wk4**	**Wk5**
0%	2.6±0.007^{a}	4.2±0.079^{b}	7.1±0.982^{c}	11.7±0.528^{d}	12.7±0.577^{d}
5%	-	-	-	4.2±0.764^{b}	6.0±1.000^{c}
10%	-	-	-	-	2.3±0.577^{a}
15%	-	-	-	-	-

Results are in Mean ± Standard deviation; Rows/columns with the same superscript are not significantly different P = 0.05

Table 2. Weekly mean height of *A. hybridus* grown with crude water extract of *M. lucida*

	Weeks				
Concentration*	**Wk1**	**Wk2**	**Wk3**	**Wk4**	**Wk5**
0%	4.3±0.073^{a}	5.9±0.021^{a}	8.6±0.702^{c}	14.2±1.046^{e}	15.4±0.917^{e}
5%	-	-	-	7.5±1.418^{b}	11.0±0.000d
10%	-	-	-	-	-
15%	-	-	-	-	-

Results are in Mean ± Standard deviation; Rows/columns with the same superscript are not significantly different P = 0.05

Table 3. Weekly leaf number of *A. spinosus* grown with crude water extract of *M. lucida*

	Weekly Leaf Number of *A. spinosus*				
Concentration*	**Wk1**	**Wk2**	**Wk3**	**Wk4**	**Wk5**
0%	2.7±0.567[a]	4.0±0.000[b]	5.0±0.000[c]	6.0±1.000[c]	7.7±0.577[d]
5%	-	-	-	2.3±0.577[a]	4.3±0.000[b]
10%	-	-	-	-	2.3±0.577[a]
15%	-	-	-	-	-

Results are in Mean ± Standard deviation; Rows/columns with the same superscript are not significantly different P = 0.05

Table 4. Weekly leaf number of *A. hybridus* grown with crude water extract of *M. lucida*

	Weekly leaf number of *A. hybridus*				
Concentration*	**Wk1**	**Wk2**	**Wk3**	**Wk4**	**Wk5**
0%	5.3±0.577[a]	5.7±0.521[b]	7.3±1.528[c]	8.0±0.000[d]	9.3±0.577[d]
5%	-	-	-	4.7±0.577[a]	6.3±0.155[c]
10%	-	-	-	-	-
15%	-	-	-	-	-

Results are in Mean ± Standard deviation; Rows/columns with the same superscript are not significantly different P = 0.05

Table 5. Weekly leaf area of *A. spinosus* grown with crude water extract of *M. lucida*

	Weekly leaf area of *A. spinosus*				
Concentration	**Wk1**	**Wk2**	**Wk3**	**Wk4**	**Wk5**
0%	4.1±0.569[b]	5.7±0.709[b]	7.6±0.644[c]	8.2±0.626[c]	9.2±0.387[c]
5%	-	-	-	3.1±0.461[a]	4.2±0.252[b]
10%	-	-	-	-	2.4±0.482[a]
15%	-	-	-	-	-

Results are in Mean ± Standard deviation; Rows/columns with the same superscript are not significantly different P = 0.05

Table 6. Weekly leaf area of *A. hybridus* grown with crude water extract of *M. lucida*

	Weekly leaf area of *A. hybridus*				
Concentration*	**Wk1**	**Wk2**	**Wk3**	**Wk4**	**Wk5**
0%	3.3±0.173[a]	4.4±0.452[b]	6.9±0.112[c]	7.3±0.616[c]	8.3±0.054[d]
5%	-	-	-	3.4±0.161[a]	4.5±0.304[b]
10%	-	-	-	-	-
15%	-	-	-	-	-

Results are in Mean ± Standard deviation; Rows/columns with the same superscript are not significantly different P = 0.05

Fig. 3. Depicts that leaf area of both *A. spinosus* and *A. hybridus* decreased with increasing concentration of the extract. In comparison, the leaf area of *A. spinosus* was higher at 0% and 5% concentration while the leaf area *A. hybridus* was higher at 10%. Analysis of variance further indicates a significant difference between the leaf area of *A. spinosus* and *A. hybridus* in various concentrations of *M. lucida* extract (*P* = 0.05).

