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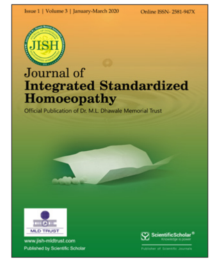

Original Article

Efficacy of homoeopathic medicines *Zincum metallicum* 6CH and *Zincum metallicum* 12CH on growth of *Abelmoschus esculentus* L. (Bhindi) in a natural environment: A placebo-controlled study

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ABSTRACT

Objectives: Homoeopathic dilutions are used to increase active principles in medicinal plants, detoxify plants, increase plant growth rate and fruit production, improve plant metabolism and control diseases. This controlled experimental prospective study was conducted to evaluate the effect of homoeopathic medicines *Zincum metallicum* 6CH and *Z. metallicum* 12CH on plant growth of *Abelmoschus esculentus* L. in a natural environment. This study helps assess and establish the role of homoeopathy in propagating plant growth.

Materials and Methods: *A. esculentus* seeds were cultivated in a designated area of the Homoeopathy University campus. Among these, 30 received *Zincum* 6CH (20 drops in 1 litre water), while 30 received *Zincum* 12CH (20 drops in 1 L water) and 30 received normal water. After 60 days, the entire plant was measured for height, pod length and productivity.

Results: After 60 days, the number of fruits (plant productivity) in the groups receiving *Zincum* 6CH and 12CH was 335 and 267, respectively; in the group receiving normal water, the number of fruits was 159. The heights of plants receiving *Zincum* 6CH (M = 48.4 cm, SD = 2.65) and 12CH (M = 40.1 cm, SD = 2.39) were comparatively more than in plants receiving normal water (M = 31.6 cm SD = 2.26). The length of pods in plants receiving *Zincum* 6CH (M=13.3 cm, SD = 0.96) and 12CH (M = 10.3 cm, SD = 0.97) was comparatively more than in plants receiving normal water (M = 8.9 cm SD = 0.62).

Conclusion: The application of potentised homoeopathic medicines *Zincum* 6CH and 12CH on *A. esculentus* demonstrated a beneficial result, as observed through significant differences in plant productivity, mean plant height and mean pod length among the experimental and control groups. *Zincum* 6CH showed more efficacy than 12CH in all aspects of growth.

Keywords: Agro-homoeopathy, Zincum metallicum 6CH, Zincum metallicum 12CH, Abelmoschus esculentus (L.)

INTRODUCTION

The extensive use of synthetic fertilisers in agriculture is causing environmental problems, such as damage to trace elements in the soil, release of harmful gases in the atmosphere, pollution of underground water and killing the beneficial microbes present in the soil.[1] We need to discover substitutes that will increase plant growth without compromising their quality and prevent

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environmental hazards. In homoeopathy, a substance produces morbid symptoms at high doses in healthy individuals, ameliorates the disease at ultra-low doses in a patient showing similar symptoms.[2] Dynamisation or potentisation (through trituration or succussion) is a unique aspect of the science of homoeopathy that, in comparison to simple dilution, even at higher levels, is more effective.[3] A high potency of a drug is considered the best antidote for the effects of the crude drug.[4] The use of homoeopathic preparations in agriculture has started recently by following the above mentioned principle of similia.[5]

Agro-homoeopathy builds the plant's basic structure and gives it optimum health, thus reducing and sometimes even eliminating its susceptibility.[6,7]

Homoeopathic preparations are being used efficiently for increasing active principles in medicinal plants, detoxification from metals such as aluminium, phosphorus, sulphur and copper, increasing plant growth rate and productivity,[5] improving plant metabolism[8,9]and disease control.[10-12]

This controlled experimental prospective study was conducted to evaluate the effect of homoeopathic medicines *Zincum metallicum* 6CH and *Z. metallicum* 12CH on plant growth of *Abelmoschus esculentus* L. in its natural environment in a study area where industrial wastes contaminate the soil. This study will help to assess and establish the role of homoeopathy in propagating plant growth.

