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# A comparative evaluation of weight loss in grains of *Vigna aconitifolia* caused by *Callosobruchus chinensis* Linn. when treated with different plant extracts

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**Abstract**

Pulses are amongst the rich sources of protein and play a very significant role in the diet of common men but unfortunately they suffer an extensive damage during the storage especially due to insect infestation. The pulse beetle, *Callosobruchus chinensis* Linn. (Coleoptera: Bruchidae), is a notorious pest that causes serious major damage to stored pulses, resulting in economic losses for farmers and the food industry. The losses caused are both, quantitative as well as qualitative. The various hazards linked with presently employed synthetic pesticides, such as residual effects, pest resurgence, prevalent environmental and ecological hazards, insect pest resistance, and farmer economy, have led us to the use of some alternates to manage insect pests that are environmentally friendly, biodegradable, economical, and equally effective, and also causing no harm to the non-target species. One such strategy is to employ phytochemicals, which are natural plant-derived compounds with insecticidal properties. The present work was therefore undertaken to screen certain plant formulations to test their efficacy against the bruchid raised on grains of *Vigna aconitifolia* and to study their potency as grain protectant against the bruchid.

The plants selected for the study were *Azadirachta indica* (Meliaceae, *Prosopis juliflora* (Fabaceae) and *Leptadenia pyrotechnica* (Apocynaceae). The plant parts taken included bark, leaves and fruit (*A. indica*); bark, leaves and fruits (*P.juliflora*) and stem (*L. pyrotechnica*). Different formulations were employed in the form of aqueous extract, ethanol extract, petroleum ether extract and a novel Triton X-100 extract at various dose concentrations viz., 1%, 2.5%, 5% and 10%. Overall, no weight loss in grains was noted in sets treated with novel Triton X-100 extract and ethanol extract of 5 and 10% concentrations of stem of *L. pyrotechnica*

## Introduction

Cereals, pulses, vegetables, fruits are all cultivated to meet the need of food. One of the major challenges man has been facing since its origin is provisioning of food and the biggest threat are the insects which compete with him. Many species of insects have been documented to damage stored commodities, resulting a loss of about 10–20% (Esther et al., 2014), these include nearly 600 species of beetle and 70 species of moths (Rajendran & Sriranjini, 2008). Insect pests infesting stored grains include *Helicoverpa spp., A. ipsilon, S. exigua, Chromatomyia horticola, Acyrthosiphon pisum, Helicoverpa armigera, Spodoptera litura, Callosobruchus chinensis, Callosobruchus maculatus, C.* analis (Yadav & Patel, 2015a, 2015b; Kaushik, 2014; Chakravarty et al. 2016; Kumar, 2013). The losses caused are both, quantitative as well as qualitative.

Pulses are amongst the rich sources of protein and play a very significant role in the diet of common men but unfortunately they suffer an extensive damage during the storage especially due to insect infestation. India has been the major producer of pulses in the world though its share in both area and pulse production, from 1961 to 2019, has marginally declined from 37% to 35% in area, from 32% to 26% in production (Bhat *et al*., 2022).

During last few decades, synthetic organic insecticides have been used as major and successful mechanism for managing and saving the crop from the insect attack. But unfortunately they result in serious health and environmental hazards. The various hazards linked with presently employed synthetic pesticides, such as residual effects, pest resurgence, prevalent environmental and ecological hazards, insect pest resistance, and farmer economy, have led us to the use of some alternates to manage insect pests that are environmentally friendly, biodegradable, economical, and equally effective, and also causing no harm to the non-target species. One such strategy is to employ phytochemicals, which are natural plant-derived compounds with insecticidal properties. During the past few decades the focus has been in the development of novel phytochemical formulations for the management of pests, including the pulse beetle.

There are around 2,500 species from 235 plant groups that are beneficial in pest control worldwide. Several studies have found that botanical pesticidal constituents are made up of a variety of isolated secondary metabolites that have behavioral and physiological effects on agriculturally important pests and diseases (repellence, oviposition, feeding deterrence, acute toxicity, developmental disruption, and growth suppression). Botanical insecticides are suggested to biodegrade in easy manner and ecologically safe against pest to prevent from further damage or loss of stored products (Wink, 1993). The plant based chemicals which include the essential oils, flavonoids, alkaloids, glycosides, Fatty acids and esters have different characteristics affecting the various physiological aspects of the insects in different ways based on the insect species. They could act as toxicants, feeding deterrents and antifeedants, repellents, sterilants and growth retardants (Rajashekar *et al.*, 2012).

The pulse beetle, *Callosobruchus chinensis* Linn. (Coleoptera: Bruchidae), is a notorious pest that causes serious major damage to stored pulses, resulting in economic losses for farmers and the food industry. According to reports by Gbaye *et al.* (2011), *Callosobruchus* spp. damages pulses up to 100% in storage. On an average, the bruchid results in 5-10 % losses in temperate countries while in tropical countries the per cent loss has been found to be 20-30% (Kiradoo & Srivastava, 2010). The insect causes qualitative as well as quantitative loss by deteriorating the quality of seed by denaturing and decreasing the solubility of proteins. The damage is caused by both grubs and adults, the grubs eat away the endosperm and only the thin outer covering of seed coat is left behind, thus rendering the grains not only unfit for consumption but also for the used as seed. The female cements the eggs on to the surface of the healthy grains. The larvae (grubs) burrow in to the seed and they complete entire development comprising of 4 instars and the pupal stage and finally mature adults emerge out leaving a holed grain behind *C. chinensis* is a cosmopolitan pest of stored pulses causing substantial losses to legumes and pulses (Hill, 1990). The entire life cycle by the pest is spent within the host grain, eating its endospermic part from within resulting in holed grains and their weight loss.

The present work was therefore undertaken to screen certain plant formulations to test their efficacy against the bruchid pest *Callosobruchus chinensis* Linn. (Coleoptera: Bruchidae) raised on grains of *Vigna aconitifolia* and to study their potency as grain protectant.

A. The plants selected for the study were:

(i) *Azadirachta indica* (Meliaceae)

(ii) *Prosopis juliflora* (Fabaceae)

(iii) *Leptadenia pyrotechnica* (Apocynaceae)

B. The plant parts taken were:

(i) Bark, leaves and fruit (*A. indica*)

(ii) Bark, leaves and fruits (*P.juliflora*)

(iii) Stem (*L. pyrotechnica*)

C. Different formulations were employed in the form of:

(i) Aqueous extract

(ii) Ethanol extract

(iii) Petroleum ether extract

(iv) A novel Triton X-100 extract

D. Various dose concentrations applied were:

(i) 1%

(ii) 2.5%

(iii) 5%

(iv) 10%

E. The aspect studied was:

(i) Weight loss in grains (expressed in per cent)

## Material and method

The present study was carried out against stored grain pest *Callosobruchus chinensis* Linn. (Coleoptera: Bruchidae) commonly also known as pulse beetle (bruchid) and its pure line culture was raised on moth bean *Vigna aconitifolia* L. grains. The host grains for raising of the culture were purchased from the local market, were cleaned and further exposed to a temperature of 60°C for 4 hours in an incubator to remove any infestation, if present.

The bruchid shows a clear cut dimorphism. The male and female insect can be easily identified. A single pair of the adult beetle was released on the host grains placed in a glass beaker, covered and tightly tied with a muslin cloth. The beakers were placed in a BOD incubator which was set and maintained at a temperature of 28±2°C and RH of 70% for rearing a pure line culture.

The select plants were collected from in and around Bikaner city which is situated between 27°11' & 20° 03' North latitude and 71°54'& 74°12' East longitude. For the present study, different plant parts used were bark, leaves and fruits of *A. indica* and *P. juliflora* and stem of *L. pyrotechnica.* These parts were separated and washed with GDW and then dried in shade for about 25 days. Different plant parts were ground in electric grinder and placed separately, up till further use, in air tight glass containers.

Different parts as follows: namely bark, leaves and fruits of *A. indica* and *P. juliflora* and stem of *L. pyrotechnica* were used separately to prepare different extracts.

**Preparation of aqueous extract**

Initially, 10 g of dried and ground plant material (bark of *A.indica,* leaf of *A. indica*, fruit of *A. indica*, bark of *P. juliflora*, leaf of *P .juliflora*, fruit of *P. juliflora* and stem of *L. pyrotechnica*) was taken in a thimble. The thimble with weighed plant material was then placed in a soxhlet extraction unit with 100ml distilled water and distilled. This extract was collected and made to a fix volume of 10ml which was 100% concentrated worked as stock solution. Further dilutions of 1, 2.5, 5 and 10 concentrations were further prepared by dilutions using GDW.