Fig. 4. Depicts that the fresh weight of both plant decreases with concentration. In the control (0%) the fresh weights of *A. spinosus* and *A. hybridus* were the same while at 5% the fresh weights of Amaranthus spinosus was higher. Analysis of variance shows no significant difference between the fresh weight *A. spinosus* and *A. hybridus* cultivated with extracts of *M. lucida*.

Fig. 5. Depicts that the dry weight of both plant decreases with concentration. In the control (0%) the dry weights of *A. spinosus* and *A. hybridus* were the same; at 5% the dry weights of *A. spinosus* was higher while at 10% the dry weights of *A. hybridus* was higher. Analysis of variance shows no significant difference between the dry weight *A. spinosus* and *A. hybridus* cultivated with extracts of *M. lucida* [3].

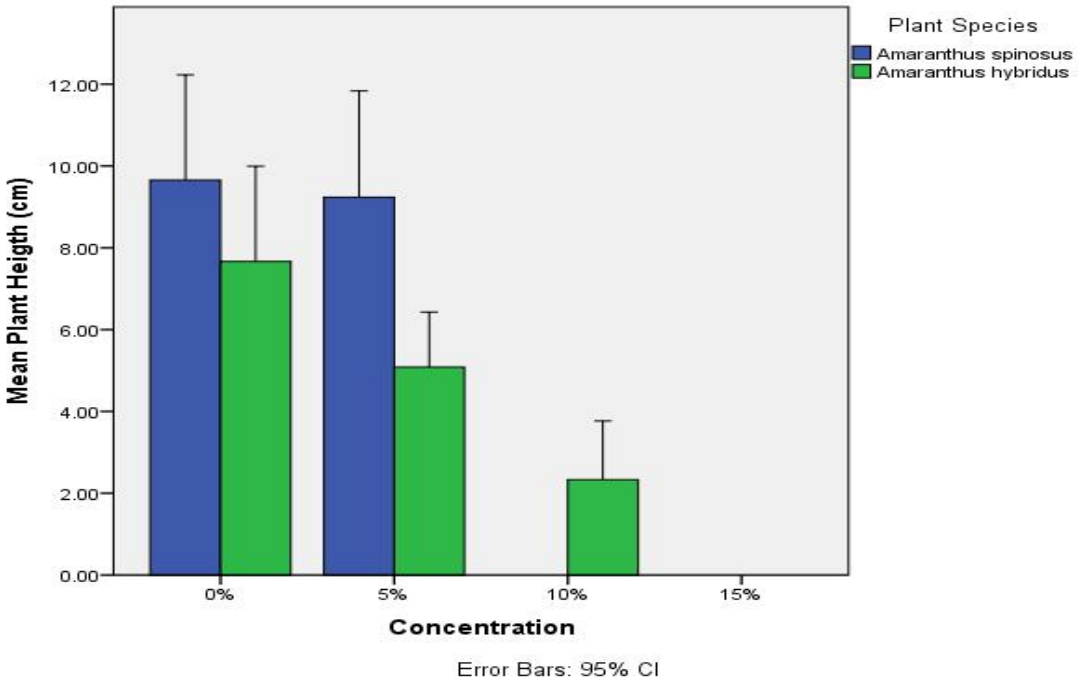

Fig. 1. The mean height of *A. spinosus* and *A. hybridus* in various concentrations of *M. lucida* extract