A. esculentus

Okra (*A. esculentus* [L.]; common name lady finger) is an important vegetable crop widely grown in tropical, subtropical and warm temperate regions worldwide. This plant is a native of Africa, also known in many English speaking countries as lady's fingers, *Bhindi* in India and *bamia* in Arabic countries. It is an annual plant and a popular vegetable in Indian kitchens. Okra is a very good source of dietary fibre, magnesium, manganese, potassium, Vitamin K, Vitamin C, folate, Vitamin B1 and Vitamin B6. Okra seed oil is rich in unsaturated fatty acids such as linoleic acid, which is essential for human nutrition.[13,14] Okra has health benefits in diabetes and some cancers. The mucilage from the immature pods is found to be suitable for industrial and medicinal applications.[13]

Zinc and its role in agriculture

Natural sources

Zinc exists naturally in rocks. The amount of zinc present in the soil depends on the parent materials of that soil. Plants take up zinc as the divalent ionic form (Zn^{2+}) and chelated zinc.[15]

Role

Zinc (Zn) is one of the eight essential micronutrients. It is needed by plants in small amounts, but is crucial to plant development. In plants, zinc is a key constituent of many enzymes and proteins that are responsible for driving metabolic reactions in all crops. It plays an important role in a wide range of processes, such as growth hormone production and internode elongation.[16] Carbohydrate, protein and chlorophyll formation are significantly reduced in zinc-deficient plants. Therefore, a constant and continuous supply of zinc is needed for optimum growth and maximum yield.[15] Zinc has a positive role on the okra plant growth (height), pod length, number of fruits per plant[17,18] and duration of growth.[18]

Zinc deficiency symptoms in plants

1. Chlorosis – yellowing of leaves; often interveinal; in some species, young leaves are the most affected, but in others, both old and new leaves are chlorotic. Zinc deficiency in plants can be observed by some symptoms[19] [Figure 1]:
2. Necrotic spots – death of leaf tissue on areas of chlorosis
3. Bronzing of leaves – chlorotic areas may turn bronze coloured
4. Stunting of plants – small plants may occur as a result of reduced growth or because of reduced internode elongation
5. Dwarf leaves ('little leaf') – small leaves that often show chlorosis, necrotic spots or bronzing
6. Malformed leaves – leaves are often narrower or have wavy margins.

Zinc toxicity symptoms in plants

Most crops are tolerant to high zinc levels in their tissue without any visible symptoms.[15] Zinc toxicity depends on pH, which controls the concentration of zinc in solution. High concentrations of zinc can cause toxicity in plants. The general symptoms are stunting of shoot, curling and rolling of young leaves, death of leaf tips and chlorosis.[20] The level of zinc in the soil above 150 mg kg-1 has been proved to be toxic.[21]

Zinc toxicity in the soil of Sanganer, Jaipur, Rajasthan

The Sanganer and Sitapura Industrial Areas are approximately 20 km away from Jaipur city. This area is famous for textile industries; Sanganer prints are famous all over India. Dye industries require a lot of water. The untreated wastewater is being discharged directly or indirectly into the main drainage network (the Dravyavati River) in the city. Use of this water for crop cultivation has affected the quality of the nearby land. Sanganer town comprises 635.5 km²; the urban area is 12.9 km² and rural area is 622.6 km².

The results[22] indicated that the application of industrial effluent/polluted water affected the physicochemical properties of soil [Table 1].

Table 1: Analysis of soil sample from Sanganer Industrial Area for heavy metals/ micronutrients in parts per million (ppm).[22]

Sampling sites	S1	S2	S3	S4	S5	Permissible limits
Zn	1.21	1.56	1.29	1.77	1.72	0.6

Homoeopathy is defined as a system of therapeutics based on the 'Law of Similars.' It is a particular way of applying drugs to diseases according to the principle of '*similia similibus curentur*' (let likes be treated by likes). The theories of vital force, chronic disease and drug dynamisation are integral parts of this science.