**Preparation of ethanol extract**

Initially, 10 g of dried and ground plant material (bark of *A.indica,* leaf of *A. indica*, fruit of *A. indica*, bark of *P. juliflora*, leaf of *P .juliflora*, fruit of *P. juliflora* and stem of *L. pyrotechnica*) was taken in a thimble. The thimble with weighed plant material was then placed in a soxhlet extraction unit with ethanol (Assay 99.50%) and distilled. This extract was collected and made to a fix volume of 10ml which was 100% concentrated worked as stock solution. Further dilutions of 1, 2.5, 5 and 10 concentrations were further prepared by dilutions using ethanol to avoid evaporation loss and concomitant alteration in concentrations, the ethanol extracts were prepared fresh at the time of application.

**Preparation of petroleum ether extract**

The same procedure as for ethanol extract was followed except for in this extract preparation, ethanol was replaced by solvent petroleum ether (Assay 99.0%).

**Preparation of novel Triton X-100 extract**

Initial solvent was prepared by dissolving 1ml of Triton X-100 (Assay 99.0%) which acted as surfactant in 500ml of GDW. This was taken as a solvent and further, the same procedure was followed as carried out for other extracts using soxhlet.

**Experimental protocol followed**

For the present study, as required for comparison, normal, control and experimental sets were taken, each with ten replicas. In all these sets, 10g host grains were taken in a beaker and 10 pairs of freshly emerged adults of the pest insect *C. chinensis* were released in each set covered with muslin cloth tied with rubber bands.

Sets treated with 1 ml of aqueous extracts, ethanol extracts, petroleum ether extracts and Triton X-100 extract (1ml Triton X-100 as surfactant + 500ml GDW) of different plant parts namely bark, leaves and fruits (*A. indica* and *P. juliflora*) and stem (*L. pyrotechnica*) and concentrations (1%, 2.5%, 5% and 10%) were kept. Besides, the normal and control sets were kept for comparisons.

**The recording of observations**

Initially, 10g of host moth bean grains was taken in a beaker and into which 10 pairs of adult pest beetles were released. The difference between the initial weight and final weight of grains, after the emergence of progeny of insects was assessed and weight loss of grains was calculated in terms of biomass:

$$\text{Percent weight loss} = Iw – Fw / 5 * 100$$

Where,

Iw = initial weight (10g);

Fw = Final weight

The values in all ten replicas in Control, Normal and Experimental sets for each aspect studied were noted and averaged and expressed as per cent weight loss in grains.

## Statistical analysis

Statistical analysis was done employing analysis of variance (ANOVA) using SPSS Software version 2021 (Duncan 1955 test). For this, the data obtained was subjected to analysis of variance (ANOVA) and critical difference at 1% and 5% level of significance was worked out.

## Result

Table 1a shows the main ANOVA. The mean weight loss (%) in grains of *Vigna aconitifolia* infested by the beetle *C. chinensis* under different treatments of *A. indica*, *P. juliflora* and *L. pyrotechnica* has been presented in Table 1b.

Tables 1c to 1p and Figs. 1 to 7 show the comparison of effect different formulations on the aspect of weight loss in grains.

Of the three plants screened, the extracts of *L. pyrotechnica* were found to be most effective as far as the weight loss in grains was concerned (Table 1c).

Among plant parts, stem part was noted to significantly ($p<0.01$) affect the weight loss in grains by the pulse beetle (Table 1d).

Further, the novel Triton X-100 extract was found to be superior over other solvents as it significantly ($p<0.01$) reduced the weight loss of grains (Table 1e).

The extracts of 10% concentration were noted to result in significant ($p<0.01$) reduction in weight loss of grains of *V. aconitifolia* as compared to rest of the concentrations employed (Table 1f).

Overall, no weight loss in grains was noted in sets treated with novel Triton X-100 extract and ethanol extract of 5 and 10% concentrations of stem of *L. pyrotechnica* (Table 1b).

## Discussion

Overall, no weight loss in grains was noted in sets treated with novel Triton X-100 extract and ethanol extract of 5 and 10% concentrations of stem of *L. pyrotechnica*.

Of the three plants screened, the extracts of *L. pyrotechnica* were found to be most effective as far as the weight loss in grains was concerned. Govindan *et al.* (2023) observed no seed weight loss when *P.nigrum* formulations were employed, and similar observations were made by Islam *et al*. (2013). Significant weight loss in grains was also observed by the treatments of *A. indica, Abutilon indicum, Tephrosia pupurea, Acalypa indica, Sesbania grandiflora* and *Cocinia indica and P.nigrum* (Rathod *et al.*, 2019; Govindan et al., 2023). *A.indica* treatments were noted to reduce weight loss in seeds of black gram by Niranjana & Karunakaran (2019), while, Saranya *et al*. (2019) also recorded similar findings by the use of A.calamus on cow pea seeds. Ehimemen & Salisu (2020) found extracts of *Hyptis suaveolens*, *Alstonia boonei* and *Tephrosia vogelii* to protect the stored cow pea seeds from the infestation of *C. maculatus*. When *V. unguiculata* treated with *M. arvensis* and *O. sanctum* as compared to control, Kamakshi *et al.* (2000) found that seed weight loss was minimum. These reports by various earlier workers support the present findings.

Among plant parts, stem part was noted to significantly affect the weight loss in grains by the pulse beetle. Extracts of different plant parts effect the weight loss in grains differently has been suggested by earlier workers from time to time. These include the works of Ghose *et al*. (1981), who documented that *A. indica* seed kernel powder to result in minimum damage of 4.23% caused by *C. chinensis* to the grains of *C. arietinum* as compared to 31.72% in control; the dry leaf powder of *M. spicata* was effective against *C. analis* on green gram was found by George & Patel (1992); Ofuya (1986), observed dry chilly pepper fruits, onion scale leaves and wood ash to result in least per cent seed damage caused by *C. maculatus*; minimum infestation of cowpea seeds by *C. maculatus*, when treated with dried neem fruit and ginger root powder was documented by Echendu *et al.* (1988); Chiranjeevi (1991), observed cow dung ash to be most effective followed by sweetflag rhizome powder, neem seed powder and neem leaf powder in reducing weight loss of green gram infested with bruchid; Miah *et al.* (1993), documented minimum seed damage when treated with *V. negundo* leaf powder. The seeds can be effectively protected from the infestation by *C. chinensis* has been found by Pandey & Singh (1995), when treated with dried powder of neem leaves, while Juneja & Patel (1994) observed no damage to grains by *C. analis,* when treated green gram grains with seed powder of black pepper, custard apple, leaves of mint and peel of orange. All these reports therefore are in conformation with the present study. Earlier Mishra *et al*. (1992) found neem seed powder and custard apple seed powder to be most effective against wheat infected with *S. oryzae* result in reduced weight loss, while, similar effect by the treatments of *L. camara* were noted by Prasad *et al.* (1998). Okonkwo & Okoye (1992) suggested that the treatments of leaves of *R. communis* could be

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Vol. 33 Issue 2, December – 2023, Pages: 515-545

effective against *C. chinensis* for more than three months, while, mung seed could be effectively protected for at least hundred days with treatments of powder of *Annona* was observed by Pandey & Verma (1977). Neem bark powder was documented to be effective against adult *C. chinensis* resulting in minimum infestation of chickpea in storage has been suggested by Pandey & Singh (1997).

The novel Triton X-100 extract was found to be superior over other solvents as it significantly reduced the weight loss of grains. Aqueous and ether extracts were found to be more effective in reducing the weight loss (Mann, 1997). Ghei (2001) also noted reduced weight loss of grains infested with bruchid, when treated with aqueous extracts, while, Gupta (2004) observed ether extract and powder suspension to be superior rest of the formulations in preventing seed damage caused by *C. chinensis.* Reddy & Reddy (1987) found benzene extract to provide best protection against the pulse beetle. All these studies corroborate the present results.

The extracts of 10% concentration were noted to result in significant reduction in weight loss of grains of *V. aconitifolia* as compared to rest of the concentrations employed. Niber (1994) found that 10% concentration of leaves and roots of *Datura alba* result in reduced weight loss of grains of wheat and maize against *S. oryzae.* Dry leaf powder of *M. spicata* at 10% was effective against *C. analis* on green gram was found by George & Patel (1992). Treatments of *M. arvensis* and *O. sanctum* with 5 and 10% concentrations resulted in minimum seed weight loss as compared to control was documented by Kamakshi *et al*. (2000). Shivanna *et al.* (1994) found that leaf powder of tulsi, *M. viridis* at vaious doses of 0.5, 1.5 and 2.5 g/ 50 g gave maximum protection against *C. chinensis*. Jood *et al*. (1996) suggested that the efficacy of pudina powders and neem oil in sorghum grains to be effective against larvae of *T. granarium.* Paniker & Vijaylakshmi (1998) observed 10% turmeric powder to be effective resulting in maximum reduction in weight loss caused by *S. oryzae*. Dose concentration to be directly proportional with the weight loss has earlier been suggested by various workers (Srivastava & Mann, 1998a; Ghei, 2001; Gupta, 2004; Kiradoo, 2009). Minimum weight loss of grains by the insect pest was noted by Kareem *et al*. (1988) when treated with 3% neem seed kernal extract. When increase the amount of *E. balsamifera* from 0.5–2.0g resulted in reducing sorghum grain damage from 23 to 6% found by Suleiman *et al*. (2012) while, Suleiman & Suleiman (2014) observed increase in the amount of *E. balsamifera* plant powder to result in reduction in cowpea seed damage. Oil and powder of leaves of *M. spicata* in stored maize at concentrations 1 and 2% (w/w) as grain protectant against *T. granarium* was suggested by Jood *et al*. (1993) and groundnut and coconut oils at 0.5% and sesame, cotton, palm and neem oil at 0.25% to be effective against *C. chinensis* in reducing percentage of damaged grains was reported by Sujatha & Punnaiah (1985) and thusare in conformation with the present findings.