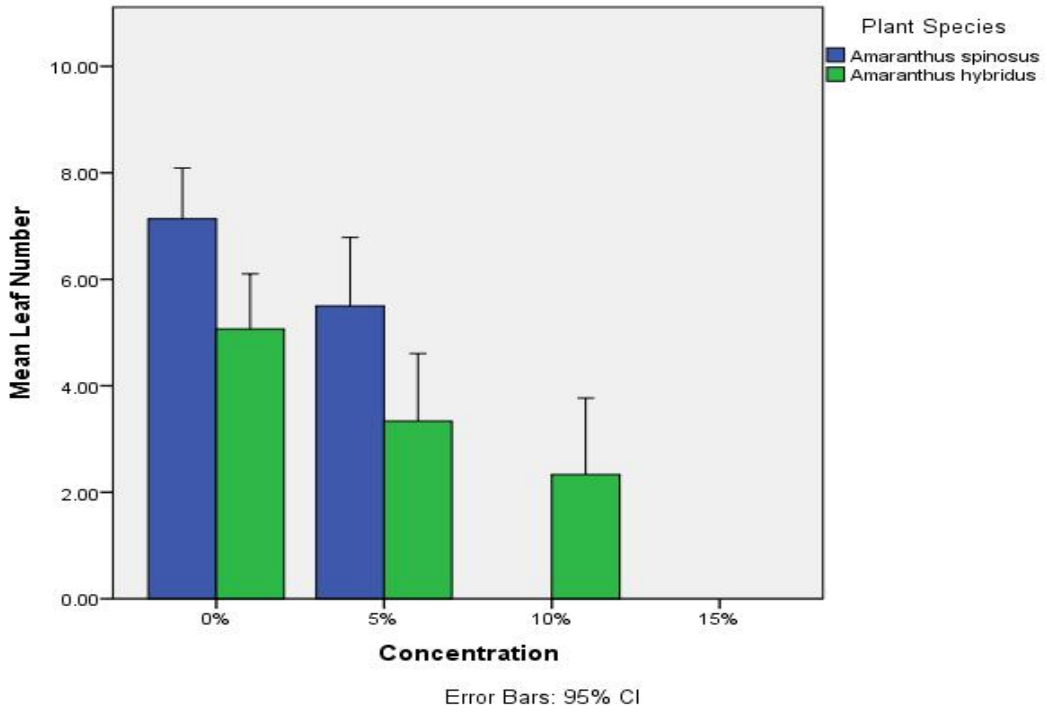

Fig. 2. The mean number of leaf produced by *A. spinosus* and *A. hybridus* in various concentrations of *M. lucida* extract

