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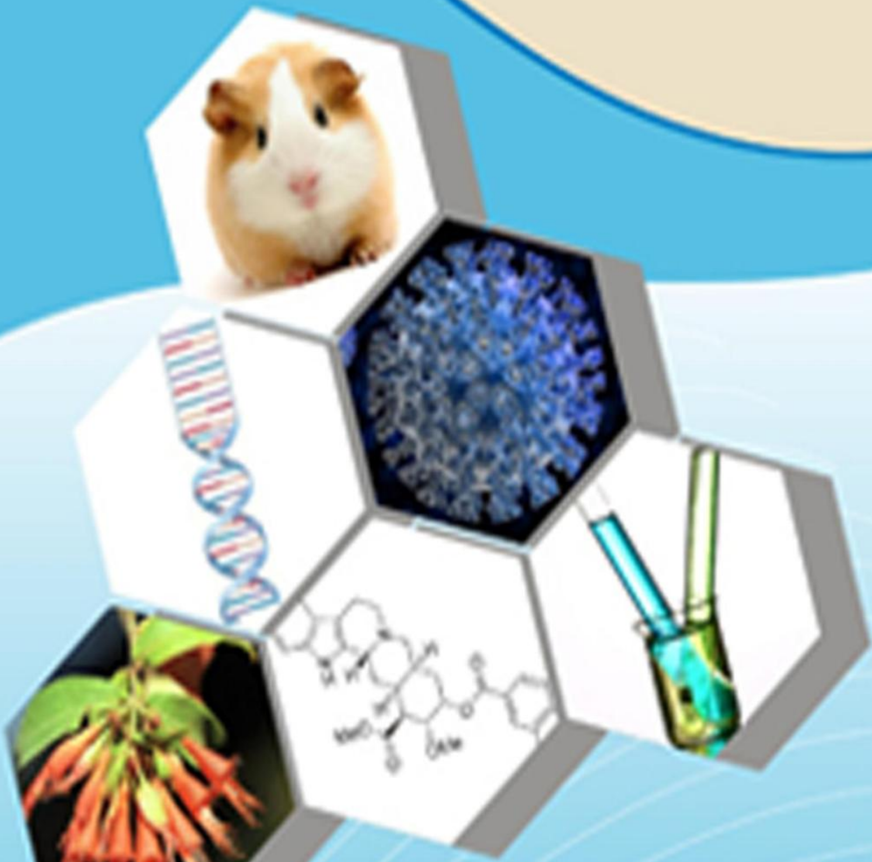

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EFFECTS OF *CHROMOLAENA ODORATA* ALLELOCHEMICALS ON CARBOHYDRATE DYNAMICS IN COASTAL VEGETATION.

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Abstract:

Allelochemical substances significantly influence the growth and survival of plants through positive and negative allelopathy, affecting nutrient competition and production. Allelochemicals are secondary metabolites not essential for the mother organism's growth, with negative effects crucial for defense against herbivores. The paper discusses the invasive weed *Chromolaena odorata*, highlighting its allelopathic properties and toxic effects on crops and livestock. Research focuses on the effects of its leaf extract and leachate on the biochemical parameters of coastal plants like Sonneratia alba and Salvadora persica, exploring carbohydrate metabolism related to reducing sugars, total sugars, starch, and overall carbohydrate content. Findings show that the leaf extract enhances carbohydrate contents, while the leachate negatively impacts growth, indicating potential for herbicide development from allelochemical characteristics of *C. odorata*. Leaf leachate of *Chromolena odorata* adversely effects on photosynthesis subsequently overall metabolism of influenced plants.

Keywords: Allelopathy, *Chromolaena odorata,* Carbohydrates, coastal species, Mangroves, etc.

INTRODUCTION

Allelochemical compounds affect the growth, survival, reproduction, and biological processes of other species, causing either positive or negative allelopathy. Stamp and Nancy (2003) claim that allelochemicals contain secondary metabolites that are unneeded for growth, development, and reproduction in the parent organism. Negative allelochemicals help plants fight herbivores (Fraenkel, 1959). Allelopathy, according to Rice (1974), occurs when one plant releases toxins into the environment and harms another. Crops and weeds grow together in an ecosystem at the same time. Weeds and crops compete for light, water, space, and nutrients. This has reduced agricultural yield and released harmful pollutants.

De Candolle initially said weeds harm crops because they release phytotoxins in 1832. These effects are concentration-dependent and selective. They may inhibit or accelerate weed or crop growth (Jalili, et al., 2007). Volatilization, leaching, degradation, and root exudation release many chemicals from crops. various people know that plants contain various organic, bioorganic, and other toxic chemicals. Biochemicals in plant roots can interact to form allelochemicals that prevent seed germination. According to Hakim et al. (2011), aqueous extracts from common weeds significantly limit vegetable crop growth.