Weight loss indicates the quantitative loss to the stored grain due to insect feeding, showing a direct relationship between insect population and biomass of grains. This seems to be true during the present study also, wherein various plant formulations employed resulted in reduced weight loss of grains.

It could therefore be concluded that, plants selected for the study viz., *Azadirachta indica* (Meliaceae), *Prosopis juliflora* (Fabaceae), *Leptadenia pyrotechnica* (Apocynaceae) do possess chemicals, which are toxic to insects and therefore have a potential to be used especially against the pest *C. chinensis.* Although, the three select plants, their parts, the type of extract and their concentrations showed varied degree of effect on weight loss in grains, the 10% novel Triton X-100 extract of stem of *L. pyrotechnica* was found to be most effective. The difference in efficacy may be attributed to either in the structural difference of the chemical compounds as suggested by Onyilagha *et al*. (2004), or their concentrations and solubility in different solvents. The further lies in identifying the actual toxic component, going for field trails and using it for pest management programs.

Overall, it could be suggested that adding of surfactant could prove to be a preferred formulation as observed during the present study during which the novel 10% Triton X-100 extracts of stem of *Leptadenia pyrotechnica* were observed to be most effective against the bruchid, *C. chinensis.*

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**Table. 1a. ANOVA for weight loss in grains showing different interactions and level of significance**

| Dependent Variable | | | | | |
|---|---|---|---|---|---|
| **Source** | **Type III Sum of Squares** | **df** | **Mean Square** | **F** | **Sig.** |
| Corrected Model | 465104.728[a] | 167 | 2785.058 | 2940.543 | 0.000 |
| Intercept | 4242534.804 | 1 | 4242534.804 | 4479387.604 | 0.000 |
| Plant | 1387.141 | 2 | 693.571 | 732.291 | 0.000 |
| Extracts | 2847.981 | 3 | 949.327 | 1002.326 | 0.000 |
| Concentrations | 410283.964 | 5 | 82056.793 | 86637.870 | 0.000 |
| Plant parts | 11.986 | 2 | 5.993 | 6.327 | 0.002 |
| Plants * Extracts | 400.126 | 6 | 66.688 | 70.411 | 0.000 |
| Plants * Concentrations | 648.945 | 10 | 64.894 | 68.517 | 0.000 |
| Plants * Plant parts | 375.880 | 2 | 187.940 | 198.432 | 0.000 |
| Extracts * Concentrations | 1696.612 | 15 | 113.107 | 119.422 | 0.000 |
| Extracts * Plant parts | 117.809 | 6 | 19.635 | 20.731 | 0.000 |
| Concentrations * Plant parts | 101.855 | 10 | 10.186 | 10.754 | 0.000 |
| Plants * Extracts * Concentrations | 301.920 | 30 | 10.064 | 10.626 | 0.000 |
| Plants * Extracts * Plant parts | 369.266 | 6 | 61.544 | 64.980 | 0.000 |
| Plants * Concentrations * Plant parts | 94.263 | 10 | 9.426 | 9.953 | 0.000 |
| Extracts * Concentrations * Plant parts | 184.640 | 30 | 6.155 | 6.498 | 0.000 |
| Plants * Extracts * Concentrations * Plant parts | 315.219 | 30 | 10.507 | 11.094 | 0.000 |
| Error | 636.467 | 672 | 0.947 | | |
| Total | 5180972.250 | 840 | | | |
| Corrected Total | 465741.195 | 839 | | | |
| a. R Squared = .999 (Adjusted R Squared = .998) | | | | | |

**Table. 1b. Mean weight loss in grains infested with *C. chinensis* under treatments of different extracts of various plant parts of select three plants**