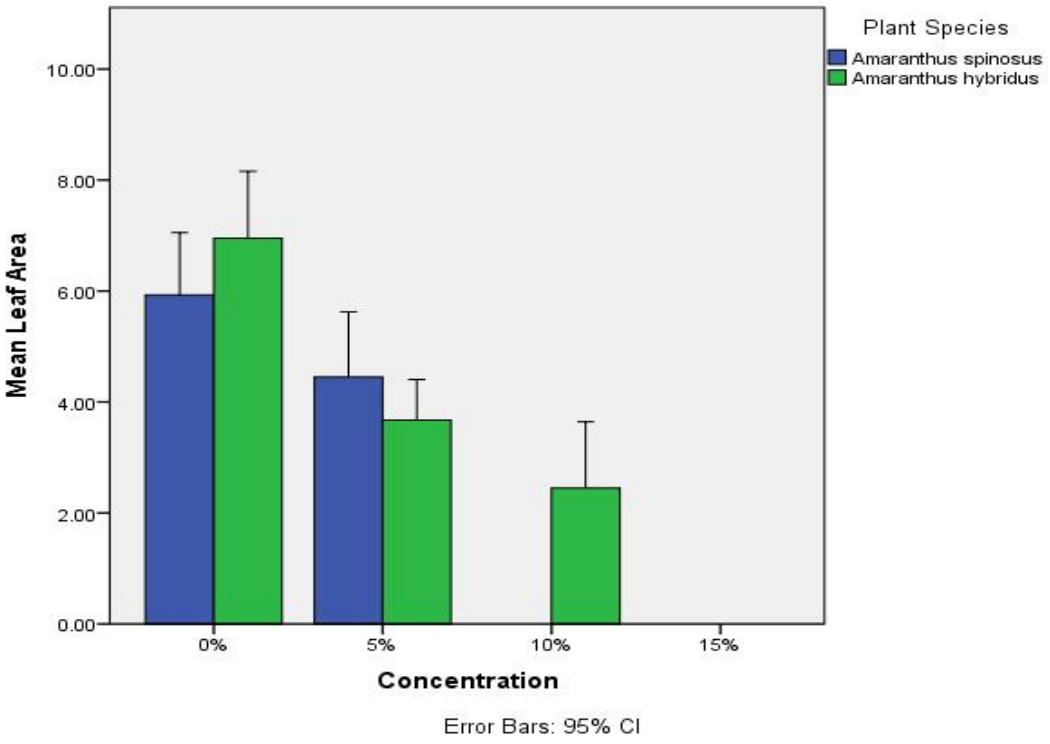

Fig. 3. The mean leaf of *A. spinosus* and *A. hybridus* in various concentrations of *M. lucida* extract

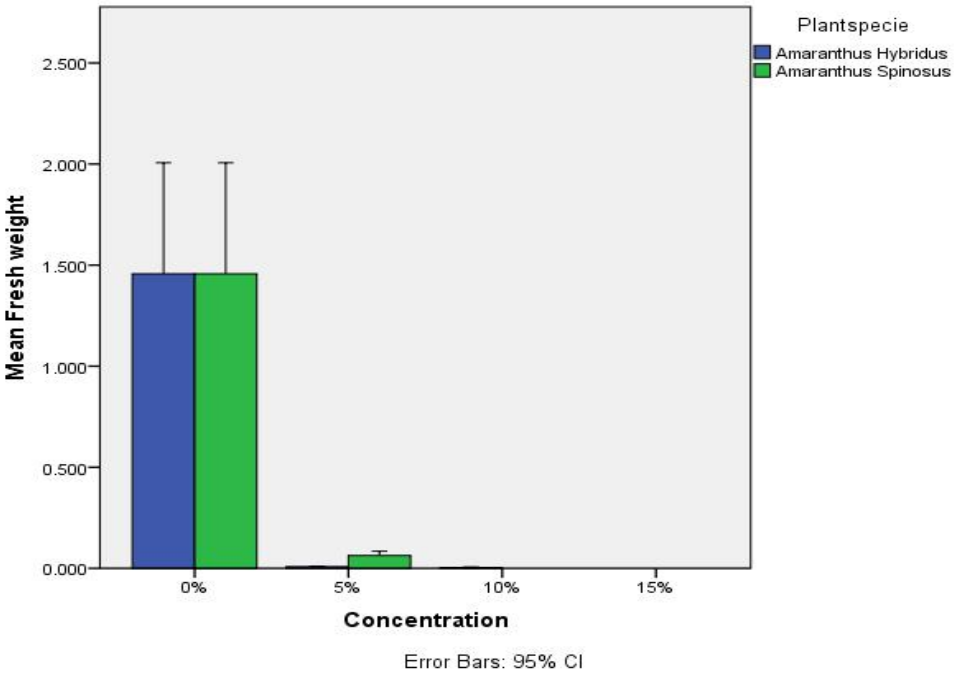

Fig. 4. The fresh weight (g) of *A. spinosus* and *A. hybridus* in extracts of *M. lucida*