Agro-homoeopathy

The use of homoeopathic preparations in agriculture is fairly recent. Homoeopathic preparations are being used efficiently for increasing active principles in medicinal plants, plant detoxification for metals such as aluminium, sulphur and copper, increasing plant growth rate and productivity,[5] improving plant metabolism[8,9] and disease control.[10-12] The high potency of a drug is sometimes the best antidote for the effects of the crude drug.[4]

Hypothesis

- Null hypothesis (H_0): There is no significant difference among the groups of *A. esculentus* plants receiving water (control Group C), those receiving *Zincum* 6CH (experimental Group A) and those receiving *Zincum* 12CH (experimental Group B).

MATERIALS AND METHODS

Type of study and study design

Prospective experimental controlled parallel arm study.

Study site and arrangements for study groups

Dr. M.P.K. Homoeopathic Medical College Hospital and Research Centre, Homoeopathy University, Saipura, Sanganer, Jaipur, Rajasthan. The university is located in the immediate vicinity of Sanganer Industrial Area. Okra seeds were sown directly in a field in a designated area of the university campus. The plants in three study groups (A, B and C) were grown in three plots, each of size 6 × 5 square metres; plots were 1 m apart with boundaries marked using double bricked walls. Seeds were sown in rows having a depth of 2–3 cm maintaining a distance of one metre from plant to plant and row to row in each plot.

Study duration

Sixty days.

Sample size

Ninety plants.

1. Experimental group: Group A: 30 plants receiving *Zincum* 6CH
2. Experimental group: Group B: 30 plants receiving *Zincum* 12CH
3. Control group: Group C: 30 plants receiving only water.

Proposed intervention

a. Experimental groups: 20 drops in 1 L of water
   - Group A: 30 plants of *A. esculentus* receiving *Zincum* 6CH
   - Group B: 30 plants of *A. esculentus* receiving *Zincum* 12CH.
     (Medicines were procured from a GMP certified pharmacy/manufacturer.)

b. Control Group C: 30 plants of *A. esculentus* receiving normal water.

Dosage and repetition

a. Experimental Group A: 20 drops of *Zincum* 6CH in 1 litre of water every alternate day
b. Experimental Group B: 20 drops of *Zincum* 12CH in 1 litre of water every alternate day
c. Control Group C: Normal water every day.

Data collection

After 60 days, the entire plant was measured for plant productivity (number of fruits), plant height and pod length.

Plan of analysis/statistical tools

Analysis of variance (ANOVA)[23]

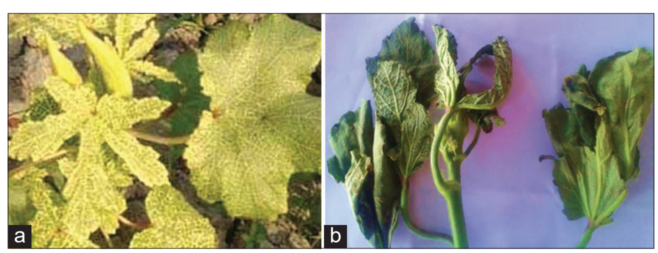

Figure 1: Zinc deficiency symptoms (a) mottled leaves (b) dwarf leaves.

RESULTS

A controlled interventional study was performed to evaluate effect of *Zincum* 6CH and *Zincum* 12CH on plant productivity, mean plant height and mean pod length of the *A. esculentus* plant. The results were analysed comparing the mean values and standard deviation within groups:

Germination time

[Table 2] shows the duration of germination in all the study groups.