Recent attention has focused on how plant leachates, extracts, and decomposing plant waste affect agriculture rather than allelopathy. Many plant residues include toxic compounds that hinder seed germination and seedling growth (An et al., 1997). Seed germination, vegetative propagules, early seedling growth, and radicle growth are inhibited by plant leachates (Babu and Kandasamy, 1997; Dhawan and Gupta, 1996). Patrick (1971) claims that root exposure to leachates or wastes affects crop loss. Microbes can cause phytotoxicity in crops indirectly and directly (Rice et al., 1981). Aqueous extracts from several plants slow seedling, root, and shoot growth, germination, and even kill them (Lydon et al., 1997).

Siam weed, Chromolaena odorata (Linn) R.M. King & H. Robinson (Asteraceae), is a scrambling, fast-growing perennial shrub. It is now an invasive weed in tropical Asia, Africa, and the Pacific after spreading from Central and Southern America. Outdoor plants can reach 3–7 meters tall. Devil weed, French weed, communist weed, hagonoy, co joy, and others are its names (Vaisakh and Pandey, 2012; Otarigho and Morenikeji, 2013). Ranmodi is its name in Sawantwadi, Sindhudurg, Maharashtra. People intentionally or accidentally transport this invasive weed to many regions as a beautiful plant. As an invasive and allelopathic weed, it is one of the most harmful on Earth. Otarigho and Morenikeji (2013); Vaisakh and Pandey (2012). Central Africa calls C. odorata Matanga Mbala (the invader) in the Congo and Mighbe (the one that crashes all) in Cameroon. These names demonstrate this plant's aggressive landscape invasion (Kouamé et al., 2013). The plant's leaves and young shoots contain 5–6 times the harmful level of nitrate, which could kill livestock who consume it (Rao et al., 2010).

In nature, they form thick clumps that block other plant species [Raimundo et al., 2007]. This weed competes for water and nutrients, shades nearby plants, and releases toxic compounds that destroy them. Young C. odorata leaves are poisonous due to nitrate [Zachariades et al., 2002]. Heliophile C. odorata likes sunlight. It grows better in sunlight and less when other plants shade it. Many substances can support the plant. Vesicular-arbuscular mycorrhizae help it survive in poor soil [Chakraborty et al., 2011]. Since it can grow new shoots on damaged or burned roots, C. odorata may be able to handle cuts and burns. If the plant is severely injured, it won't recover as rapidly [Faridah Hanum and Van der Maesen, 2007]. Allelochemicals in C. odorata affect weed germination, growth, development, distribution, and behavior. It could also harm livestock and humans with allergies. A early evaluation found the weed infesting a broad region, particularly along Sawantwadi, Maharashtra's shore. Today, it thrives in estuaries and seashores. Few studies have examined how Siam weed or its components affect coastal plant growth. The current study aimed to assess the allelopathic effects of Siam weed aqueous leaf extract and leaf litter leachate on biochemical parameters, carbohydrate and nitrogen metabolism, antioxidative enzymes, and mineral nutrition of selected coastal plants, identify allelochemicals via GC-MS analysis of both extracts, and determine which extracts induce significant growth.

MATERIALS AND METHODS

i) Procurement of leaf litter and seedlings.

Senescent leaves of *Chromolaena odorata* L. were collected from the coastal area of Sawantwadi taluka, maharashtra.The leaf litter was preserved in polythene bags and stored in dry conditions. The fresh matured, insect and disease free leaves of *Chromolaena odorata* collected from same place at the time of experimental work. Seedlings of *Sonneratia alba, Acanthus ilicifolius, Derris trifoliata, Salvadora persica, Crotalaria verrucosa, crotalria striata and Ipomoea pes-caprae* were collected from Aronda, Sawantwadi taluka and potted in pots.

