CHAPTER-II

REVIEW OF LITERATURE

The literature in any field forms the foundation upon which all future work is built. If we fail to build the foundation of knowledge provided by the review of literature, our work is likely to be shallow and native and will often be duplicate work that has already been done better by someone else.

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Review of related literature is an important and crucial aspect of a research report which means to locate, to read, and to evaluate the past as well as current literature of research concerned with the present investigation. The study of related literature helps the investigator to acquire comprehensive information about what has been done in a particular area. It also serves as a source of guideline for the study in hand. It places the study in a historical and associational perspective and helps to avoid unintentional and unnecessary replications. It provides an opportunity of gaining insight into the methods, measures, subjects, and approaches employed by other researchers. In every research, it is essential to acquaint oneself with what has already been thought, expressed, and done about the problem under investigation. The review is therefore, essential and is possible only by reviewing and surveying journals, books, dissertations, abstracts, and other sources of information directly or indirectly connected with the problem. The results of previous studies in an area enlighten the researcher about what has been done and what is yet to be done, thus serving a guidance function towards formulation of the problem.

Therefore, in this chapter, a detailed account of researches related to the Shankhavipshpi has been presented. The review was collected from 1948 to 2014. For this purpose, search engines like Google, Medline, Pubmed, and Science direct etc. were used. The obtained data provided the base for a journal based search for compilation of the primary sources from National Medical Library, New Delhi. The major journals consulted were- Journal of Ayurveda and Integrative Medicine, Planta Medica, Journal
of Research in Indian Medicine, Yoga, and Homeopathy, Indian Journal of Experimental Biology, Asian Journal of Pharmaceuticals and Clinical Research, Pharmacologyonline, Journal of Herbal Medicine and Toxicology, Alternative Medicine, Indian Journal of Pharmacology etc. Besides these journals, various books dealing with the subject under study were also referred.

While reviewing the literature related to Shankhapushpi, it was observed that earlier studies did not show any relationship of this herb with attentional processes. A few studies were related to its memory enhancing capacity. Majority of the studies were related with the disease related effects of Shankhapushpi. However, to deeply probe and understand the mechanism of action of this plant, it was decided to go through whatever studies are available. Therefore, all studies conducted on this herb were reviewed in this chapter to find out any direct or indirect effect of this herb on attention. In the following sections, first the studies regarding pharmacological constituents of Shankhapushpi would be reviewed. Then, studies in which Shankhapushpi has been used as an ingredient of a herbal formulation would be given. After that, studies in which effect of only Shankhapushpi plant was studied would be reviewed in which the disease related effects, and memory or other cognitive effects related studies would be reviewed. In the last section, to understand the mechanism of action of this plant, studies on biochemical investigation of this plant would be given.

Basu and Dandiya (1948) isolated an alkaloid from this plant, named as C_{17}H_{23}NO_{3}. They studied the effects of this isolated base on frog’s heart and found no action on the heart or vessels in a concentration of 1:5000. The same authors reported the presence of an essential oil present in Shankhapushpi. However, the exact oil was perhaps not identified and there was no mention of the name and chemical properties of this oil.

Another effort to understand the composition of Shankhapushpi was made by Basu and Bhan (1951). They confirmed the presence of C_{17}H_{23}NO_{3} which was found to be soluble in chloroform. Besides this, they reported the presence of two other water soluble bases: one- acetone-insoluble base C_{3}H_{14}NO_{6}, m.p.84^{0}c, hydrochloride m.p. 214^{0}c, picrate m.p. 176^{0}c and the second base was an acetone soluble base.
Rakhit and Basu (1958) conducted a study to isolate the alkaloidal principles present in the Convolvulus pluricaulis, to characterize them, and to study their pharmacological properties. Two bases had been isolated from the plant. The base A (C₅H₁₁NO₂) and base B (C₅H₉NO₂). When studied for their pharmacological actions, it was found that the base A depressed the blood pressure of an anaesthetized dog, stimulated the muscle of isolated ileum of rat, and had temporary inhibitory action on pithed frog’s heart. The base B was devoid of such pharmacological action.

In another study, Deshpande and Srivastava (1969) reported the presence of scopoletin, D-glucose, maltose in 1% HCL soluble portion, ceryl alcohol, and β-sitosterol in nonsaponifiable part.

Many herbal formulas containing Shankhpushpi in combination with other drugs are available in Indian market. Some of these preparations have been subjected to clinical trials. The details of such studies are given below:

Chandra and Kumar (1986) investigated the clinical efficacy of Abana in angina pectoris. Abana is one such herbal remedy from Ayurvedic system which contains Arjun, Ashwagandha, Giloe, Amla, Billilotan, Hirda, Bhrangraj, Yashtimadhu, Shatavar, Brahmi, Shankhpushpi etc. as an ingredient. Sixty cases of classical effort angina, attending the cardiovascular medicine clinics, were selected for the trial. After a detailed clinical evaluation for anginal frequency, nitroglycerine (NG) consumption, exercise capacity in the form of walking distance, and recording of the standard 12 lead ECG at rest, all the cases were put on Abana, 2 tablets thrice daily, along with any existing treatment. They were followed up for their subjective or objective improvement over 1 month. The average rate of anginal attacks was reduced from 8.4/week to 4.7/week after starting Abana. There was a significant reduction in number of nitroglycerine tablet consumption in 50% of the cases after institution of Abana. Walking distance which was assessed subjectively was also significantly increased in 2/3rds of the cases after commencement of Abana. It was concluded that Abana appears to be a useful adjunct in the treatment of angina pectoris.
Dubey, Agarwal, and Udupa (1986) conducted a study to investigate the clinical efficacy of Abana in the prevention and management of coronary heart disease. Seventy-seven diagnosed cases of essential hypertension, angina pectoris, stabilized cases of myocardial infarction, and sinus tachycardia were selected for the clinical trial. The subjects were divided into two groups - control group which was given placebo whereas experimental group was treated with Abana. Abana was given orally in the dose of two tablets twice a day continuously for 3 months along with existing treatment. A laboratory profile including a complete blood count, ESR, urine analysis, blood sugar, blood urea, creatinine, SGOT, SGPT, and alkaline phosphatase was obtained at the end of one month of the follow-up study. Electrocardiographic recordings were also obtained at the end of one month’s therapy. All the special investigations like total lipid profile, epinephrine, and norepinephrine levels were repeated for comparison in the treated as well as the placebo groups. Abana brought about significant clinical improvement in cases of essential hypertension, angina pectoris, and ischaemic heart disease. Specific clinical features like palpitation, precordial discomfort, and insomnia were considerably reduced after the drug therapy. There was significant reduction in pulse rate in all the cases following Abana treatment (p<0.05). There was significant (p<0.05) decrease in total lipids, triglycerides, and cholesterol levels as compared to the patients on placebo treatment. Epinephrine as well as norepinephrine levels showed significant reduction (p<0.05) after Abana therapy in all cases except tachycardia cases. It was concluded that the herbomineral compound Abana might provide a useful alternative remedy or act as an adjuvant in the prevention and management of coronary heart disease.