| | | | *Leptadenia pyrotechnica* | *Prosopis juliflora* | *Azadirachta indica* | Overall Mean |
|---|---|---|---|---|---|---|
| **Extracts** | **Concentrations** | **Plant parts** | **MEAN±SE** | **MEAN±SE** | **MEAN±SE** | **MEAN±SE** |
| Aqueous extract | Normal | | 93.34±0.441 | 91.98±0.494 | 90.78±0.252 | 92.03±0.389 |
| | Control | | 89.46±0.458 | 89.47±0.717 | 88.46±0.091 | 89.13±0.408 |
| | 1% | Stem (Bark) | 20.12±0.361 | 22.94±0.337 | 23.12±0.354 | 22.06±0.22 |
| | | Leaf | - | 24.66±0.262 | 24.64±0.463 | 24.65±0.709 |
| | | Fruit | - | 25.34±0.189 | 24.59±0.297 | 24.96±0.349 |
| | | Total | 20.12±0.361 | 24.31±0.531 | 24.11±0.273 | 22.84±0.263 |
| | 2.5% | Stem (Bark) (Bark) | 18.14±0.43 | 21.14±0.27 | 21.20±0.354 | 20.16±0.209 |
| | | Leaf | - | 24.4±0.534 | 25.74±0.445 | 25.07±0.794 |
| | | Fruit | - | 25.92±0.124 | 23.64±0.463 | 24.78±0.311 |
| | | Total | 18.14±0.43 | 23.33±0.429 | 23.32±0.333 | 21.59±0.255 |
| | 5% | Stem (Bark) (Bark) | 17.22±0.717 | 20.38±0.24 | 20.23±0.545 | 19.27±0.302 |
| | | Leaf | - | 23.23±0.679 | 22.8±0.13 | 23.01±0.569 |
| | | Fruit | - | 23.1±0.239 | 23.28±0.416 | 23.19±0.228 |
| | | Total | 17.22±0.717 | 22.23±0.283 | 21.66±0.272 | 20.37±0.217 |
| | 10% | Stem (Bark) (Bark) | 12.42±0.567 | 19.04±0.214 | 18.28±0.275 | 16.58±0.313 |
| | | Leaf | - | 20.22±0.482 | 19.42±0.34 | 19.82±0.308 |
| | | Fruit | - | 21.08±0.124 | 20.44±0.216 | 20.76±0.159 |
| | | Total | 12.42±0.567 | 20.04±0.214 | 19.38±0.19 | 17.28±0.194 |
| Ethanol extract | Normal | | 93.34±0.441 | 91.98±0.494 | 90.78±0.252 | 92.03±0.389 |
| | Control | | 89.46±0.458 | 87.46±0.256 | 87.46±0.456 | 88.12±0.39 |
| | 1% | Stem (Bark) | 14.48±0.139 | 25.8±0.158 | 28.88±0.93 | 23.05±1.354 |
| | | Leaf | - | 26.95±0.443 | 24.38±0.373 | 25.66±0.289 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | Fruit | - | 28.58±0.626 | 28.06±1.031 | 28.32±0.812 |
| | | Total | 14.48±0.139 | 27.11±0.292 | 27.10±0.597 | 22.89±0.736 |
| | 2.5% | Stem (Bark) | 12.96±0.178 | 27.58±0.229 | 24.14±0.489 | 21.56±1.259 |
| | | Leaf | - | 30.16±0.391 | 28.32±0.124 | 29.54±0.362 |
| | | Fruit | - | 39.3±0.466 | 27.7±0.93 | 33.5±0.882 |
| | | Total | 12.96±0.178 | 32.34±0.35 | 26.72±0.779 | 24.00±0.666 |
| | 5% | Stem (Bark) | 0±0 | 25.52±0.107 | 21±0.354 | 15.50±0.153 |
| | | Leaf | - | 29.58±0.521 | 23.66±0.196 | 26.62±0.553 |
| | | Fruit | - | 25.54±0.674 | 27.08±0.208 | 26.31±0.827 |
| | | Total | 0±0 | 26.88±0.574 | 23.91±0.94 | 16.93±0.504 |
| | 10% | Stem (Bark) | 0±0 | 12.62±0.67 | 15.36±0.121 | 9.32±0.263 |
| | | Leaf | - | 16.28±0.442 | 12.94±0.211 | 14.61±0.603 |
| | | Fruit | - | 18.88±0.575 | 18.94±0.314 | 18.91±0.596 |
| | | Total | 0±0 | 15.92±0.437 | 15.74±0.793 | 21.16±0.41 |
| Petroleum ether extract | Normal | | 93.34±0.441 | 91.98±0.494 | 90.78±0.252 | 92.03±0.389 |
| | Control | | 87.46±0.458 | 87.46±0.458 | 87.46±0.458 | 87.46±0.458 |
| | 1% | Stem (Bark) | 18.86±0.309 | 30.42±0.139 | 27.1±0.714 | 25.46±0.41 |
| | | Leaf | - | 32.46±0.186 | 36.14±0.334 | 34.3±0.284 |
| | | Fruit | - | 34.16±0.331 | 39.04±0.432 | 36.6±1.502 |
| | | Total | 18.86±0.309 | 32.34±0.926 | 34.09±0.425 | 28.43±0.519 |
| | 2.5% | Stem (Bark) | 16.94±0.77 | 28.7±0.288 | 26.28±0.317 | 23.97±0.571 |
| | | Leaf | - | 30.28±0.185 | 32.12±0.412 | 31.2±0.288 |
| | | Fruit | - | 32.48±0.343 | 34.22±0.503 | 33.35±1.485 |
| | | Total | 16.94±0.77 | 30.48±0.773 | 30.87±0.5 | 26.09±0.547 |
| | 5% | Stem (Bark) | 13.22±0.351 | 25.26±0.225 | 24.72±0.416 | 21.0±0.821 |
| | | Leaf | - | 32.42±0.576 | 30.24±0.411 | 31.33±0.493 |
| | | Fruit | - | 30.02±0.519 | 33.64±0.38 | 31.83±0.828 |
| | | Total | 13.22±0.351 | 29.23±0.451 | 29.53±0.43 | 23.66±0.459 |
| | 10% | Stem (Bark) | 10.06±0.175 | 23.52±0.404 | 22.2±0.464 | 18.59±0.767 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | Leaf | - | 22.4±0.513 | 31.98±0.177 | 38.39±0.478 |
| | | Fruit | - | 25.5±0.263 | 32.22±0.354 | 28.86±0.619 |
| | | Total | 10.06±0.175 | 23.80±0.322 | 28.8±0.478 | 20.88±0.415 |
| Triton X-100 extract | Normal | | 93.34±0.441 | 91.98±0.494 | 90.78±0.252 | 92.03±0.389 |
| | Control | | 88.46±0.458 | 88.46±0.421 | 88.46±0.420 | 88.46±0.433 |
| | 1% | Stem (Bark) | 18.22±0.206 | 20.8±0.338 | 21.04±0.552 | 20.02±1.278 |
| | | Leaf | - | 22.72±0.62 | 22.08±0.762 | 22.4±0.608 |
| | | Fruit | - | 21.98±0.166 | 28.3±0.539 | 25.14±0.926 |
| | | Total | 18.22±0.206 | 21.59±0.322 | 23.80±0.466 | 21.20±0.676 |
| | 2.5% | Stem (Bark) | 15.38±0.22 | 19.12±0.08 | 20.76±0.225 | 18.42±1.168 |
| | | Leaf | - | 24.7±0.539 | 22.94±0.258 | 25.64±0.609 |
| | | Fruit | - | 20.74±0.144 | 26.54±0.37 | 23.64±1.313 |
| | | Total | 15.38±0.22 | 21.52±0.507 | 23.41±0.181 | 20.10±0.655 |
| | 5% | Stem (Bark) | 0±0 | 16.26±0.172 | 19.78±0.25 | 12.01±0.140 |
| | | Leaf | - | 22.94±0.25 | 20.12±0.116 | 10.76±0.133 |
| | | Fruit | - | 19.86±0.35 | 24.44±0.157 | 22.15±0.947 |
| | | Total | 0±0 | 19.68±0.774 | 21.44±0.121 | 13.70±0.328 |
| | 10% | Stem (Bark) | 0±0 | 14.44±0.641 | 16.82±0.107 | 10.42±0.249 |
| | | Leaf | - | 12.12±0.302 | 15.28±1.385 | 13.7±0.669 |
| | | Fruit | - | 11.56±0.556 | 17.94±0.314 | 14.75±0.498 |
| | | Total | 0±0 | 12.70±0.59 | 16.68±0.471 | 9.79±0.353 |

**Table. 1c. Comparison of weight loss in grains infested with *C. chinensis* with respect to treatments of different plants**

| Dependent Variable | | |
|---|---|---|
| **Plants** | **Mean** | **Std. Error** |
| *Leptadenia pyrotechnica* | 45.79a | 2.33 |
| *Prosopis juliflora* | 56.72c | 1.187 |
| *Azardirachta indica* | 54.18b | 1.258 |

**Table. 1d. Comparison of weight loss in grains infested with *C. chinensis* with respect to treatments of different plant parts**

| Dependent Variable | | |
|---|---|---|
| **Plant parts** | **Mean** | **Std. Error** |
| Stem (Bark) | 40.44a | 1.278 |
| Leaf | 45.57b | 1.47 |
| Fruit | 50.52c | 1.505 |

**Table. 1e. Comparison of weight loss in grains infested with *C. chinensis* with respect to treatments of different extracts**

| Dependent Variable | | |
|---|---|---|
| **Extracts** | **Mean** | **Std. Error** |
| | | |
| Aqueous extract | 66.34d | 1.486 |
| Ethanol extract | 46.45b | 1.67 |
| Petroleum ether extract | 58.65c | 1.594 |
| Triton X 100 extract | 40.24a | 1.735 |

**Table. 1f. Comparison of weight loss in grains infested with *C. chinensis* with respect to treatments of different concentrations**

| Dependent Variable | | |
|---|---|---|
| **Concentrations** | **Mean** | **Std. Error** |
| Normal | 84.95f | 0.118 |
| Control | 70.31e | 0.084 |
| 1% | 55.84d | 0.394 |
| 2.5% | 46.09c | 0.382 |
| 5% | 40.61b | 0.342 |
| 10% | 32.74a | 0.262 |

MSW MANAGEMENT -Multidisciplinary, Scientific Work and Management Journal
ISSN: 1053-7899
Vol. 33 Issue 2, December – 2023, Pages: 515-545

**Table. 1g. Comparison of weight loss in grains infested with *C. chinensis* with respect to treatments of Plants X Extracts**

| | | | | |
|---|---|---|---|---|
| **Plants** | ***Leptadenia pyrotechnica*** | ***Prosopis juliflora*** | ***Azadirachta indica*** | **Overall Mean** |
| **Extracts** | **MEAN±SE** | **MEAN±SE** | **MEAN±SE** | **MEAN±SE** |
| Aqueous extract | 52.91±4.049 | 62.15±2.246 | 68.33±2.297 | 61.13±1.69 |
| Ethanol extract | 40.37±4.989 | 58.49±2.423 | 49.82±2.569 | 49.56±1.67 |
| Petroleum ether extract | 58..31±4.621 | 60.01±2.353 | 65.39±2.451 | 61.23±1.594 |
| Triton X-100 extract | 42.57±5.014 | 55.19±2.493 | 45.19±2.728 | 47.65±1.735 |
| Total | 48.54±5.021 | 58.96±2.56 | 57.18±273 | 54.89±0.813 |

**Table. 1h. Comparison of weight loss in grains infested with *C. chinensis* with respect to treatments of Plants X Concentrations**

| | | | | |
|---|---|---|---|---|
| **Plants** | ***Leptadenia pyrotechnica*** | ***Prosopis juliflora*** | ***Azadirachta indica*** | **Overall Mean** |
| **Concentrations** | **MEAN±SE** | **MEAN±SE** | **MEAN±SE** | **MEAN±SE** |
| Normal | 85.34±0.202 | 85.34±0.202 | 85.34±0.202 | 85.34±0.202 |
| Control | 80.46±0.21 | 80.46±0.21 | 80.46±0.21 | 80.46±0.21 |
| 1% | 58.86±1.464 | 60.73±0.384 | 58.26±0.505 | 59.28±0.394 |
| 2.5% | 55.36±1.253 | 57.73±0.366 | 57.03±0.538 | 56.70±0.382 |
| 5% | 45.61±1.029 | 50.66±0.362 | 48.23±0.485 | 48.16±0.342 |
| 10% | 40.12±0.643 | 48.56±0.258 | 42.28±0.423 | 43.65±0.262 |
| Total | 60.95±2.33 | 63.41±1.187 | 61.93±1.258 | 62.13±0.813 |

MSW MANAGEMENT -Multidisciplinary, Scientific Work and Management Journal
ISSN: 1053-7899
Vol. 33 Issue 2, December – 2023, Pages: 515-545