Carbohydrates

Carbohydrates were estimated according to the method described by Nelson (1944). 0.5 g oven dried plant material was homogenized in mortar with pestle and extracted with 80% alcohol. It was filtered through Bucher's funnel using Whatman No.1 filter paper. The residue on filter paper was washed with 80% alcohol repeatedly. All the washing and filtrate were mixed together. This filtrate was used for estimation of soluble sugars while the residue was saved for estimation of starch.

a) Reducing sugars:

The filtrate was condensed on the water bath to about 2-3 ml and to it, were added Lead acetate and Potassium oxalate (1 gm each) to decolourise the extract. It was mixed together with the help of glass rod with the addition of some water. It was again filtered and washed with distilled water 2-3 times, colleting the washings in the same filtrate. The final volume of filtrate was made to 50 ml with distilled water. This filtrate was used for estimation of reducing sugars (A).

b) Total sugars:

From the above filtrate, 20 ml were taken into the conical flask and hydrolyzed with 2-3 ml conc. HCL in an autoclave at 15 lbs pressure for half an hour. The contents were cooled, neutralized with Na_2CO_3 and filtered. This filtrate was used for the estimation of total (reducing + non-reducing) sugars (B). The volume of the filtrate was noted down.

c) Starch:

The residue on the filter paper saved for starch estimation was transferred to a conical flask with 50 ml of distilled water and 3-5 ml of conc. HCL. This was hydrolyzed, neutralized and filtered as stated above. This filtrate contains reducing sugars produced as a result of hydrolysis of starch. The sugars so available were estimated to determine the starch present in the tissue (C). The volume of the filtrate was also noted down.

The requisite quantity, (2ml each of A and B and 0.1 ml of filtrate C) were taken separately in 10 ml marked test tubes. 1 ml of alkaline copper tartarate reagent- (4 g $CuSO_4.5H_2O$, 24 g unhydrous Na_2CO_3, 16 g Na-K- tartarate and 180 g unhydrous Na_2SO_4 were dissolved in distilled water and volume was made to 1000 ml) was added to each test tube.

All the test tubes containing the reaction mixtures were subjected to boiling water bath for about 10 min and then cooled to room temparature.1ml of arsenomolybdate reagent (25 g ammonium molybdate in 450 ml distilled water and to this were added 21 ml of conc. H_2SO_4. This was mixed with solution containing 3 g sodium arsenate dissolved in 25 ml distilled water. The mixture of the solutions was placed in an incubator at 37 ^{0}C for 48 hours) was added to each test tube and shaken vigorously. The volume of the reaction mixture in each test tube was made 10 ml with distilled water. A blank was prepared in the same way but without sugar solution. After 10 minutes, the absorbance was read at 560 nm on double beam spectrophotometer (Shimadzu, UV-VIS 190). A standard curve of glucose ($0.1 mg.ml^{-1}$) was prepared and the sugar content was calculated.

LITERATURE REVIEW:

Allelopathy, the biochemical interaction between plants that releases secondary metabolites, has been studied in ecological study, especially invasive species. *Chromolaena odorata,* known as scientific gold, shows how allelopathic mechanisms can change native plant groups. Kato-Noguchi and Kato (2023) emphasize the importance of secondary metabolites in C. odorata, suggesting they have defensive and allelopathic effects. Mostly produced in reaction to environmental stressors, such metabolites boost the species' competitiveness while reducing nearby plant growth. *C. odorata* allelopathic effects impede native flora seed germination and seedling development, according to empirical investigations. Rai and Singh (2024) showed that allelochemicals generated by *C. odorata* inhibit plant species coexistence, changing plant community competitive dynamics. Muzzo et al. (2023) showed that allelochemicals from C. odorata inhibited plant growth in diverse species. Allelopathic effects on *Cucumis sativus* and *Citrullus lanatus* may diminish agricultural productivity in shrub-infested areas (UGWUNNA et al., 2023). Allelopathic effects of *C. odorata* geographical and temporal fluctuations reveal its ecological effectiveness as an invasive plant. A comparative Tanzanian study found that aqueous leaf extracts strongly affected critical pasture species germination and growth (Muzzo et al) (2018). This suggests that C. odorata's allelopathic capability in agricultural and natural habitats can affect native biodiversity and agricultural operations.

The adaptation of *C. odorata* enhances its allelopathic properties. This invasive plant adjusts to various ecological niches by exhibiting allelopathic effects under varying levels of irradiance and nutrient availability, as noted by Quan *et al.* (2015). Indigenous flora have lower adaptability compared to *C. odorata*. Xu *et al.* (2020) assert that *C. odorata* allelopathic interactions exploit resources to outcompete native flora and weeds. The diverse allelopathic methods of *Chromolaena odorata* influence numerous plant assemblages. The intricate link between secondary metabolites and plant interaction dynamics renders this invasive shrub ecologically important. The repercussions extend beyond immediate competition, jeopardizing biodiversity and ecosystem functionality. Effective management of *C. odorata* invasion necessitates comprehension of these mechanisms to mitigate ecological impact. The allelopathy of *Chromolaena odorata* impacts ecosystems beyond flora. This invasive shrub modifies soil and microfaunal communities through allelochemicals and root exudates (Juru *et al.,* 2024; Debnath, 2018). Nematodes and other invertebrates sustain soil health and nutrient cycling. *C. odorata* cascades diminish soil fertility and alter nutrient dynamics for indigenous plant growth (Juru *et al.,* 2024). The allelopathy of *C. odorata* significantly diminishes plant diversification. Poudel *et al.* (2024) assert that *C. odorata* induces water stress, adversely affecting the growth of native trees such as Aegle marmelos. The dominance of *C. odorata* may lead to competition among native plants for space, altering plant communities and diminishing biodiversity. Southern Nigerians regard *C. odorata* as both a resource and an environmental concern. Infested ecosystems adversely affect native species, signifying an ecological alteration (Otabor *et al.,* 2025). The allelopathic compounds diminish agricultural yields and exacerbate the challenges faced by local farmers, intensifying worries around food security.