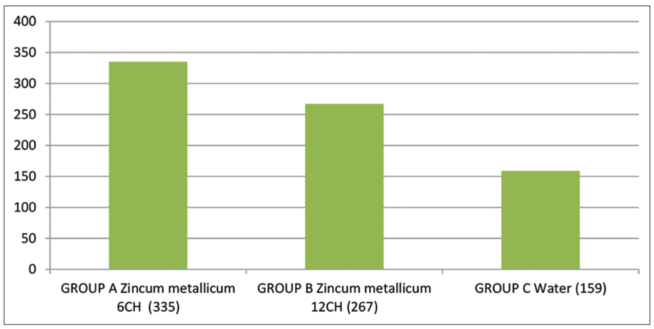

Figure 2: Graphical representation of plant productivity (number of fruits per group).

Figure 3: Measurement of height of the grown *Abelmoschus esculentus* (okra plants).

Productivity of plants

As shown in [Figure 2], the productivity (number of fruits per group) of plants in Groups A, B and C was 335, 267 and 159 fruits, respectively.

Plant height (shoot length)

As shown in [Figures 3 and 4], the mean plant height in Groups A, B and C was 48.4 cm, 40.1 cm and 31.6 cm, respectively.

Pod length

As shown in [Figures 5-8], the mean pod length in Groups A, B and C was 13.3 cm, 10.3 cm and 8.9 cm, respectively.

Statistical analysis

Productivity

The F (2, 87) = 40.136, where the significance value is 0 (i.e. P = 0.003), which is below 0.05; therefore, there is a statistically significant difference in the productivity of *A. esculentus* plant among the control and experimental groups [Tables 3 and 4].

A Tukey *post hoc* test [Table 5] revealed that plant productivity was statistically significantly higher after giving *Zincum* 6CH (Group A) (11.2 ± 2.7, P = 0.0003) and *Zincum*

Table 2: Germination time.

	Experimental Group A	Experimental Group B	Control Group C
Day	Day 5	Day 6	Day 8

Table 3: Statistical analysis of productivity of *Abelmoschus esculentus* plant in experimental Groups A and B and control Group C.

Description					
Groups	**Count**	**Sum**	**Average**	**Std. deviation**	**Variance**
Group A	30	335	11.2	2.7	7.454022989
Group B	30	267	8.9	2.5	6.3
Group C	30	159	5.3	2.4	5.872413793

Table 4: Group statistics (analysis of variance).

	Sum of squares	df	Mean square	F	Sig.
Between groups	525.156	2	262.578	40.136	0
Within group	569.167	87	6.542		
Total	1094.322	89			

Table 5: *Post hoc* tests.

Dependent variable: Productivity

Tukey HSD

(I) VAR00002	(J) VAR00002	Mean difference (I-J)	Std. error	Sig.	95% confidence interval	
					Lower bound	Upper bound
Group A	Group B	2.26667*	0.66041	0.003	0.6919	3.8414
	Group C	5.86667*	0.66041	0	4.2919	7.4414
Group B	Group A	−2.26667*	0.66041	0.003	−3.8414	−0.6919
	Group C	3.60000*	0.66041	0	2.0253	5.1747
Group C	Group A	−5.86667*	0.66041	0	−7.4414	−4.2919
	Group B	−3.60000*	0.66041	0	−5.1747	−2.0253

*The mean difference is significant at the 0.05 level.

Table 6: Statistical analysis of heights of *Abelmoschus esculentus* plants in experimental Groups A and B and control Group C.

Description

Groups	Count	Average	Std. deviation	Variance
Group A	30	48.4	2.652420278	7.277931034
Group B	30	40.1	2.391162043	5.914816092
Group C	30	31.6	2.26421436	5.303448276

Table 7: Group statistics (analysis of variance).

	Sum of squares	df	Mean square	F	Sig.
Between groups	4233.814	2	2116.907	343.353	0
Within group	536.39	87	6.165		
Total	4770.203	89			

12CH (Group B) (8.9 ± 2.5, P = 0) compared to the control Group C (water) (5.3 ± 2.4).

Thus, the null hypothesis is rejected and alternative hypothesis is accepted. There is a significant difference among the groups of plants of *A. esculentus* receiving water (control Group C), those receiving *Zincum* 6CH (experimental Group A) and those receiving *Zincum* 12CH (experimental Group B).