Tiwari, Shukla, Agarwal, and Dubey (1990) investigated the cardioprotective effect of Abana in their study. Fifty one diagnosed cases of hypercholesterolaemia were selected for this clinical trial. A comprehensive clinical examination was carried out. Apart from routine investigations, glucose tolerance and obesity index were also measured. The overnight fasting blood sample was taken and the serum TC\textsuperscript{12} and HDL-C\textsuperscript{8} were measured. For comparable results, apparently normal individuals with no evidence of lipid disorders were selected to serve as controls. Abana was introduced at a dosage of 2 tablets twice daily continuously for twelve weeks. The normal as well as hypercholesterolaemic cases were advised a prescribed regimen of diet and exercise...
during the entire course of study. At the end of 12 weeks, all the investigations were repeated. After 3 months of therapy, TC showed a significant (p<0.001) decreasing trend and ratio of TC/HDL-C was also found decreased to a significant extent (p<0.001). It was concluded that Abana might be advocated for cardioprotective therapy.

Ojha, Kumar, and Rai (2007) conducted a clinical study to examine the role of an Ayurvedic compound (Manas Niyamak yoga) and Shirodhara in the management of ADHD in children. The Ayurvedic compound contained Brahmi, Mandukparni, Shankhapushpi, Jatamansi, Vacha, Ashwagandha, Vidanga, Madhuyasti, Chitraka, and Pippali as an ingredient. A randomized double blind placebo control study was conducted. Total 40 children between 6 to 15 years, who met ADHD assessment criteria based on DSM – IV, were chosen for the investigation. Selected children were randomly divided into four groups. Group A was treated with Manas Niyamak Yoga. Group B was given both Ayurvedic compound and Shirodhara. Group C was treated with placebo and group D received placebo along with Shirodhara. Doses were according to the body weight of the child (200 mg/kg/day) in 2 divided doses with milk for 3 months. Children were called for follow up every fortnightly. The core symptoms of ADHD that are inattention, hyperactivity, impulsivity, and deviation of attention were assessed before and after the treatment. Besides that, reaction time test and finger dexterity tests were also administered. Statistical analysis of the results obtained on all the core symptoms of ADHD showed statistically highly significant improvement in groups A and B (p<0.001). Results obtained for the change in reaction time showed highly significant change in RT (p<0.001) in groups A, B, and D. Results on time taken and number of errors in finger dexterity test with both hands for assessing the effect of therapy in improving motor ability indicated highly significant improvement in groups A and B (p<0.001). Obtained scores on overall improvement in the core symptoms of ADHD showed maximum improvement in group B. It was concluded that both drug and Shirodhara were effective in alleviating the symptoms of ADHD.

Rao, Sharma, Katiyar, and Prasad (2009) conducted a clinical study to examine the immunoglobulin enhancing effect of “Bala compound” on infants. Bala compound is an Ayurvedic receipe containing Atibala, Amalaki, Vidanga, Guduchi, Pippali, Yashtimadhu, Shankhapushpi, Vacha, Musta, and Ativisha. 24 neonates were selected
on random basis and divided into two groups, A and B with 12 cases in each group. Group A was administered orally with 5 drops of ‘Bala compound’ twice daily and group B with 5 drops of conventional vitamin drops twice daily irrespective of neonatal age and weight from 11th day of life onwards for a period of six months. Result was assessed for serum immunoglobulins IgG, IgM, IgA for three months of interval of two follow ups. There was significant increase (p<0.001) of mean serum levels of immunoglobulins IgG, IgM, and IgA in both groups after three months of administration of the trial drug ‘Bala compound’ and conventional multi vitamin drops (i.e. I follow up), but better increase observed in group A. And also there was a highly significant increase (p<0.001) of immunoglobulins observed after six months of trial (i.e. II follow up) in both groups.

Guruprasad, Mascarenhas, Gopinath, and Satyamoorthy (2010) conducted a study to assess the role of Brahma Rasayana (BR) on genotoxicity in vivo in a mouse test system. Brahma Rasayana is an example of such a Medhya Rasayana comprising more than 35 different plant extracts including Convolvulus pluricaulis. Male swiss albino mice aged 9 months and weighing 35-40 g were employed. The animals were divided randomly into four groups. Group A was control group whereas groups B, C, and D received Brahma Rasayana at the doses of 1g, 2g, and 4g respectively. The treated groups showed no signs of dose – dependent toxicity at the dosage levels tested. The body weight loss/gain and feed consumption were unaffected at tested doses. Furthermore, sperm abnormalities and chromosomal aberrations were insignificant in the treatment group when compared to controls. However, there was a marginal increase in sperm count in the BR treated animals. It was concluded that the BR does not elicit genotoxic effects in the mouse system, rather than it is a moderate enhancer of reproductive and mitotic cellularity, and a protector against certain kinds of sperm abnormality.

Shah and Goyal (2010) conducted a study on comparative clinical evaluation of a polyherbal formulation (PHF) with multivitamin formulation (MV) for memory and learning enhancement. PHF is a polyherbal formulation containing Ashwagandha, Jatamansi, Sarpagandha, Shankhpushpi, Shatavari, Amalki, Kauch bij extract, Khurasani ajmo, Shilajit, Mukta shukhti pishti, and Praval pishti. MV is vitamin B
complex capsule. This investigation was randomized, placebo controlled, double blind clinical study approved by institutional Human Ethics committee. Forty seven healthy human volunteers from various colleges of Mehsana (18 – 24 years), who were ready to sign informed consent form, were included in the study. 10 subjects were randomized as control (Placebo treated), 15 subjects as PHF treated, and 22 subjects as MV treated. All these subjects were given either one capsule of placebo or two capsules of PHF (500 mg) at night or MV (500mg) 1 capsule two times a day for a period of three months. All the subjects were monitored for neuropsychological tests initially, and after first and third month of active treatment with PHF/MV. Verbal test of intelligence, Bhatia battery of performance tests of intelligence, and short – term memory tests were used to assess the memory parameters and IQ of these students. All the values were expressed as mean ± SEM. The statistical analysis was carried out using one way analysis of variance followed by Tukey’s multiple comparison post test. Results showed that there was a significant (p<0.001) increase in IQ scores in PHF treated group between 0 days and 90 days treatment, whereas no significant change in IQ scores was found in control group or MV treated group. In picture construction test, there was a significant increase in scores between 0 day (6.38±0.45) and 30 days (8.15±0.58, p<0.05) and also between 0 day and 90 days (10.3±0.34, p<0.01) in PHF treated group. In pass along test and 3-unrelated meaningful words short term memory test, significant change was observed not only in MV or PHF treated group but also in control group. In CCC trigram test, PHF treated groups exhibited a significant change in score between 0 day (50 ± 7.74) and 90 days (80 ± 5.44, p <0.001), whereas there was no change in score between 0 day and 30 days. In MV treated group, significant changes were observed between 0 day and 30 days as well as 0 day and 90 days interval (p<0.001). It was concluded that PHF appeared to be more active than MV in enhancing learning and memory, due to its antioxidant property or by contributing to the production of important brain neurotransmitters such as acetylcholine, adrenal hormones, steroids, and cortisone or by maintaining adequate levels of various micronutrients, which ultimately affect mental functions and enhance learning ability.