The selective impact of C. odorata on specific crop species has been investigated, revealing its biocontrol potential as well as the concerns of herbicidal activity that may jeopardize agricultural systems (Akter & Begum, 2024). These findings indicate that while C. odorata may improve integrated pest management, it also poses a danger to native biodiversity and agricultural sustainability. Allelopathy's role in ecosystem dynamics has to be understood. Given these ecological repercussions, further research is required to inform C. odorata conservation and management efforts to limit its invasiveness in a variety of settings. Understanding C. odorata's interactions with indigenous plant communities can aid in restoring ecological balance and biodiversity in places impacted by this invasive shrub (Nzenwa et al., 2024; Poudel, 2025). Understanding C. odorata's allelopathic impacts is essential for developing effective strategies to conserve native ecosystems and promote sustainable land use.

RESULT AND DISCUSSION

Carbohydrates contents

Photosynthesis is a crucial metabolic process in plants. They assimilate carbon to synthesize various carbohydrates. Parenchyma cells store carbohydrates and either amalgamate or exit the organism upon their demise (Ziegler, 1964). Carbohydrates, as the initial phase of respiration, provide plants with the energy required for growth and development. Various plant locations yield distinct types and quantities of carbohydrates. Figures 6–9 illustrate the impact of allelochemicals from *Chromolaena odorata* on the glucose metabolism of *Sonnertia alba, Acanthus ilicifolius, Derris trifoliata, Salvadora persica, Crotolaria verrucosa, Crotalaria retusa* and *Ipomoea pescaprae.* This study examines the reduction of sugar, total sugar, starch, and overall carbohydrate metabolism. Hellebust (1976) asserts that plants can acclimatize to osmotic stress by synthesizing increased sucrose levels in their leaves and roots.

Reducing Sugar

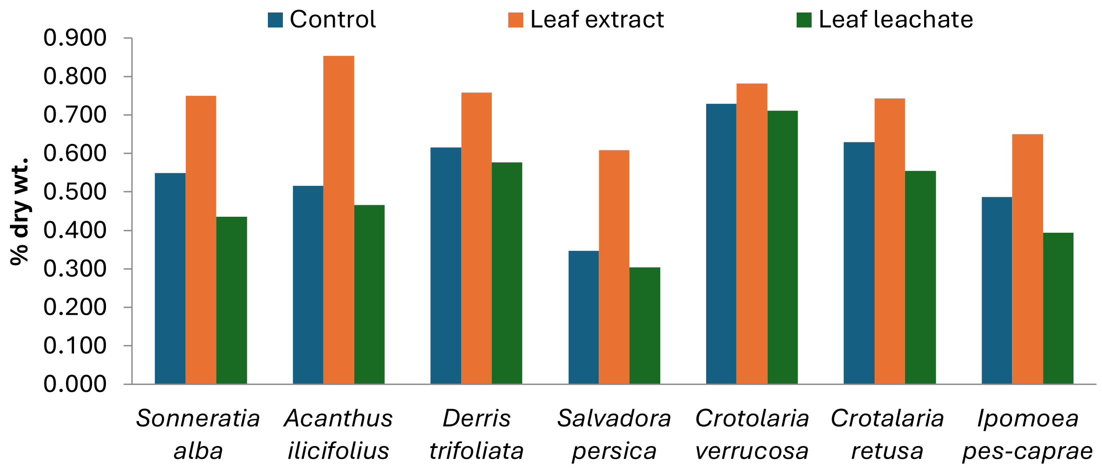
Effect of leaf extract & leaf leachate of *Chromolena odorata* on reducing sugar contents have been depicated in Fig. 1. Under controlled condition among studied species highest reducing sugar contents found in *Crotolaria Verrucosa* 0.728% dry wt. & that lowest observed in *Salvadora* (0.346% dry wt.) That in other studied species as in *Sonnertia alba* 0.549% dry wt., in *Acanthus ilicifolius* 0.516% dry wt. in Derris trifoliate 0.615% dry wt., in *Crotolaria retusa* 0.630% dry wt. and in *Ipomoea pescaprae* 0.487% dry wt. It is clear from result that under leaf extract treatment elevation in reducing sugar level observed. While under leaf leachate treatment of *Chromolena odrata* decline in same observed in all studied species.