**Table. 1i. Comparison of weight loss in grains infested with *C. chinensis* with respect to treatments of Plants X Plant parts**

| | | | | |
|---|---|---|---|---|
| **Plants** | ***Leptadenia pyrotechnica*** | ***Prosopis juliflora*** | ***Azadirachta indica*** | **Overall Mean** |
| **Plant parts** | **MEAN±SE** | **MEAN±SE** | **MEAN±SE** | **MEAN±SE** |
| Stem (Bark) | 42.79±2.33 | 50.93±2.085 | 48.6±2.215 | 47.44±1.278 |
| Leaf | - | 66.84±2.056 | 64.29±2.121 | 65.56±1.474 |
| Fruit | - | 68.34±2.041 | 62.66±2.216 | 65.5±1.505 |
| Total | 42.79±2.33 | 62.03±1.187 | 58.51±1.258 | 54.44±0.813 |

**Table. 1j. Comparison of weight loss in grains infested with *C. chinensis* with respect to treatments of Extracts X Concentrations**

| | | | | | |
|---|---|---|---|---|---|
| | **Aqueous extract** | **Ethanol extract** | **Petroleum ether extract** | **Triton X-100 extract** | **Overall Mean** |
| **Concentrations** | **MEAN±SE** | **MEAN±SE** | **MEAN±SE** | **MEAN±SE** | **MEAN±SE** |
| Normal | 89.16±0.317 | 89.16±0.317 | 89.16±0.317 | 89.16±0.317 | 89.44±0.317 |
| Control | 77.31±0.171 | 75.31±0.171 | 74.31±0.171 | 70.31±0.171 | 74.31±0.084 |
| 1% | 58.42±0.263 | 48.02±0.736 | 55.74±0.519 | 38.16±0.676 | 50.08±0.394 |
| 2.5% | 55.89±0.255 | 45.74±0.666 | 52.57±0.547 | 36.17±0.655 | 47.59±0.382 |
| 5% | 52.53±0.217 | 42.91±0.684 | 48.07±0.459 | 35.91±0.56 | 44.85±0.342 |
| 10% | 48.7±0.194 | 40.86±0.5 | 42.38±0.415 | 30.02±0.447 | 40.49±0.262 |
| Total | 63.66±0.318 | 56.54±1.67 | 60.37±1.594 | 49.95±1.735 | 57.63±0.813 |

ISSN: 1053-7899
Vol. 33 Issue 2, December – 2023, Pages: 515-545

**Table. 1k. Comparison of weight loss in grains infested with of *C. chinensis* with respect to treatments of Extracts X Plant parts**

| | | | | | |
|---|---|---|---|---|---|
| **Extracts** | **Aqueous extract** | **Ethanol extract** | **Petroleum ether extract** | **Triton X-100 extract** | **Overall Mean** |
| **Plant parts** | **MEAN±SE** | **MEAN±SE** | **MEAN±SE** | **MEAN±SE** | **MEAN±SE** |
| Stem (Bark) | 48.28±2.311 | 45.82±2.665 | 50.04±2.517 | 40.62±2.717 | 47.94±1.278 |
| Leaf | 52.45±2.735 | 48.32±2.936 | 55.05±2.911 | 45.45±3.225 | 50.11±1.474 |
| Fruit | 58.3±2.797 | 50.57±3.13 | 58.67±2.939 | 48.47±3.193 | 54.00±1.505 |
| Total | 53.01±1.486 | 48.23±1.67 | 54.58±1.594 | 44.84±1.735 | 50.16±0.813 |

**Table. 1l. Comparison of weight loss in grains infested with *C. chinensis* with respect to treatments of Concentrations X Plant parts**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Plant parts** | **Normal** | **Control** | **1%** | **2.5%** | **5%** | **10%** | **Total** |
| Stem (Bark) | 95.7±0.129 | 90.79±0.117 | 50.29±0.705 | 48.2±0.64 | 45.28±0.592 | 38.4±0.447 | 61.24±1.278 |
| Leaf | 95.7±0.129 | 90.79±0.117 | 56.75±0.527 | 54.21±0.581 | 49.97±0.552 | 48.96±0.408 | 66.04±1.474 |
| Fruit | 95.7±0.129 | 90.79±0.117 | 60.75±0.623 | 58.32±0.69 | 52.25±0.569 | 49.54±0.452 | 62.85±1.505 |
| Total | 95.52±0.129 | 90.79±0.107 | 55.93±0.394 | 53.57±0.382 | 49.16±0.342 | 45.63±0.262 | 65.1±0.813 |

MSW MANAGEMENT -Multidisciplinary, Scientific Work and Management Journal
ISSN: 1053-7899
Vol. 33 Issue 2, December – 2023, Pages: 515-545

**Table. 1m. Comparison of weight loss in grains infested with *C. chinensis* with respect to treatments of Plants X Extracts X Concentrations**

| | | | | | | |
|---|---|---|---|---|---|---|
| | | **Aqueous extract** | **Ethanol extract** | **Petroleum ether extract** | **Triton X-100 extract** | **Overall Mean** |
| **Plants** | **Concentrations** | **MEAN±SE** | **MEAN±SE** | **MEAN±SE** | **MEAN±SE** | **MEAN±SE** |
| *Leptadenia pyrotechnica* | Normal | 90.02±0.441 | 90.02±0.441 | 90.02±0.441 | 90.02±0.441 | 90.02±0.431 |
| | Control | 89.46±0.458 | 86.46±0.458 | 86.46±0.458 | 82.46±0.458 | 85.75±0.21 |
| | 1% | 66.88±0.361 | 55.48±0.139 | 58.86±0.309 | 45.22±0.206 | 56.61±1.464 |
| | 2.5% | 62.14±0.43 | 52.96±0.178 | 58.94±0.77 | 40.38±0.22 | 53.60±1.253 |
| | 5% | 58.22±0.717 | 0±0 | 50.22±0.351 | 0±0 | 27.11±0.267 |
| | 10% | 50.42±0.567 | 0±0 | 48.06±0.175 | 0±0 | 24.62±0.185 |
| | Total | 69.52±4.049 | 57.48±4.989 | 65.92±4.621 | 53.01±5.014 | 60.16±2.33 |
| *Prosopis juliflora* | Normal | 90.02±0.441 | 90.02±0.441 | 90.02±0.441 | 90.02±0.441 | 90.02±0.441 |
| | Control | 89.46±0.458 | 86.46±0.458 | 86.46±0.458 | 82.46±0.458 | 86.21±0.21 |
| | 1% | 68.98±0.531 | 56.44±0.292 | 59.01±0.926 | 55.5±0.322 | 59.98±0.384 |
| | 2.5% | 65.24±0.429 | 51.01±0.35 | 56.49±0.773 | 52.19±0.507 | 56.23±0.366 |
| | 5% | 57.83±0.283 | 46.21±0.574 | 56.57±0.451 | 50.02±0.774 | 52.65±0.362 |
| | 10% | 55.78±0.214 | 47.26±0.437 | 50.14±0.322 | 45.04±0.59 | 49.55±0.258 |
| | Total | 71.21±2.246 | 62.9±2.423 | 66.44±2.353 | 62.53±2.493 | 65.77±1.187 |
| *Azadirachta indica* | Normal | 90.02±0.441 | 90.02±0.441 | 90.02±0.441 | 90.02±0.441 | 90.02±0.431 |
| | Control | 89.46±0.458 | 86.46±0.458 | 86.46±0.458 | 82.46±0.458 | 86.21±0.21 |
| | 1% | 63.71±0.273 | 54.44±0.597 | 60.42±2.46 | 55.47±0.466 | 58.51±0.505 |
| | 2.5% | 62.46±0.333 | 52.05±0.779 | 58.11±0.5 | 50.41±0.181 | 55.75±0.538 |
| | 5% | 55.01±0.272 | 50.58±0.94 | 55.87±0.43 | 46.45±0.121 | 51.97±0.485 |
| | 10% | 52.05±0.19 | 50.08±0.793 | 52.06±0.478 | 46.01±0.471 | 50.05±0.423 |
| | Total | 68.70±2.297 | 63.85±2.569 | 67.07±2.451 | 61.65±2.728 | 65.38±1.258 |