Bhargava and Khan (2012) conducted a study to compare the efficacy and the side effects of imipramine, sertraline, and an Ayurvedic formulation in patients of depression. The Ayurvedic formulation consisted of aqueous extracts of Brahmi, Shankhpushpi,
Malkangni, and Jatamansi which were mixed in equal proportions (250 mg each). This study was an open labeled, randomized clinical trial which involved 90 depressive patients, who were in the age group of 18 – 60 years and divided into three groups of 30 each. The patients were assigned to a 12 week trial with imipramine at the dose of 150 mg/day, those in the sertraline group received a dose of 150 mg/day and the third group was the group that was given an Ayurvedic formulation in the dose of 500 mg twice a day. The effect of the treatment on the treated patients was repeatedly assessed at a continuous interval of two weeks for three months. The values were expressed as mean ± S.D. The data was analyzed by one-way ANOVA, followed by Dunnett’s post hoc test. There was a significant progressive decrease in the depression scores from the 3rd visit to the 6th visit for the imipramine treated group (p<0.0001) and from the 2nd visit to the 6th visit for the sertraline (p<0.0001) and the Ayurvedic formulation treated groups (p<0.0001). The more the ‘q’ value for the Dunnett’s post hoc test was, the higher was the decrease in the depression score of the patients. At visit 3, 4, and 5, sertraline had the highest ‘q’ value and so it showed the best anti-depressant activity as compared to imipramine and the Ayurvedic formulation. But at visit 6 (after 3 months), the Ayurvedic formulation had the highest ‘q’ value and so it showed the best anti-depressant activity as compared to imipramine and sertraline. Further, the Ayurvedic formulation virtually had the least side effect profile in comparison to imipramine and sertraline.

In addition to these studies, many researchers have studied the effect of Shankhpushpi alone and the results of such studies reported that Shankhpushpi has anti-anxiety, anti-stress, hypotensive, and anti-depressant properties. This plant controls the production of body’s stress hormones like adrenaline and cotisol and works as tranquilizer. Following is the review of such studies which provide support to this notion.

Sharma, Barar, Khanna, and Mahawar (1965) examined some pharmacological actions of Convolvulus pluricaulis choisy. To see the effect of drug, some behaviors were taken as dependent variables such as spontaneous motor activity, potentiation of barbiturate hypnosis, conditioned avoidance response, fighting response of mice, analgesic activity, maximal electroshock seizures, and chemically induced tremors. The extracts in doses of 200 mg/kg and 1 g/kg caused reduction in the spontaneous motor activity of groups
of mice. The extract in a dose of 1.0 ml abolished the conditioned avoidance response in 20% of the animals. This action started after 30 minutes and lasted for two hours. The escape response remained unaffected. Fighting response of mice was found to be suppressed in 50% of the animal pairs when the extract was administered at a dose of 0.5 ml. The reaction time was not markedly affected by 0.5 ml dose of the extract. But when it was administered prior to the determined sub analgesic dose of morphine (1.5 mg/kg), it exhibited a marked increase in the reaction time. The extract in doses of 0.5 ml, administered prior to pentobarbitone (40 mg/kg) elicited a potentiation of sleeping time. The control animals showed a sleeping time of 56.7 minutes, whereas the extract pretreated animals showed a sleeping time of 180 minutes. The mean duration of extensor tonic spasm in control animals was 9.5 seconds, whereas it was reduced to 2 seconds in rats, 30 minutes after the administration of the extract in 0.5 ml dose. None of the extract treated animal died. The extract in doses of 0.5 ml exhibited a marked lessening effect on tremors induced by tremorine (20 mg/kg) administered 15 minutes later. It was concluded that the extract might possess a centrally – medicated action in the form of depression, or an increase in the stimulation threshold. The extract did not possess any sedative or hypnotic action of its own, though it significantly potentiated the hypnotic action of pentobarbitone. The extract abolished the conditioned avoidance response but the escape response remained unaffected, which is a property possessed by ataraxic agents. The extract has anticonvulsant potential but it did not possess an analgesic activity.

Chaturvedi, Sharma, and Sen (1966) conducted a study on some indigenous drugs. The study was aimed at the search of hypotensive drugs, with a view to see if any of these drugs has any positive effect on arterial blood pressure warranting their use in the treatment of hypertension. The drugs taken for this study were – Convolvulus pluricaulis, Nardostachys jatamansi, Acorus calamus, Celastrus paniculatus, Benincassa hispida, Allium sativum, and Abrus precatorius. Study was made to find out the effect of these drugs on the arterial blood pressure of anaesthetized dogs as well as on frog’s myocardium. Convolvulus pluricaulis was tested in the form of expressed juice at the dose of 50 and 100 mg/kg, aqueous decoction (100 mg/kg), and water soluble alcoholic extract at the doses of 1.5, 3.0, 6.0, and 7.5 mg/kg body weight. Results showed that Convolvulus pluricaulis caused a persistent fall in the arterial blood pressure. In larger
doses (7.5 mg/kg), the plant was found to profuse transitory inhibitory effect on both force and rate of contraction of the heart. The plant was also found to have some cardiotonic effect. Convolvulus pluricaulis had been concluded the most effective hypotensive drug in this study.