In leaf extract treatment *Sonnertia alba* shown elevation upto 36.41%, in *Acanthus ilicifolius* upto 65.32% enhance, in *Derris trifoliata* upto 23.30% increase, in *Salvadora persica* 75.86% increase, in *Crotolaria verrucosa* upto 7.38%, in *Crotolaria retusa* upto 18.01% & in *Ipomoea pescaprae* upto 33.74% enhancement observed in reducing sugar contents. It is evident from result that highest enhancement observed in *Salvadora persica* from 0.346 to 0.606% reducing sugar dry wt & that lowest elevation observed in *Crotolaria verrucosa* from 0.728 to 0.728% reducing sugar as compare to control one of same under this treatment.

Leaf leachate treatment of *Chromolena odorata* responsible to decline in reducing sugar level in all studied coastle species. It is evident from result that highest decline of reducing sugar observed in *Sonnertia alba* (20.65%) & lowest decline observed in *Crotolaria verrucosa* (2.46%) In other studied plant species decline in reducing sugar contents observed as in *Acanthus ilicifolius* 9.83%, in *Derris trifoliata* 6.31%, in *Salvadora persica* 12.07%, in *Crotolaria retusa* 11.85% and that in *Ipomoea pescaprae* 19.02% loss.

From the overall findings it can be conclude that leaf leachate (treatment) of *Chromolena odorata* influences on osmoregulation potential of other plants. On the other hand, leaf extract from the same plants can improve other plants' capacity for osmoregulation.

Fig.1. Allelopathic effect of *Chromolena odorata* on reducing sugar contents of few coastle species



1. Total Sugar

Photosynthesis produces sugars, which parenchymatous reservoir cells store in various ways. In carbohydrate metabolism, triose, tetrose, pentose, hexose, heptulose, and octulose are sugars' carbon atom counts. The sugar pool contains pentose sugars, which are needed to make DNA, RNA, and ATP. Certain sugars produce aromatic chemicals and aid cellular metabolism.

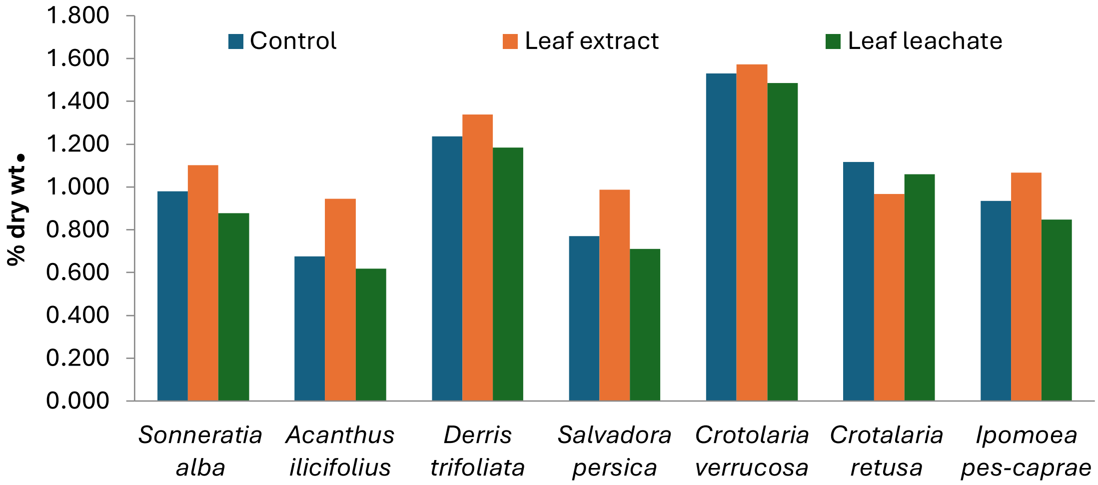
Allelopathic effect of *Chromolena odorata* on total sugar contents of few coastal plant species have been recorded in Fig. 2. It is evident from result that under controlled condition highest total sugar contents observed in *Crotolaria verrucosa* (1.53% dry wt.) and that lowest in *Acanthus ilicifolius* (0.676% dry wt.) Total sugar content under same condition in other studied species found as in *Sonnertia alba* 0.981% dry wt. in *Derris trifoliate* 1.236% dry wt., in *Salvadora persica* 0.770% dry wt. in *crotolaria retusa* 1.117% dry wt. and that in *Ipomoea pescaprae* 0.934% dry wt.