**Table. 1n. Comparison of weight loss in grains infested with *C. chinensis* with respect to treatments of Plants X Extracts X Plant parts**

| | | | | | |
|---|---|---|---|---|---|
| **Extracts** | **Plant parts** | ***Leptadenia pyrotechnica*** | ***Prosopis juliflora*** | ***Azadirachta indica*** | **Overall Mean** |
| Aqueous extract | 1.Stem (Bark) | 55.91±4.049 | 71.77±4.084 | 55.17±4.007 | 60.95±2.311 |
| | 2.Leaf | - | 72±3.698 | 68.9±4.093 | 70.45±2.735 |
| | 3.Fruit | - | 72.66±4.01 | 62.94±3.969 | 67.8±2.797 |
| | Total | 55.91±4.049 | 72.14±2.246 | 62.33±2.297 | 63.46±1.486 |
| Ethanol extract | 1.Stem (Bark) | 30.37±4.989 | 48.9±4.214 | 50.19±4.666 | 43.15±2.665 |
| | 2.Leaf | - | 49.28±4.224 | 53.35±4.144 | 51.31±2.936 |
| | 3.Fruit | - | 50.36±4.262 | 56.93±4.638 | 53.64±3.13 |
| | Total | 30.37±4.989 | 49.51±2.423 | 53.49±2.569 | 44.45±1.67 |
| Petroleum ether extract | 1.Stem (Bark) | 45.31±4.621 | 53.46±4.283 | 50.35±4.285 | 49.70±2.517 |
| | 2.Leaf | - | 54.88±4.168 | 55.21±4.131 | 55.04±2.911 |
| | 3.Fruit | - | 58.65±3.862 | 56.61±4.449 | 57.63±2.939 |
| | Total | 45.31±4.621 | 55.66±2.353 | 54.05±2.451 | 51.67±1.594 |
| Triton X-100 extract | 1.Stem (Bark) | 30.57±5.014 | 53.58±4.298 | 35.7±4.84 | 39.95±2.717 |
| | 2.Leaf | - | 57.2±4.474 | 45.7±4.721 | 51.45±3.225 |
| | 3.Fruit | - | 58.78±4.3 | 49.17±4.774 | 53.93±3.193 |
| | Total | 30.57±5.014 | 56.52±2.493 | 43.52±2.728 | 43.53±1.735 |

**Table. 1o. Comparison of weight loss in grains infested with *C. chinensis* with respect to treatments of Plants X Concentrations X Plant parts**

| | | | | | |
|---|---|---|---|---|---|
| | **Plants** | ***Leptadenia pyrotechnica*** | ***Proopis juliflora*** | ***Azadirachta indica*** | **Overall Mean** |
| **Concentrations** | **Plant parts** | **MEAN±SE** | **MEAN±SE** | **MEAN±SE** | **MEAN±SE** |
| Normal | - | 90.02±0.441 | 90.02±0.441 | 90.02±0.441 | 90.02±0.431 |
| Control | - | 87.31±0.171 | 87.31±0.171 | 87.31±0.171 | 87.31±0.161 |
| 1% | 1.Stem (Bark) | 42.86±1.464 | 58.24±0.461 | 48.76±1.05 | 63.28±0.705 |
| | 2.Leaf | - | 56.2±0.794 | 57.31±0.691 | 56.75±0.527 |
| | 3.Fruit | - | 55.77±0.677 | 50.73±0.85 | 53.25±0.623 |
| | Total | 42.86±1.464 | 56.73±0.384 | 52.26±0.505 | 50.61±0.394 |
| 2.5% | 1.Stem (Bark) | 42.36±1.253 | 45±0.348 | 48.55±0.972 | 45.30±0.64 |
| | 2.Leaf | - | 55.64±0.806 | 54.78±0.836 | 55.21±0.581 |
| | 3.Fruit | - | 56.86±0.63 | 52.78±0.961 | 54.82±0.69 |
| | Total | 42.36±1.253 | 52.5±0.366 | 52.03±0.538 | 48.96±0.382 |
| 5% | 1.Stem (Bark) | 38.61±1.029 | 53.36±0.226 | 53.86±0.863 | 48.61±0.592 |
| | 2.Leaf | - | 52.24±0.844 | 51.71±0.728 | 51.96±0.552 |
| | 3.Fruit | - | 50.38±0.48 | 49.11±0.856 | 27.24±0.569 |
| | Total | 38.61±1.029 | 51.66±0.362 | 51.56±0.485 | 47.27±0.342 |
| 10% | 1.Stem (Bark) | 30.12±0.643 | 48.41±0.242 | 45.67±0.724 | 41.4±0.447 |
| | 2.Leaf | - | 49.76±0.452 | 43.16±0.642 | 46.46±0.408 |
| | 3.Fruit | - | 53.51±0.457 | 45.58±0.718 | 49.54±0.452 |
| | Total | 30.12±0.643 | 50.56±0.258 | 44.80±0.423 | 45.8±0.262 |

MSW MANAGEMENT -Multidisciplinary, Scientific Work and Management Journal
ISSN: 1053-7899
Vol. 33 Issue 2, December – 2023, Pages: 515-545

**Table. 1p. Comparison of weight loss in grains infested with *C. chinensis* with respect to treatments of Extracts X Concentrations X Plant parts**

| | | | | | | |
|---|---|---|---|---|---|---|
| | **Extracts** | **Aqueous extract** | **Ethanol extract** | **Petroleum ether extract** | **Triton X 100 extract** | **Overall Mean** |
| **Concentrations** | **Plant parts** | **MEAN±SE** | **MEAN±SE** | **MEAN±SE** | **MEAN±SE** | **MEAN±SE** |
| 1.Normal | | 90.02±0.441 | 90.02±0.441 | 90.02±0.441 | 90.02±0.441 | 90.02±0.441 |
| 2Control | | 87.31±0.171 | 87.31±0.171 | 87.31±0.171 | 87.31±0.171 | 87.31±0.171 |
| 1% | Stem (Bark) | 66.27±0.22 | 55.72±1.354 | 59.13±0.41 | 54.02±1.278 | 58.78±0.705 |
| | Leaf | 64.5±0.709 | 58.66±0.289 | 57.8±0.284 | 55.9±0.608 | 59.21±0.527 |
| | Fruit | 64.42±0.349 | 57.32±0.812 | 55.6±1.502 | 55.64±0.926 | 58.24±0.623 |
| | Total | 65.06±0.263 | 57.23±0.736 | 57.1±0.519 | 55.18±0.676 | 58.64±0.394 |
| 2.5% | Stem (Bark) | 60.85±0.209 | 38.32±1.259 | 45.22±0.571 | 42±1.168 | 46.59±0.64 |
| | Leaf | 62.57±0.794 | 45.24±0.362 | 57.7±0.288 | 36.32±0.609 | 50.45±0.581 |
| | Fruit | 6228±0.311 | 49.5±0.882 | 56.85±1.485 | 48.64±1.313 | 54.41±0.69 |
| | Total | 61.9±0.255 | 44.35±0.666 | 53.25±0.547 | 42.32±0.655 | 50.45±0.382 |
| 5% | Stem (Bark) | 55.85±0.302 | 30.17±1.304 | 45.07±0.821 | 30.01±1.118 | 40.27±0.592 |
| | Leaf | 53.4±0.569 | 41.12±0.553 | 52.23±0.493 | 40.03±0.133 | 46.69±0.552 |
| | Fruit | 57.19±0.228 | 46.81±0.827 | 51.33±0.828 | 45.65±0.947 | 50.24±0.569 |
| | Total | 55.48±0.217 | 39.36±0.684 | 49.54±0.459 | 38.56±0.56 | 42.73±0.342 |
| 10% | Stem (Bark) | 46.25±0.313 | 30.99±0.871 | 45.26±0.767 | 30.09±0.91 | 38.17±0.447 |
| | Leaf | 48.82±0.308 | 39.61±0.603 | 43.19±0.478 | 38.2±0.669 | 42.45±0.408 |
| | Fruit | 50.76±0.159 | 42.41±0.596 | 45.25±0.619 | 40.75±0.498 | 44.79±0.452 |
| | Total | 48.61±0.194 | 37.67±0.5 | 44.56±0.415 | 36.34±0.447 | 41.79±0.262 |

MSW MANAGEMENT -Multidisciplinary, Scientific Work and Management Journal
ISSN: 1053-7899
Vol. 33 Issue 2, December – 2023, Pages: 515-545