Mudgal (1975) conducted a study to investigate the medicinal properties of Convolvulus pluricaulis and Boerhaavia diffusa and also the seasonal variations in their pharmacological activities. The study assessed the barbiturate hypnosis potentiation and hypotensive action of the plant – Convolvulus pluricaulis. To assess the hypotensive action, acclimatized dogs (weighing around 10 kg) were anaesthetized with sodium pentabarbitone (35 mg/kg). Carotid artery blood pressure was recorded with mercury manometer. The drug was injected through the cannulated femoral vein. For each part of the plant as well as for the whole plant, hypotensive action was recorded by injecting 24 mg/kg (i.e. 0.2ml/kg of 12% water soluble alcoholic extractives) of the drug. For the estimation of potentiation of barbiturate hypnosis, thirty inbred albino rats of IMS strain ranging from 100-120 g were divided into five sub groups comprising of six animals. Second, third, fourth, and fifth sub groups were injected intraperitoneally water soluble alcoholic extractives (3%) of roots, stems, leaves (including flowers), and the whole plants respectively, in the dose of 300 mg/kg. First sub group (control) was given equivalent quantity of distilled water in a similar manner. After 15 minutes, all the groups of animals were given 15 mg/kg of sodium pentobarbitone intraperitoneally. The sleeping time of the animals was recorded and the mean sleeping times obtained in different groups was compared. Results showed the barbiturate hypnosis potentiating and hypotensive activities were significantly (p<0.05) more in leaves (including flowers) extracts in comparison to the root, stems, and the whole plant extract in case of Convolvulus pluricaulis and it was also observed that these activities were more pronounced in the plant when collected during spring season. The activities were found to be minimum in rainy season.

Mudgal, Singh, Srivastava, and Udupa (1977) conducted a comparative study to investigate the medicinal activity of leaves with flowers and leaves without flowers of Shankhpushpi and Punarnava. The aerial parts of the plants were collected. The stems were separated and discarded. The test extract of leaves and flower was prepared.
Required amount of leaves were separated and the flowers were discarded to prepare the test extracts of leaves only. The investigation revealed a significantly enhanced (p<0.05) barbiturate hypnosis potentiation and antihypertensive activity in Shankhpushpi leaves with flowers as compared to leaves without flowers. Blood pressure was found to be significantly (p<0.05) reduced under the influence of the extract of Shankhpushpi leaves with flowers (24mg/kg). Sleeping time was found to be enhanced significantly at 0.05 levels under the influence of the extract of Shankhpushpi leaves with flowers (300mg/kg) as compared to without flowers. It was concluded that increased rate of biosynthesis of active principle in flowering or growing season is responsible for the increased medicinal properties of these plants.

Singh, Agarwal, and Mehta (1977) conducted a study on Shankhpushpi to see its effects on general behavior and to examine its analgesic, anticonvulsive, and hypotensive activities. The drug was also analyzed for the presence of K+ and Ca++. To assess the general behavior of the drug, healthy albino rats of average weight of about hundred grams were taken and divided into three groups each having five rats. Group 1 was given Shankhpushpi extract in the dose of 50mg/100g body weight given orally. Group 2 received triflupromazine (Siquil 2mg/100g. orally) as the reference drug. Group 3 was kept as control. The study showed slight sedative effect in the drug as was evident by the general behavior and reduced locomotor activity of the treated animals. Anticonvulsant effect was observed in an hour pretreated albino rats by testing them against electric shock (150mA, for 0.2 sec.) induced hind limb extensor response. The drug was given orally in graded concentration viz. 250mg., 500mg., and 1g/kg body weight. The drug was also tested against metrazol induced convulsions. For checking the analgesic activity, the drug was given orally in the dose of 250mg., 500mg., and 1g/kg body weight. The drug showed no analgesic and anti-convulsive activity. The experiments in dogs showed hypotensive effect in this drug which could not be blocked by Mepyramine Maleate, indicated that the drug has no histaminic effect. The hypotensive effect of the drug could be partially blocked by atropin sulphate, but it could not be blocked by propranolol. The crude drug showed the presence of K+ and Ca++, 32.76mg% and 40.2mg% respectively. However, these inorganic ions in the above concentration did not show hypotensive activity.
Mudgal and Udupa (1977) conducted a study to examine the hypotensive activity of Shankhpushpi with different doses of extracts of various parts of this plant. For assessment, an anaesthetized dog was taken. The carotid artery was cannulated and connected to a manometer in kymograph drum. The test extracts i.e. root, stems, leaves, and flowers, and the whole plant were administered in successive doses (6, 12, 18, 24, 30, 36, 42, 48, and 54 mg/kg body weight) through the femoral vein. The degrees of fall in blood pressure following the administration of increasing doses were recorded. A direct dose response relationship was observed in all parts of the plant. However, after an optimum dose, the response was found to be constant. This constant maximum response was achieved at different dose levels in different parts of the plant. The constant response was found in leaves at the dose of 42 mg/kg, in the roots at the dose of 48 mg/kg, and in the stems at the dose of 54 mg/kg, indicated the varied concentrations of the active principles in different parts of the plant.

Singh and Mehta (1977) reported psychotropic effect of the Medhya Rasayana drug, Shankhpushpi. A series of 30 outdoor patients of anxiety neurosis were selected for the study. After clinical diagnosis and basal evaluation, these patients were subjected to a course of treatment with Shankhpushpi syrup in the dose of 30ml per day in 3 divided doses. They were instructed for uniform diet and regimen. The patients were reassessed on the following parameters after 1 month- 1) clinical relief, 2) psychological changes studied by (a) total and differential anxiety level with the help of Middle Sex Hospital Questionnaire, (b) Neuroticism index as per MPI, (c) Mental fatigue rate as per Joshi’s digit cancellation test, (d) immediate memory span as per Joshi’s digit renounce test, 3) physiological changes viz. pulse rate, blood pressure, and body weight, 4) biochemical changes viz. plasma cortisol and urinary catecholamines. A significant (p<0.05) symptomatic relief was observed after one month of treatment as regard to the major symptoms like nervousness, palpitation, insomnia, weakness and fatigue, dyspepsia, and general feeling of not being well. The total and differential anxiety levels were found reduced after treatment. The free floating anxiety, obsessive compulsive neurosis, phobic features, somatic features, depressive features, and hysterical features were found reduced though the differences were statistically not significant except in case of hysterical features (p<0.05). The mental fatigability was reduced as indicated by significant increase in work output for a given time along with significant reduction in
mistake score (p<0.05). The immediate memory span was also significantly improved (p<0.01). The MPI scores showed significant (p<0.05) reduction in the degree of neuroticism with corresponding increase in extroversion. The plasma cortisol and urinary VMA were reduced. The body weight was found increased. On the other hand, pulse rate and blood pressure were found decreased, though these changes were statistically not significant. The study concluded that this drug appeared to be a centrally active anti-anxiety agent.