Leaf extract treatment of *Chromolena odorata* found responsible to improve in total sugar level in all studied species except *Crotolaria retusa*, In *Crotolaria retusa* there is decline up to 13.43% in total sugar content observed under this treatment while other studied species shown elevation in it. Highest elevation in it observed in *Acanthus ilicifolius* 39.74% & lowest elevation observed in *Crotolaria Verrucosa* 2.78% as compare to control one of same. Under this treatment other species studied shown enhancement as *Sonnertia alba* 12.33%, *Derris trifoliate* 8.33%, *Salvadora persica* 28.20% and that *Ipomoea pescaprae* 14.15% as compare to control one of same.

In case of leaf leachate treatment of *Chromolena odorata* all studied species shown decline in total sugar contents as compare to control one. Highest loss of total sugar content observed 10.50% in *Sonnertia* alba & that lowest 2.82% loss in *Crotolaria Verrucosa*. The other studied species showed loss in total sugar level as 8.61% in *Acanthus ilicifolius*, 4.17% in *Derris trifoliata*, 7.85% in *Salvadora persica*, 5.21% in Crotolaria retusa and 9.11% loss in *Ipomoea pescaprae* as compare to control one. Sugar act as main energy source in various cellular reactions, it also helpful for osmotic adjustment in the plants under various environmental stresses, it plays important role in membrane and macromolecular stabilization (Hoekstra and Golovina, 1999). According to Xiong *et al.* (2002) enzymes invertase and sucrose synthase are responsible for degradation of sucrose.

The drop in total sugar levels in all *Chromolaena odorata* leaf leachate-treated plants indicates a major impact on photosynthetic carbon metabolism. Results show that both treatments considerably change carbohydrate fractions. Except for Crotalaria verrucosa, all coastal plants respond similarly to decreased sugar content relative to total sugar concentration. The current study suggests that *Chromolaena odorata* may increase invertase and sucrose synthase activity, lowering plant sugar levels.

Fig. 2 Allelopathic effect of *Chromolena odorata* on total sugar contents of few coastle species



2. Starch Contents

Starch is a polysaccharide made from glycosidic connections between glucose molecules. This polysaccharide specializes in energy storage. Starch contains 20–25% amylose and 75–80% amylopectin, according to Brown and Poon (2005). Starch levels vary by plant. The genetic constitution determines starch molecule quantities of these two components. Starch levels in plant organs are controlled by biosynthesis and catabolism.

Here in current study, allelochemical influence of *Chromolena odorata* (leaf extract & leaf leachate treatment) on different coastal plants have been depicated in Fig. 3. Under controlled condition starch content found highest (14.66% dry wt.) in *Crotolaria verrucosa* & lowest (8.852% dry wt.) in *Salvadora persica* among studied coastal plant species. In *Sonnertia alba* 12.301% starch observed, that in *Acanthus ilicifolius* 9.454%, in *Derris trifoliate*

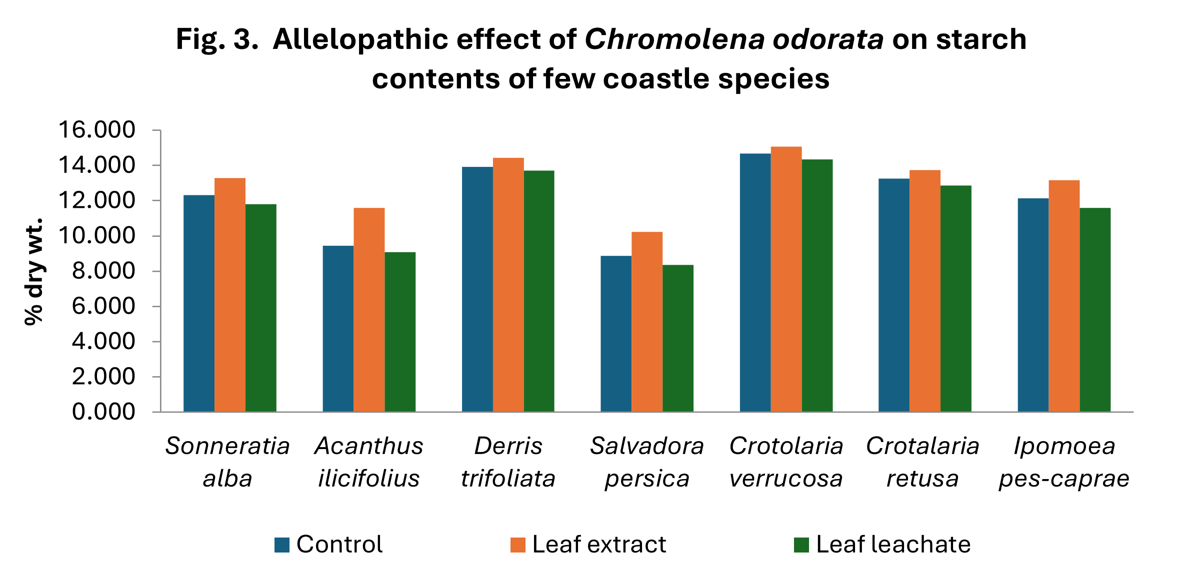
13.915%, in *Crotolaria retusa* up to 13.26% & 12.118% starch on dry wt. basis observed in *Ipomoea pescaprae* under same controlled condition.