Plant height

There was a statistically significant difference [Tables 6 and 7] among groups as determined using one-way ANOVA; F (2, 87) = 343.35, P =0 (0<5). A Tukey *post hoc* test [Table 8] revealed that the plant height was statistically significantly higher after giving *Zincum* 6CH (Group A) (48.4 ± 2.65 cm, P = 0) and *Zincum* 12CH (Group B) (40.1 ± 2.39 cm, P = 0) compared to the control Group C (water) (31.6 ± 2.2 cm).

Thus, the null hypothesis is rejected and alternative hypothesis is accepted. There are significant differences among the groups of plants of *A. esculentus* receiving water (control Group C), those receiving *Zincum* 6CH (experimental Group A) and those receiving *Zincum* 12CH (experimental Group B).

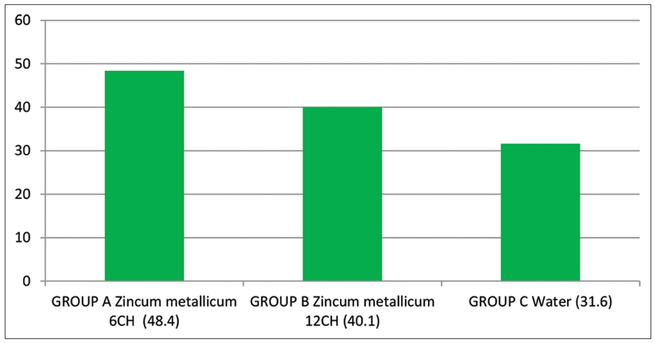

Figure 4: Graphical representation of mean plant height (shoot length in cm).

Group A Group B

Figure 5: Pod length in experimental Groups A and B (the fruits were washed before being measured).

Pod length

There was a statistically significant difference [Tables 9 and 10] among the groups as determined with one-way

Table 8: *Post hoc* tests.

Dependent variable: Plant height						
Tukey HSD						
(I) VAR00002	**(J) VAR00002**	**Mean difference (I-J)**	**Std. error**	**Sig.**	**95% confidence interval**	
					Lower bound	**Upper bound**
Group A	Group B	8.29667*	0.64111	0	6.7679	9.8254
	Group C	16.80000*	0.64111	0	15.2713	18.3287
Group B	Group A	−8.29667*	0.64111	0	−9.8254	−6.7679
	Group C	8.50333*	0.64111	0	6.9746	10.0321
Group C	Group A	−16.80000*	0.64111	0	−18.3287	−15.2713
	Group B	−8.50333*	0.64111	0	−10.0321	−6.9746

*The mean difference is significant at the 0.05 level.

Table 9: Statistical analysis of pod lengths in experimental Groups A and B and control Group C.

Description				
Groups	**Count**	**Average**	**Std. deviation**	**Variance**
Group A	30	13.3	0.963494982	0.960333333
Group B	30	10.33	0.96863722	0.970574713
Group C	30	8.887	0.621686918	0.399816092

Table 10: Group statistics (analysis of variance).

	Sum of squars	**df**	**Mean square**	**F**	**Sig.**
Between groups	304.207	2	152.103	195.78	0
Within group	67.591	87	0.777		
Total	371.798	89			

ANOVA; F (2, 87) = 195.78, *P* = 0 (0<5). A Tukey *post hoc* test [Table 11] revealed that the pod length of *A. esculentus* plant was statistically significantly higher after giving *Zincum* 6CH (Group A) (13.3 ± 0.96 cm, *P* = 0) and *Zincum* 12CH (Group B) (10.3 ± 0.97 cm, *P* = 0) as compared to the control Group C (water) (8.9 ± 0.62 cm).

Thus, the null hypothesis is rejected and alternative hypothesis is accepted. There is a significant difference among the groups of plants receiving water (control Group C), those receiving *Zincum* 6CH (experimental Group A) and those receiving *Zincum* 12CH (experimental Group B).