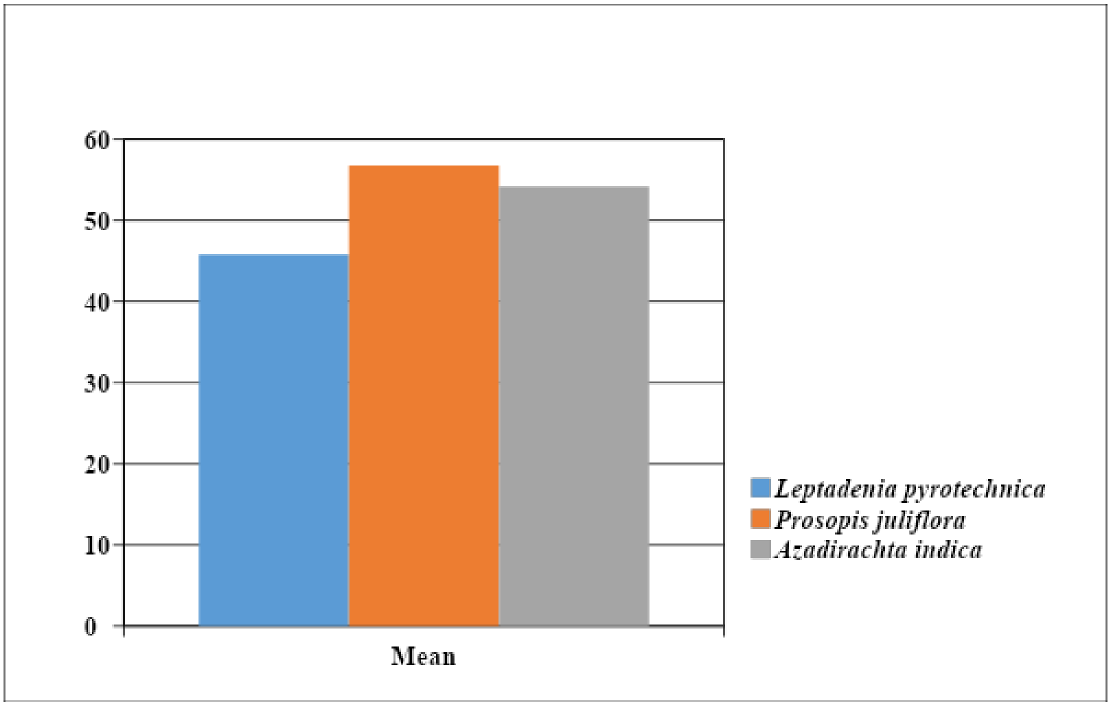


**Fig. 1. Comparison of weight loss in grains infested with *C. chinensis* with respect to treatments of different plants.**

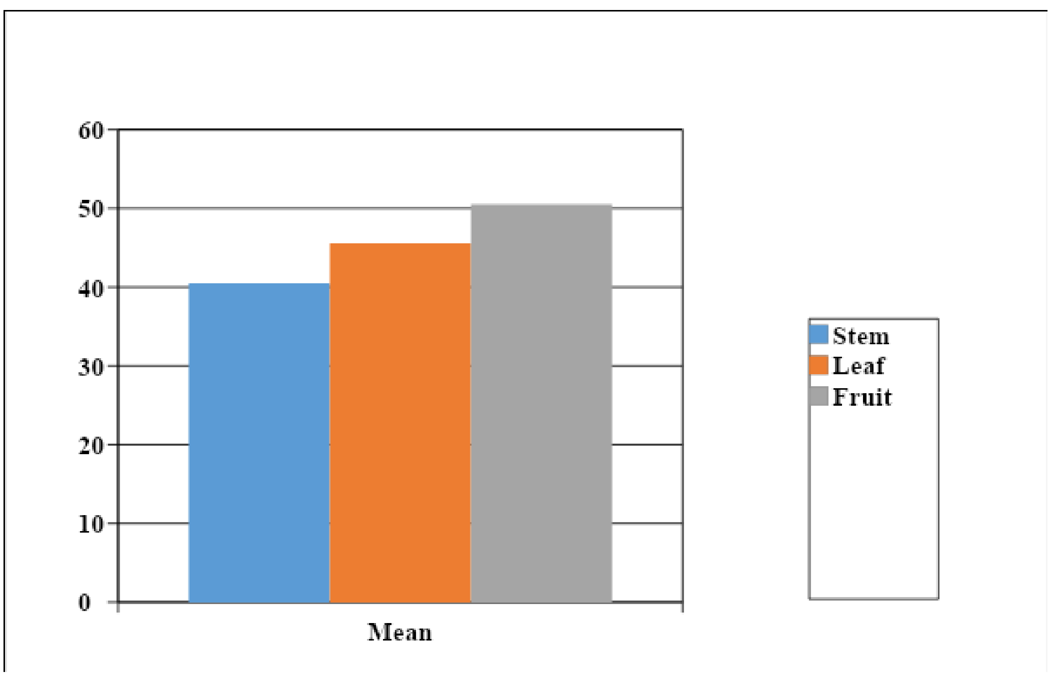


**Fig. 2. Comparison of weight loss in grains infested with *C. chinensis* with respect to treatments of different plant parts.**

MSW MANAGEMENT -Multidisciplinary, Scientific Work and Management Journal
ISSN: 1053-7899
Vol. 33 Issue 2, December – 2023, Pages: 515-545

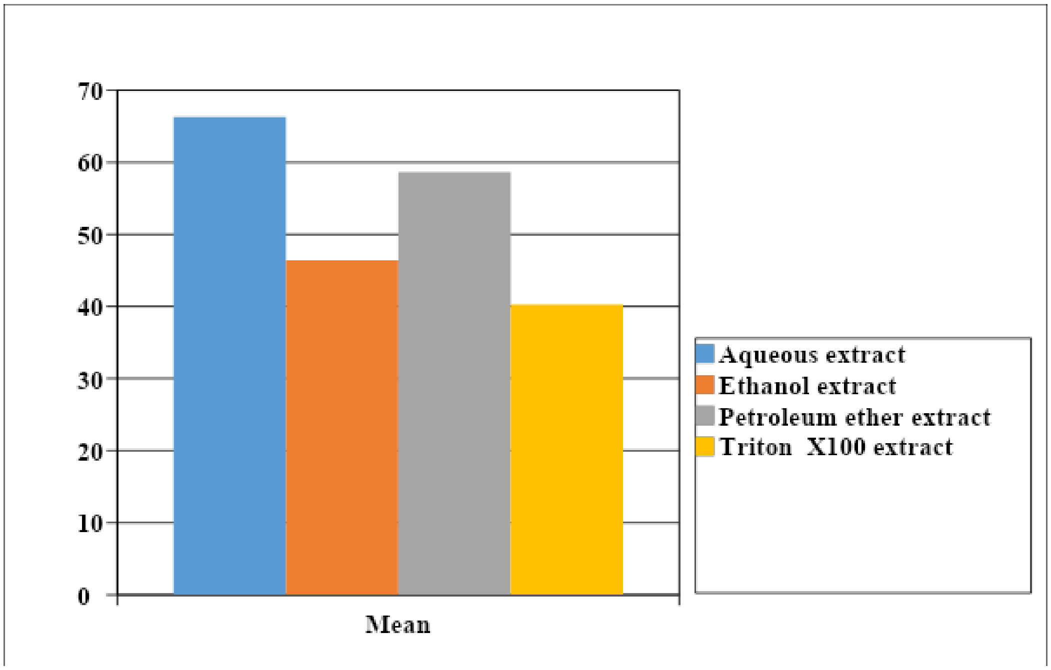


**Fig. 3. Comparison of weight loss in grains infested with *C. chinensis* with respect to treatments of different extracts.**

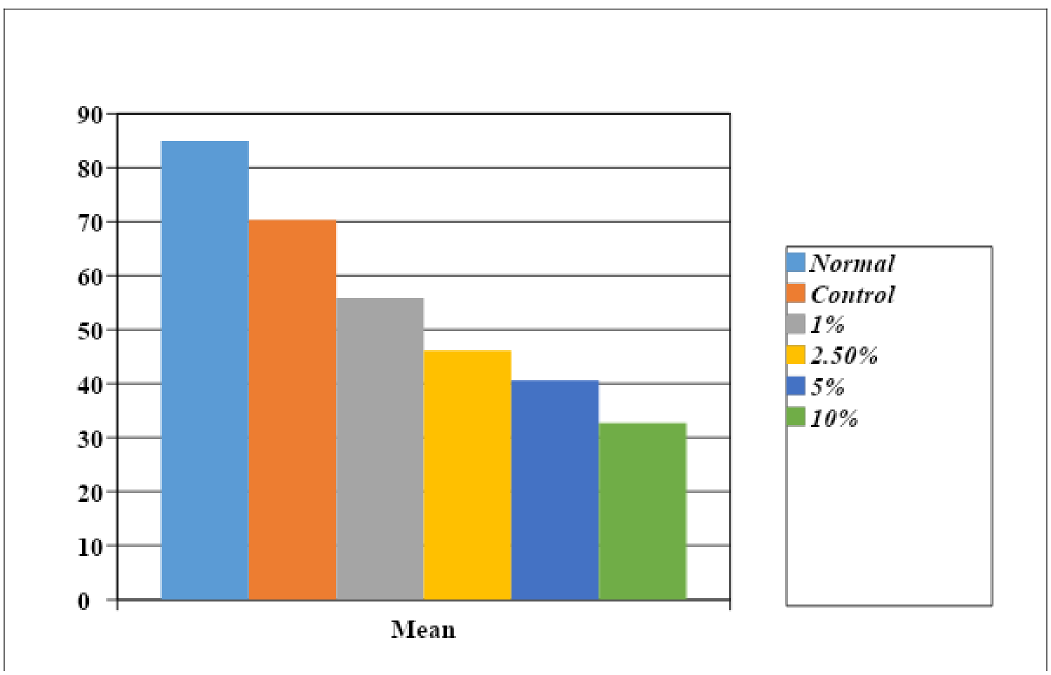


**Fig. 4. Comparison of weight loss in grains infested with *C. chinensis* with respect to treatments of different concentrations.**