Among the different sugars present in the plant tissue and forming a total sugar pool, sucrose is perhaps the most important. This non reducing sugar is the major product of photosynthetic CO_2 fixation UDP-glucose plays a key role in sucrose biosynthesis along with the enzymes sucrose phosphate synthase and sucrose phosphatase.

In case of leaf extract treatment of *Chromolena odorata* there is enhancement found in all coastal plants that are in under study. In this treatment highest elevation in starch content observed upto 22.71% in *Acanthus ilicifolious* (from 9.454 to 11.60% dry wt) & lowest enhancement found in *Crotolaria verrucosa* as 2.70% (from 14.661 to 15.06% dry wt) as compare to control one of same. Elevation in starch content found in other studied plants are as in *Sonnertia alba* 8.04%, in *Derris trifoliate* 3.72%, in *Salvadora persica* 15.63%, in *Crotolaria retusa* 3.56% and 8.54% increase in starch content in *Ipomoea pescaprae* under same treatment as compare to control ones of them.

In case of leaf leachate treatment exact reverse condition observed than that of leaf extract treatment i.e. decline in starch contents of all studied plant species. Highest decline in starch contents 5.61% observed in *Salvadora persica* & Lowest decline observed in *Derris trifoliate* (1.42%) under this treatment. Leaf leachate treatment responsible to decline 3.96% in *Sonnertia alba*, 4.03% loss in *Acanthus ilicifolious*, 2.18% fall down of starch level in *Crotolaria verrucosa*, 3.10% loss in *Crotolaria retusa* and 4.27% decline of starch observed in *Ipomoea pescaprae*. Starch biosynthesis carried out by Enzyme ADP glucose pyrophosphorylase, starch synthase and branching enzyme (Zeeman *et al.,* 2010) and degradation of starch is carried out by some hydrolytic enzymes as α-amylase, β-amylase and debranching enzyme.

The current study demonstrated that *Chromolaena odorata* leaf extract activates ADP glucose pyrophosphorylase, starch synthase, and branching enzymes to improve plant productivity. Leaf leachate treatment affects plant production by activating hydrolytic enzymes as α-amylase, β-amylase, and debranching enzymes. As a result, it will aid in the creation of herbicides to manage weeds. The *Chromolaena odorata* leaf leachate also inhibits starch production in other plants. These medicines change starch levels for osmotic correction in afflicted plant species.



3. Total Carbohydrates

Allelochemical effect of *Chromolena odorata* on total carbohydrate contents of few coastal plants have been depicated in Fig. 4. Under controlled condition highest carbohydrate content observed in *Crotolaria verrucosa* (16.192%) & lowest total carbohydrate observed in *Salvadora persica* (9.622%) among studied plant species. Total Carbohydrate content found in other studied species are as in *Sonnertia alba* (13.281%), in *Acanthus ilicifolics* (10.13%), in *Derris trifoliate* (15.15% dry wt basis), *Crotolaria retusa* (14.377%) & 13.052% total carbohydrate on dry wt basis observed in *Ipomoea pescaprae* as compare to control one.

Total carbohydrates levels in plants indicate tissue metabolism and energy content. Carbohydrates are the main products of photosynthetic carbon absorption and the main substrates for respiration in all green plants. Endogenous and exogenous variables impact plant tissue glucose fraction levels, which affect photosynthesis, respiration, several biosynthetic processes, and translocation. Plant tissue contains several carbon molecules, including secondary metabolites, which are framed by carbohydrates.