Shukla (1979) conducted a chemical and pharmacological study to examine the barbiturate hypnosis potentiation effect of various fractions of total alcoholic extract of the Convolvulus pluricaulis. Young growing healthy albino rats were selected. The animals were divided in five uniform groups. Group I was kept as control and was given no treatment except 1.5 ml water orally through a stomach tube. Group II was treated with a standard anti-anxiety drug, diazepam in the dose of 1 mg/100g body weight orally suspended in 1.5 ml of water. Group III was given total alcoholic extract of the dry whole plant of Shankhpushpi in the dose of 83.3 mg of dry extractive/100g body weight suspended in 1.5 ml of water orally through a stomach tube. Group IV was given water soluble portion of the total alcoholic extract and Group V was given water insoluble portion of the total alcoholic extract, in doses proportionate to that given in group III. A standard barbiturate hypnosis potentiation test was applied to the animals in all the groups using nembutal 2.5 mg/100 g body weight intraperitoneally 30 minutes after administration of single doses of the respective test drugs. The onset and the total duration of sleep in case of each animal following the injection of nembutal were recorded in minutes. The total alcoholic extract of Shankhpushpi and its water soluble and insoluble fractions showed the barbiturate hypnosis potentiation effect. The effect was more in water insoluble portion than in its water soluble portion. In the II part of this study, water soluble and insoluble fraction of different extractives of the drug Shankhpushpi were tested for their barbiturate hypnosis potentiation effect by Shukla (1979). It was found that only the water soluble fraction of chloroform extract showed significant activity (p<0.05). The activity in rest of the fractions was statistically insignificant.
Indurwade and Biyani (2000) examined the comparative and combined depressive effect of Brahmi, Shankhpushpi, and Jatamansi in mice. To carry out the study, 66 albino mice of either sex weighing between 20-25gms were taken and divided into different 11 groups comprising 6 mice in each group. Group I was control group which received only vehicle, group II, III, and IV received 50, 100, and 200 mg/kg of body weight of drug Brahmi. Group V, VI, and VII received 50, 100, and 200 mg/kg of body weight of drug Shankhpushpi. Group VIII, IX, and X received 50, 100, and 200 mg/kg of body weight of drug Jatamansi. Group XI received 100 mg/kg of body weight combination of drug I, II, and III (1:1:1). For evaluation of depressive activity, Actophotometer was used. The readings were noted at 30 mins, 60 mins, 90 mins, and 120 mins, after intraperitoneal injection of effective drug in respective groups. The results showed that lower dose (50 mg/kg) of all three drug extract showed comparatively less depressive effect while at higher doses, each drug showed marked depressant activity. The order of potency was found to be: Jatamansi > Shankhpushpi > Brahmi. The combined extract effect at the dose of 100 mg/kg was found to be more as compared to the respective dose of individual drug extract. At this dose level the order of potency was found to be, Combined extract > Jatamansi > Shankhpushpi> Brahmi.

Dhingra and Valecha (2007) conducted a study (i) to examine the effect of the petroleum ether, chloroform, ethyl acetate fractions of total ethanolic extract of whole plant of Convolvulus pluricaulis (CP) on depression in mice employing forced swim test and tail suspension test and (ii) to explore the possible underlying mechanisms of antidepressant-like activity of these different fractions. Swiss male albino mice (3 months old and weighing around 25gm) were procured. The petroleum ether fraction (25, 50 mg/kg), chloroform fraction (25, 50, 100mg/kg), and ethyl acetate fraction (25, 50, 100mg/kg) were administered orally for 10 successive days in separate groups of mice. The effects of extracts on the mice’s immobility periods were assessed in the forced swim test (FST) and tail suspension test (TST). Effects of reserpine (2mg/kg i.p.), sulpiride (50mg/kg i.p.), prazosin (62.5µg/kg i.p.), and p-chlorophenylalanine (100mg/kg i.p.) on the extracts’ antidepressant-like effect in TST was also studied. The extracts’ antidepressant-like effect was compared with that of imipramine (15mg/kg p.o.) and fluoxetine (20mg/kg p.o.) administered for 10 successive days. Petroleum
ether fraction (25 and 50 mg/kg, p.o.) and ethyl acetate fraction (25, 50, and 100 mg/kg, p.o.) administered for 10 successive days to mice did not show any significant effect on the immobility periods in FST and TST. Lower dose of chloroform fraction (25 mg/kg, p.o.) did not show any significant effect on immobility period in FST and TST. On the other hand, the higher doses (50 and 100 mg/kg p.o.) of this fraction decreased the immobility periods significantly as compared to control group in both TST and FST, indicating significant antidepressant-like activity. This fraction did not have any significant effect on locomotor activity. Its efficacy was found to be comparable to that of imipramine and fluoxetine administered for 10 successive days. The chloroform fraction (100mg/kg) reversed reserpine-induced extension of immobility period of mice in FST and TST. Prazosin, sulpiride, and p-chlorophenylalanine significantly attenuated the chloroform fraction-induced antidepressant-like effect in TST. It was concluded that the chloroform fraction of the total ethanolic extract of Convolvulus pluricaulis elicited a significant antidepressant-like effect in mice might be due to its ability to restore brain monoamines, like norepinephrine, 5-hydroxytryptamine, and dopamine levels or due to reduction in plasma cortisol levels.

Subramani, Anand, and Murlidharan (2008) conducted a study to investigate the effect of methanolic extracts of Convolvulus pluricaulis (MECP) on obsessive compulsive disorder (OCD) with animal models by using in vivo pharmacological evaluations such as marble burying behavior, hole board test, and rotarod test using mice. The animals were divided randomly into seven groups of five animals each. And the drugs were given 30 min before the mice were subjected to the studies. First group served as control. Second and third groups were treated with 15 mg/kg and 30 mg/kg of fluoxetine respectively, which was a standard drug and also it is a selective serotonin reuptake inhibitor. Then fourth and fifth groups were treated with 2.5 mg/kg and 5 mg/kg of diazepam respectively which served as a negative control. Sixth and seventh groups were treated with 200 mg/kg and 400 mg/kg methanolic extracts of Convolvulus pluricaulis. On marble burying test, results showed that methanolic extracts of Convolvulus pluricaulis at the dose of 200 mg/kg and 400 mg/kg showed a significant (p<0.05, p<0.01 respectively) increase in the number of marbles buried to that of the standard. Motor coordination was measured by using rotarod test. There was a significant (p<0.01) decrease in the fall of time on rotarod test in negative control
groups when compared with the groups treated with 200 mg/kg and 400 mg/kg of methanolic extracts of Convolvulus pluricaulis. Hole board test was used to determine the motor activity and behavior of animals. No significant decrease was found in locomotor activity in the groups treated with 200 mg/kg and 400 mg/kg of methanolic extracts of Convolvulus pluricaulis. The study confirmed that the methanolic extracts of Convolvulus pluricaulis inhibited the marble burying activity without any significant decrease in the locomotor activity, which is a favorable criterion in the treatment of OCD.