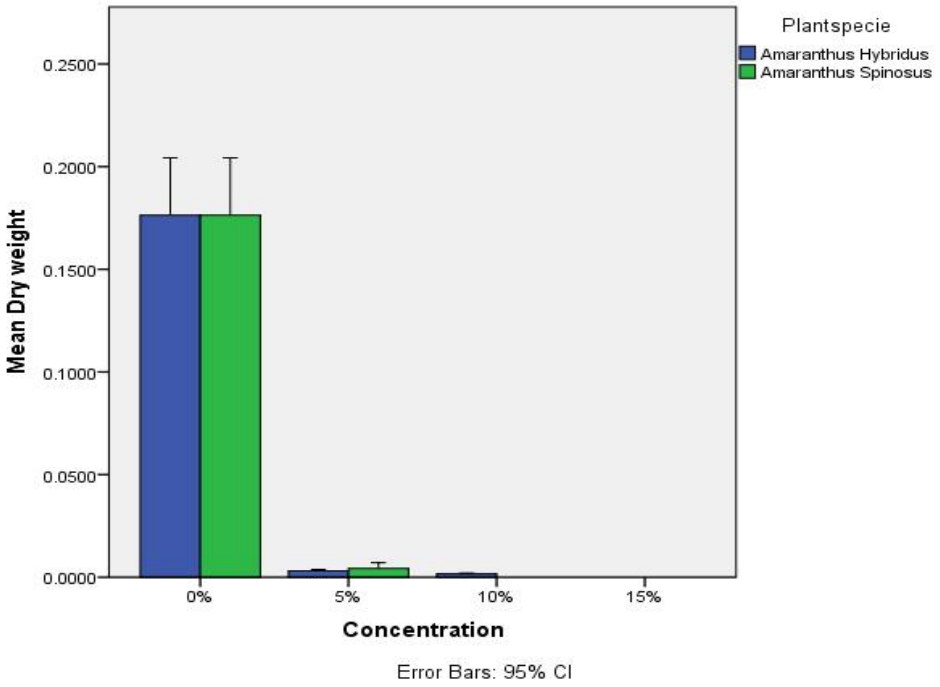

Fig. 5. The dry weight (g) of *A. spinosus* and *A. hybridus* in extracts of *M. lucida*

4. DISCUSSION

The study showed that the extract of *M. lucida* had negative effect on the growth of *A. spinosus* and *A. hybridus*. The effect was significantly higher at higher concentrations of the extract. *M. lucida* extract significantly reduced the leaf number, leaf area, stem height, fresh weight and dry weight in *A. spinosus* and *A. hybridus* when compared to the control. Additionally, the germination of *A. spinosus* and *A. hybridus* were delay considerable to the fourth and fifth weeks and in some cases no germination was observed. The results of this study were not consistent with the findings of [11] who reported a general improved crop performance in response to application of leaf extracts of *M. oleifera*. Following on [12] studies the negative effect of the plant extracts could be attributable to inhibitory substance in the plants. [13] reported that some extracts of plant such as *Eucalypt*us extract and *Morinda* extract have allelochemicals which could reduce and delay germination and crop yield.

The study further showed that the sensitivity of *A. spinosus* and *A. hybridus* to plant extracts differ. From the study *M. lucida* extract showed higher negative effect on *A. hybridus* than on *A. spinosus*. [14] report that the differences in sensitivity of *A. spinosus* and *A. hybridus* to plant extracts could be attributed to differences in the selectiveness of inhibitory growth substances. According [15] the resistant to inhibitory substance in crops differ and therefore could account for the differences in sensitivity of *A. spinosus* and *A. hybridus* to plant extracts.

Finally, this study revealed that the inhibitory activity of *M. lucida* on the growth of *A. spinosus* and *A. hybridus* was higher when compared to those of *M. oleifera*. [13] explained that most plant like *Eucalypt*us extract and *M. lucida have higher concentration of allolechemicals in their leaves.* This could account for the inhibitory activity of *M. lucida* [3].

5. CONCLUSION

This study experiment indicated that *M. lucida* leaf extract was not desirable for cultivation of *A. spinosus* and *A. hybridus* because they delayed germination, significantly reduced the leaf number, leaf area, stem height, fresh weight and dry weight. This study therefore advocates for increase research in the inhibitory substances in *M. lucida* leaf extracts.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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