In present investigation, under leaf extract treatment of *Chromolena odorata* all studied coastal plants shows elevation in total carbohydrate contents. Among studied plants highest enchancement observed in *Acanthus ilicifolius* (23.84%) and lowest elevation 2.24% of Carbohydrate observed in *Crotolaria retusa*. It is evident from result that under this same treatment other plants showed as 8.36% elevation in *Sonnertia* alba, 4.10% in *Derris trifoliata*,

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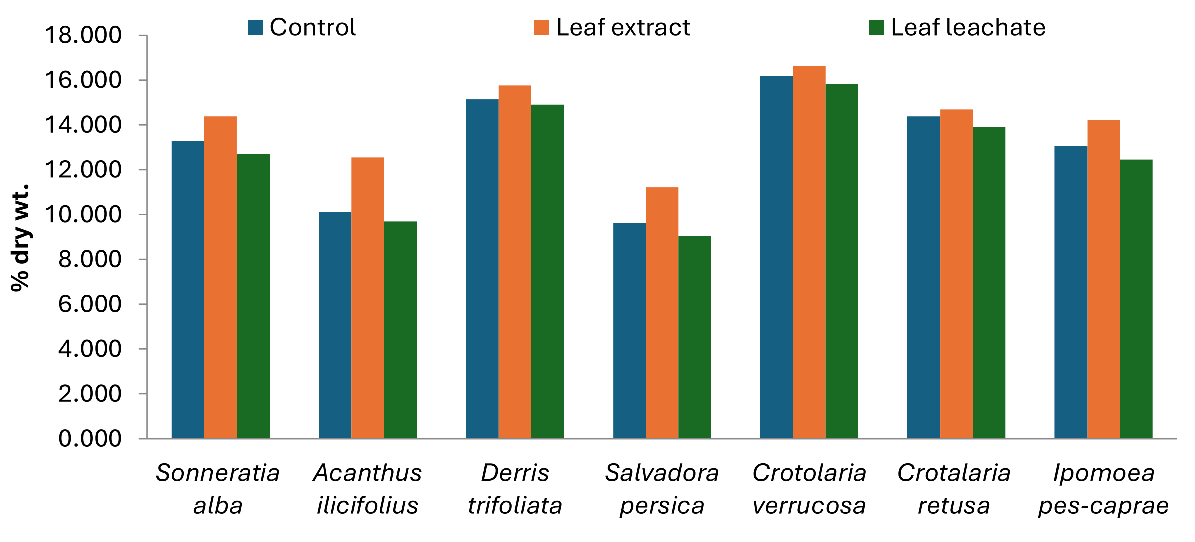
16.64% in *Salvadora persica*, 2.71% in *Crotolaria verrucosa* and 8.94% in *Ipomoea pescaprae* as compare to control one of the same.

In case of leaf leachate treatment in all studied plants decline in total carbohydrate contents observed. Among studied plants 5.79% highest loss observed in *Salvadora persica* & lowest decline 1.65% observed in *Derris trifoliata*. Under treatment of leaf leachate of *Chromotena odorata*, decline in total Carbohydrates of all other plants found. In *Sonnertia alba* 4.44% loss, in *Acanthus ilicifolius* 4.33% loss, In *Crotolaria verrucosa* 2.25% fall down, in *Crotolaria retusa* 3.26% loss & 4.67% loss observed in total carbohydrate contents as compare to control one under leaf leachate treatment of *Chromolena odorata*.

Plant productivity is generally increased by applying *Chromolaena odorata* leaf extract, and its leaf leachate can be utilized as a biocontrol agent in weedicides and herbicides. Allelopathic treatments (*Chromomolaena odorata* leaf extract and leachate) impact the glucose pathway in all coastal plants. *Chromolaena odorata* leaf leachate lowers photosynthesis and changes plant metabolism.

Fig. 4. Allelopathic effect of *Chromolena odorata* on total carbohydrate contents of few coastle species



CONCLUSION

Allelopathy encompasses biochemical interactions that influence the growth and viability of organisms. Investigations into environmental factors affecting seedling growth have demonstrated that abiotic stressors lead to diminished plant cover, whereas allelopathy also influences plant development. The invasive shrub *Chromolena odorata*, common throughout Central and South America, impacts native flora via competition and allelopathy. A study conducted by Janarthanam and Desai (2005) in Goa examined the allelopathic effects of *C. odorata*, demonstrating that its leaf extract elevated total sugar concentration in coastal plants, whereas its leachate diminished it, hence affecting photosynthetic metabolism. The leaf extract augmented starch production in all examined coastal plants, but the leachate impeded it, suggesting the possible application of the leachate as a herbicide. *Crotalaria verrucosa* demonstrated a distinctive reaction in total sugar concentration compared to the other plants evaluated.

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