MSW MANAGEMENT -Multidisciplinary, Scientific Work and Management Journal
ISSN: 1053-7899
Vol. 33 Issue 2, December – 2023, Pages: 515-545

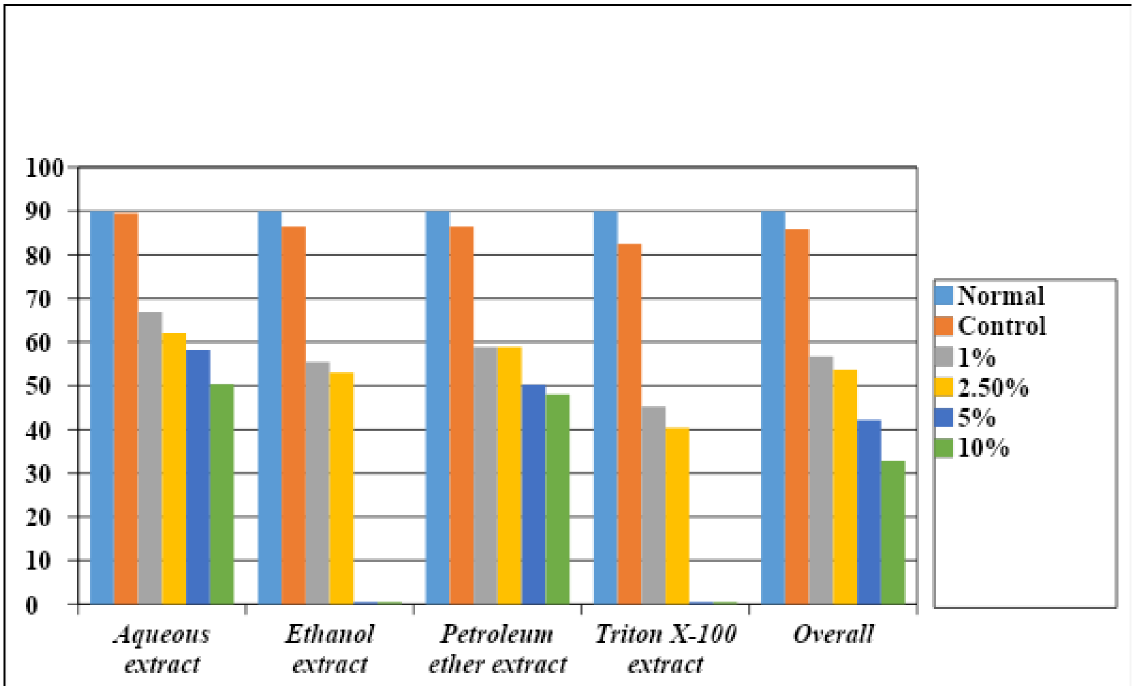


**Fig. 5. Comparison of weight loss in grains infested with *C. chinensis* with respect to treatments of plants, extracts and concentrations of *Leptadenia pyrotechnica.***

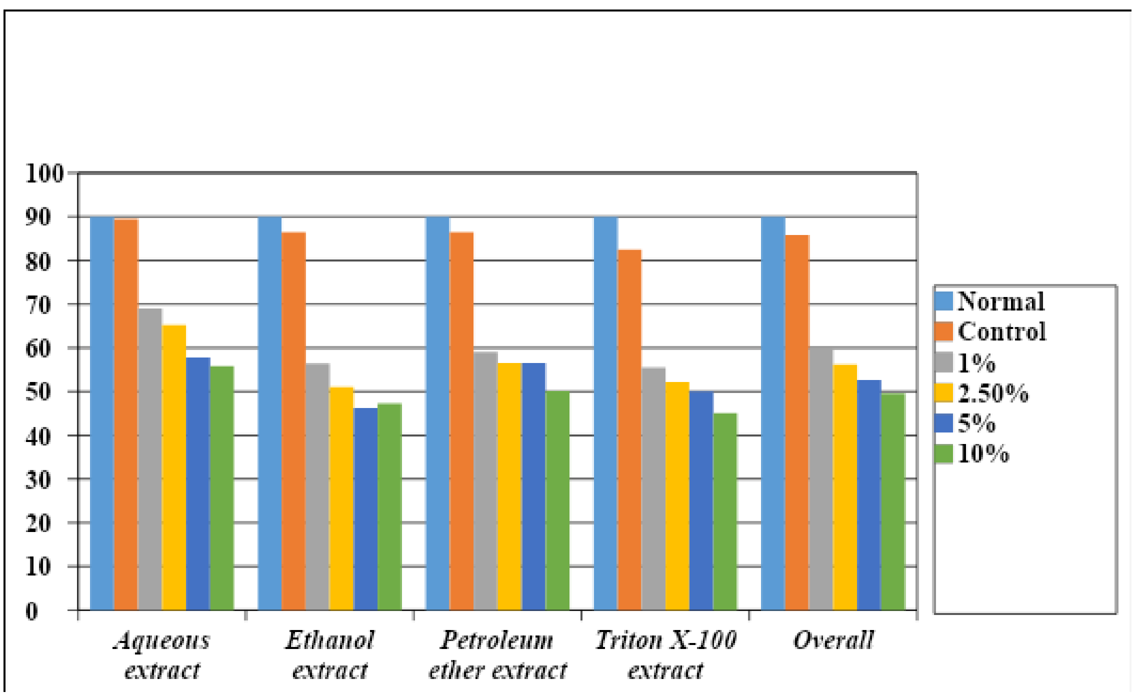


**Fig. 6. Comparison of weight loss in grains infested with *C. chinensis* with respect to treatments of plants, extracts and concentrations of *Prosopis juliflora.***

MSW MANAGEMENT -Multidisciplinary, Scientific Work and Management Journal
ISSN: 1053-7899
Vol. 33 Issue 2, December – 2023, Pages: 515-545

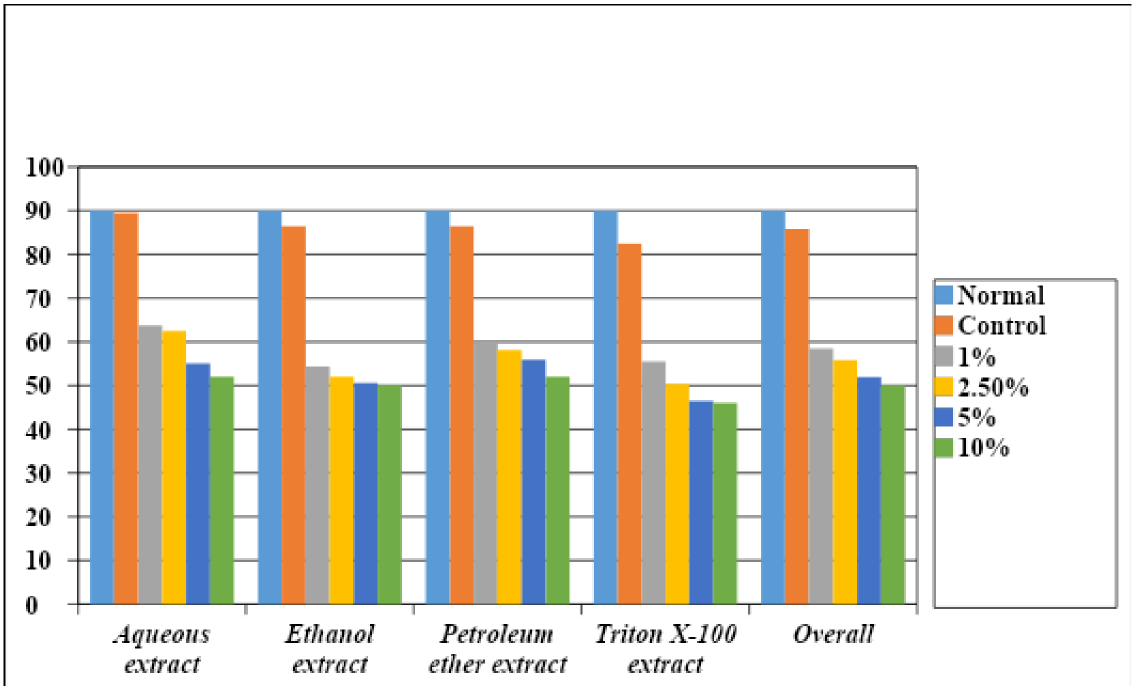


**Fig. 7. Comparison of weight loss in grains infested with *C. chinensis* with respect to treatments of plants, extracts and concentrations of *Azadirachta indica.***