DISCUSSION

Homoeopathy is a medical science that has been effectively used to fight against human ailments. According to a Dutch Homoeopath, treatment of plants is similar to the treatment of humans.[5] The present controlled interventional study was performed to evaluate the effects of homoeopathic dilutions, *Zincum* 6CH and *Zincum* 12CH, on plant height, pod length and plant productivity in *A. esculentus.* A positive effect was seen on plant height (shoot), plant productivity (number of fruits) and mean pod length. These findings correlate with those of several previous studies conducted on the use of potentised homoeopathic medicines in plants.

Figure 6: Pod lengths in control Group C (the fruits were washed before being measured).

Figure 7: Pod lengths in grown *Abelmoschus esculentus* plants.

Table 11: *Post hoc* tests.

Dependent variable: Pod length						
Tukey HSD						
(I) VAR00002	**(J) VAR00002**	**Mean difference (I-J)**	**Std. error**	**Sig.**	**95% confidence interval**	
					Lower bound	**Upper bound**
Group A	Group B	2.97000*	0.22758	0	2.4273	3.5127
	Group C	4.41667*	0.22758	0	3.874	4.9593
Group B	Group A	−2.97000*	0.22758	0	−3.5127	−2.4273
	Group C	1.44667*	0.22758	0	0.904	1.9893
Group C	Group A	−4.41667*	0.22758	0	−4.9593	−3.874
	Group B	−1.44667*	0.22758	0	−1.9893	−0.904

*The mean difference is significant at the 0.05 level

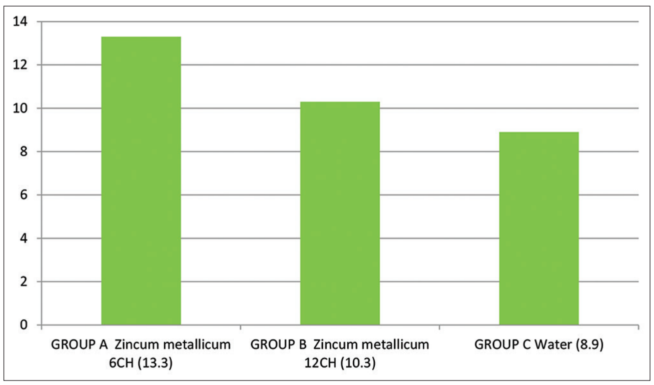

Figure 8: Graphical representation of mean pod length (cm).

Homoeopathic drug (*zinc sulphate*) exhibited growth promotion at higher potency (6X) and growth inhibition at lower potencies (×1–×5) on *Bacopa monnieri*.[24]

A study aimed at evaluating the influence of homoeopathic preparations *Alumina* 6CH, *Alumina* 12CH, *Calcarea carbonica* 6CH and *C. carbonica* 12CH on the germination and vigour of lettuce seeds subjected to toxic levels of aluminium in paper solution concluded that all the above-mentioned preparations had a significant effect on the vigour of lettuce seeds subjected to stress conditions.[25]

CONCLUSION

Agro-homeopathy is a chemical less and non-toxic method for crop cultivation. This may offer a suitable method for anti-doting the effects of high levels of heavy metals on plant growth. In the present study, the application of potentised homoeopathic medicine *Zincum* 6CH and 12CH on *A. esculentus* demonstrated a beneficial result by increasing plant height, plant productivity and pod length. Moreover, the lower dilution (6CH) showed more effectiveness in various aspects of growth of *A. esculentus* than higher dilution (12CH).

Agro-homoeopathy may be a good choice in every aspect of agriculture. For proper application of homoeopathic drugs in agriculture, this avenue needs to be explored with further studies on larger samples for confirmatory evidence, which will help in furthering homoeopathic science in addition to offering a solution for growing concerns relating to growing crops in polluted areas.

Declaration of patient consent

Patient's consent not required as there are no patients in this study.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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