Sethiya, Thakore, and Mishra (2009) conducted a study to determine a comparative account of the effects of methanolic extract of the aerial parts of the plants available as commercial sources of Shankhapushpi in India and one of its marketed formulation (Brand name – Shankhpushpi), on the experimental induced stress in albino rats. The parameters selected were conditioned avoidance response (CAR), stress induced epinephrine level, and potentiation of barbiturate induced hypnosis for the purpose of the investigation. Thirty young growing albino rats (150-200gm) of either sex were selected. Cook’s and Weidley pole climbing apparatus was used for measuring the conditioned avoidance response. All rats were initially trained to jump to the pole for the avoidance of electric shock. After optimum training, they were divided into five groups with six animals of each group. Control group was given vehicle. Group 2, 3, and 4 received methanolic extract of Evolvulus alsinoides, Convolvulus pluricaulis, and Clitorea ternatea respectively at a dose of 100 mg/kg/ml/p.o. Group 5 was treated with Shankhapushpi syrup (100mg/kg/ml/p.o.). All the extracts and formulation were given in the mentioned dose for a period of 30 days, 45 minutes prior to training. On 30th day, the activity of the animals of different group was evaluated. On all the parameters, Shankhapushpi caused significant alterations in Shankhapushpi treated groups (group 2, 3, 4, and 5) as compared to control group. Significant improvement in retention time for climbing the pole was observed in all Shankhapushpi treated groups in comparison to others. Epinephrine level was found to be significantly reduced in Shankhapushpi treated groups, which was the positive measure for its anxiolytic action. More prolonged sleeping time was found in the rats treated with Shankhapushpi. The study concluded the methanolic extract of the Convolvulus Pluricaulis to be the best among
It was also hypothesized that reduction in catecholamine level might be responsible for sedative effect of Convolvulus pluricaulis.

Nahata, Patil, and Dixit (2009) studied the comparative anxiolytic activity of Evolvulus alsinoides and Convolvulus pluricaulis in rodents. Anxiolytic activity was determined by using the elevated plus maze test and open field test as well as by assessing neuromuscular coordination by using a rotarod apparatus. The animals were divided into six groups containing six animals each. On both tests, the ethyl acetate and aqueous fractions (100 mg/kg p.o) of Evolvulus alsinoides and Convolvulus pluricaulis were administered 45 min before trial in separate group of animals. Control groups were given only the vehicle (0.2% v/v Tween 80 solution) in volume equivalent to that of the plant extract. Diazepam (1 mg/kg i.p) was used as the standard drug for comparison. In elevated plus maze test, the number of entries in the open and closed arm during a period of 5 min and duration of stay in the both arms were noted. In open field test, five behavioral aspects of animals - ambulation, rearing, self-grooming, activity in center, and fecal droppings were noted. To measure the neuromuscular co-ordination, mice were trained to remain on the rotating rod a day before the test. On the test day, mice were tested before and 45 min after the administration of vehicle, diazepam (1 mg/kg i.p) or the ethyl acetate and aqueous fractions of Evolvulus alsinoides and Convolvulus pluricaulis (100 & 200 mg/kg p.o). The number of seconds each mouse remained on the rotating rod was recorded before and after the administration. The percentage reduction in the motor coordination was calculated from the readings obtained. The oral administration of the ethyl acetate fractions of both plants (100 mg/kg p.o) produced a significant increase (p<0.05) in the time spent in the open arms as well as the number of entries in the open arm of the elevated plus maze, indicated the anxiolytic activity of the drug. Vehicle treated rats spent 27.33 ± 18. 39 seconds in the open arm. Rats treated with ethyl acetate fractions of Evolvulus alsinoides and Convolvulus pluricaulis spent 97.33 ± 3. 51 seconds and 95.66 ± 9. 95 seconds in the open arm respectively. The number of open arm entries also increased to 8.16 ± 1.57 and 8.50 ± 2.07 for Evolvulus alsinoides and Convolvulus pluricaulis, respectively, as compared to the vehicle (1.00 ± 0.44). The aqueous fractions (100 mg/kg p.o.) did not cause any significant change in the above parameters. In the open field test, ethyl acetate fractions significantly increased the ambulatory activity (p<0.05 for Evolvulus alsinoides and p<0.01 for
Convolvulus pluricaulis), rearings (p<0.01 for Evolvulus alsinoides and p<0.001 for Convolvulus pluricaulis), self-groomings (p<0.05 for both the drugs), and activity in center (p<0.01 for Evolvulus alsinoides and p<0.001 for Convolvulus pluricaulis). The ethyl acetate fractions (200 mg/kg P.O) of both plants caused significant reduction in the time spent on the rotarod compared to control group (p<0.001), indicated the muscle relaxant activity of both plants at a higher dose of 200 mg/kg. The aqueous fraction of both the drugs was devoid of the above pharmacological actions at similar dose. The extracts were also studied for their in vitro antioxidant potential to correlate their anxiolytic activity. The total ethanol extract and its ethyl acetate, and aqueous fractions of both plants exhibited significant antioxidant activity, compared to that of ascorbic acid, used as a positive control. The best superoxide radical scavenging activity was shown by the total extract followed by the ethyl acetate and aqueous fractions in both Evolvulus alsinoides and Convolvulus pluricaulis. Moreover, the samples of total extract and its ethyl acetate and aqueous fractions suppressed superoxide radical release in a dose-dependent manner. It was concluded that both of the plants could be helpful in stress-induced disorders.

Sharma, Arora, Rana, and Bhatnagar (2009) conducted a study. The study was carried out to elucidate the antianxiety effect of Convolvulus pluricaulis petals using elevated plus maze model of anxiety in mice. Male wistar albino mice (20 ± 2g) were taken for the study and divided into five groups, each containing 6 in number. Group 1 served as control and received vehicle, p.o. and after 60 minutes, animals were tested for various parameters of anxiety using elevated plus maze and locomotor activity using actophotometer. Group 2 was treated with diazepam at a dose of 2 mg/kg and animals were tested as above after 30 minutes of the administration of the treatment. Group 3, 4, and 5 received petal extracts of Convolvulus pluricaulis choisy at the dose of 100, 200, and 400 mg/kg respectively. Acute, sub-acute, and chronic studies were performed. Acute groups received the treatment for one day. In the sub-acute group, the treatment was given for consecutively seven days and chronic group received the treatment for consecutively fourteen days. Data was analyzed by prism graph pad software and presented as mean ± S.E.M. values. The statistical tests used were one-way analysis of variance followed by Dunnet’s test. A probability level of 0.05 or less was considered statistically significant. Oral administration of petal extract at the dose of 200 mg/kg
and 400 mg/kg showed a significant dose dependent increase in the total time spent and
the number of entries in the open arm as compared to that of control after acute, sub-
acute, and chronic treatment, whereas petal extract at the dose of 100mg/kg did not
show any significant increase. Acute, sub-acute, and chronic treatment with
hydroalcoholic petal extract of Convolvulus pluricaulis demonstrated a significant
decline in locomotor activity just like the standard drug diazepam. The study confirmed
the traditional claim of antianxiety effect of this plant.

In Ayurveda, Shankhpushpi has been claimed to have anti-oxidant and anti-convulsant
potential. Studies supporting this claim were also reviewed and the details are given
below.

Mudgal and Udupa (1977) conducted a study to confirm whether the plant
Shankhpushpi possesses anti-convulsive action or not. Eighteen rats were divided into
three groups. Group I was control group, which received distilled water. Group II was
Shankhpushpi treated group, which received 300mg/kg of leaves extract. Group III
was given lithium, a well-known anti-convulsive agent at the dose of 4.5umol/kg of
lithium. High pressure oxygen chamber was used to produce convulsions in rats. The
rats were placed in the chamber and the pressure was compressed to 4 atmospheric
pressure. The condition of animals was recorded and they were decompressed at the
moment they convulsed. The rats get convulsed after 60 minutes in normal as well as
Shankhpushpi treated groups, while they do not get convulsed under the influence of
lithium up to 80 minutes. However, Shankhpushpi provoked the sleeping time in rats
after compression. The study concluded that the plant did not possess any anti-
convulsive activity against the convulsions.

Joshi, Kamat, Mohan, Chintalwar, and Chattopadhyay (2003) conducted a study in
which aqueous and methanolic extracts of natural herb, Convolvulus pluricaulis was
monitored for their antioxidant ability against photosensitization and radiation induced
damages in rat brain mitochondria. Oxidative damage to lipids was studied by
monitoring formation of thiobarbituric acid reactive substances (TBARS) while protein
oxidation and degradation of mitochondrial proteins were assessed by measuring
carbonyl contents and SDS PAGE respectively. Plasmid pBR322 was exposed to γ
radiation at 6 Gy with and without Convolvulus pluricaulis extracts and protection by Convolvulus pluricaulis was assessed by gel electrophoresis and quantification. Assays of DPPH and ABTS were carried out by standard methods. Both the extracts of Convolvulus pluricaulis (50 µg/ml assay) showed significant protection against the formation of the lipid peroxidation product, TBARS. The results demonstrated about 40% decrease in TBARS levels by both the extracts of Convolvulus pluricaulis. Protein oxidation and degradation of proteins was shown to be significantly high following photosensitization, while Convolvulus pluricaulis extracts effectively modified these damages. Exposure of plasmid DNA pBR 322 to gamma radiation resulted in enhanced formation of single strand breaks (SSB). Simultaneous treatment of pBR322 DNA with Convolvulus pluricaulis extracts during radiation effectively reversed the effect of radiation by preventing the formation of SSB. Further, these extracts also showed inhibition against stable radicals, 2, 2’ – azino-bis (3 – ethylbenzthiazoline – 6 – sulfonic acid (ABTS) and 1, 1 – diphenyl – 2 – picryl hydrazyl (DPPH). The scavenging capacity of the extracts was quantified by pulse radiolysis experiments. It was concluded that Convolvulus pluricaulis might emerge as potent antioxidant/radioprotector, capable of scavenging singlet oxygen, hydroxyl radical, as well as other stable radicals, ABTS and DPPH.

Ahmad, Zafar, and Sahid (2007) conducted a study to develop in vitro cultures of Convolvulus microphyllus as an alternative source and to compare the anticonvulsant activity of developed cultures with that of natural drug. Callus culture of Convolvulus microphyllus Sieb. was induced on Murashige and Skoog’s medium supplemented with 2, 4-dichloro phenoxy acetic acid, 6-benzyl adenine, indole acetic acid, and kinetin (1ppm each). Methanolic extracts of whole plant, leaf, stem and leaf, and stem calli were tested for anticonvulsant activity against standard drug phenytoin using maximal electroshock model on mice. Swiss albino mice of either sex (22-32gm) were selected and divided into seven groups, each containing six in number. Phenytoin was given p.o. in volume of 10ml/kg and dose of 22mg/kg body weight 2 hours prior to each observation. All other test samples i.e. whole plant extract, leaf extract, stem extract, leaf callus extract, and stem callus extract, were given p.o. in a volume of 10ml/kg and doses of 200mg/kg body weight 30 minutes prior to each observation. Control group was given distilled water in a volume of 10ml/kg body weight. Results were expressed
as mean±SEM and all the extracts and standard drug phenytoin were compared with vehicle treated control group separately using one way analysis of variance followed by student’s ‘t’ test. P value <0.05 was considered statistically significant. It was observed that animals treated with methanolic extracts of stem callus, leaf callus, and whole plant showed significant protection against electroshock induced convulsions by increasing seizure threshold current (29.00, 28.26, and 26.00 respectively). The methanolic extracts of stem callus and leaf callus (200mg/kg) were found to possess 83.33% protection against ICES seizures and 100% protection against mortality, which was comparable to that of standard drug phenytoin. Since the different extracts suppressed tonic convulsions, it was concluded that the whole plant, leaf, and stem calli of this plant contains active compound which inhibited the convulsive seizure activity.

Ratha and Mishra (2012) conducted a study to evaluate the anticonvulsant activity of Shankhpushpi on strychnine induced convulsive seizures in experimental animals. Albino mice of either sex (20-25 gm) were selected and divided into 9 groups each containing 5 in number. The 9 groups were marked with the sign C, C100, C200, C300, C400, C500, strychnine, phenytoin, and phenytoin + C400. C indicated control group which received normal saline. Group 2 to 6 were administered aqueous extract of Convolvulus pluricaulis with 100 mg, 200 mg, 300 mg, 400 mg, and 500 mg/kg body weight respectively. Group 7 was given strychnine Hcl (S) at the dose of 2 mg/kg body weight intraperitoneally. Group 8 received phenytoin at the dose of 135 mg/kg body weight. Group 9 received phenytoin (135 mg/kg body weight) along with aqueous extract of Shankhpushpi (400 mg/kg body weight). Aqueous extract of Convolvulus pluricaulis was administered to the experimental animals for 14 days prior to induction of convulsion in mice. 5 sets of experiments were performed for evaluating anticonvulsant property of the plant and the results obtained from the experiments were verified by various statistical analyses. ED50 value was calculated. The time interval between strychnine Hcl (S) injection and occurrence of seizure was measured. The delay onset was calculated in comparison with the control and standard groups. From the observations, it appeared that Convolvulus pluricaulis in the dosage of (100 – 500 mg/kg) had no significant inhibition effect on strychnine induced convulsions, however, Convolvulus pluricaulis in the dose of 400 mg/kg body weight administered in combination with phenytoin sodium (135 mg/kg) showed significant inhibitory effect.
Verma, Sinha, Kumar, Amin, Jain, and Tanwar (2012) conducted a study to examine Convolvulus pluricaulis for its antioxidant and anticonvulsant activity. Swiss albino mice of either sex, weighing between 25-40g were used in this study. The antioxidant activity was determined by using a method based on the reduction of methanolic solution of coloured-free radical 1, 1 diphenyl-1-2 picryl hydrazyl (DPHH). The radical scavenging activity of tested sample was expressed as an inhibition percentage. Ascorbic acid was used as a reference standard. DPHH screening has shown the IC50 values of 2.03 µg/ml and 41.00 µg/ml for ascorbic acid and methanolic extract of Convolvulus pluricaulis respectively, indicated moderate antioxidant properties for the methanolic extract. Maximum percent inhibition of 82.89% was observed at the concentration of 80.00 µg/ml of methanolic extract. Anticonvulsant activity was determined by using the maximal electroshock seizure model. The mice were divided into 5 groups, each containing 6 in number. Control group was given normal saline. Group II was treated with standard drug, phenytoin sodium. Group III, IV, and V were given methanolic extract of Convolvulus pluricaulis at the doses of 250 mg/kg, 500 mg/kg, and 1000 mg/kg body weight respectively. All mice were given the drug twice, first 24 hrs prior to and again 1 hr prior to applying electric stimulus. The different stages of convulsions and time duration were observed in all groups of animals in each phase of the convulsion. The threshold, duration of tonic convulsion, and % inhibition were recorded. No prevention of hind limb extension was observed even at the maximum dose of 1000 mg/kg. This indicated poor protection ability of the test drug against convulsions. But, it has significantly (p<0.05) reduced various phases of convulsions, indicated its ability to prevent spread of seizures. The effect was found to be better than the prototype anticonvulsant phenytoin.

Many studies found this herb very useful in treating neurodegenerative diseases like amnesia, Alzheimer’s etc. Review of such studies is given below:
Rajesh and Batra (2009) conducted a double-blind, pre-post, placebo controlled study. They investigated the effect of Shankhpushpi on dementia rating and quality of life amongst the patients of dementia. As a sample, 80 already diagnosed patients, 40 belonged to senile dementia of Alzheimer’s type (SDAT) and 40 belonged to multi-infarct type (MIT) were selected. They were treated with either Shankhpushpi powder or placebo (3.5gm/day) for duration of 4 months. The participants were divided into 4 groups (2 control and 2 experimental groups). The assessment was done with the help of Dementia rating scale-2 (DRS-2) by Steven Mattis to assess the levels of cognitive functioning of individual with brain dysfunctions, and Dementia quality of life instrument (DQoL) by Meryl Brod to assess the quality of life of patients with dementia. The patients were assessed three times i.e. firstly in the starting, then after 2 months, and then after 4 months of administration of herbal medicine. The herbal medicine Shankhpushpi led to an improvement in both types of dementia. It was found that on DRS-2, most of the dimensions such as attention, initiation/perseveration, conceptualization showed significant improvement due to administration (both duration) of Shankhpushpi. It was observed in total scores of DQoL that Shankhpushpi improved the quality of life in both dementia types after 2 and 4 months. It was also found that Shankhpushpi improved self-esteem, positive affect, and feelings of belongingness significantly. And, on many tasks, the effect went on increasing with the increased duration.

Bihaqi, Singh, and Tiwari (2011) reported the neuroprotective effect of Convolvulus pluricaulis aqueous extract (AE) against scopolamine (1mg/kg body weight) induced neurotoxicity in the cerebral cortex of male wistar rats (age matched, weight 250±20g). The study investigated the cognitive enhancing property of aqueous extract in different doses (100, 150, and 250 mg/kg) using Elevated plus maze (transfer latency) and Morris water maze model. Besides evaluating the effects of extract on neurochemical enzymes, in vivo antioxidant and free radical scavenging activities were also screened. All the measured parameters were compared with rivastigmine tartrate (1mg/kg body weight) which was taken as standard. On elevated plus maze test, TL (transfer latency) of first day reflected learning behavior of animals, whereas TL of second day reflected retention of information or memory. Scopolamine (1mg/kg) impaired learning significantly (p<0.05) as indicated by increased TL. Aqueous extract (100mg/kg)
administered for 7 days orally showed no significant effect on TL on first day of training and on second day, whereas aqueous extract (150mg/kg) significantly decreased TL on first day as well as on second day, indicated significant (p<0.05) improvement of learning and memory. A significant increase (p<0.05) in the TL was observed in rats administered with aqueous extract (250mg/kg), indicated significant impairment in learning compared with control. Thus, oral administration of extract (150mg/kg) for 7 days protected the animals from scopolamine induced impairment in learning and memory. On Morris water maze test, aqueous extract treated rats showed a significant (p<0.05) reduction in swimming distance from day 2 to day 4. Amnesia induced by scopolamine was significantly (p<0.05) mitigated by the aqueous extract and the escape latencies reduced from 98.41±10.44 on the first day to 45.66±8.69 on the fourth day. AE (150mg/kg) attenuated the increased activity of AChE in cerebral cortex by ~46% and in hippocampus by ~56% as compared with amnesic group. AE treatment lowered MDA levels by ~68% and protein carbonyl levels by ~30% and ~61% in brain regions as compared with scopolamine treated group. Reduced activities or contents of glutathione reductase, superoxide dismutase, and reduced glutathione within the cortex and hippocampus induced by scopolamine were elevated by the extract. The study concluded that the extract might exert its potent-enhancing activity through both anti-AChE and antioxidant action.

Bihaqi, Singh, and Tiwari conducted a study in 2012. The study was conducted on male wistar rats (250 ± 20g), randomly assigned into four groups of eight animals each. Group 1 served as control and received saline only. Group 2 received scopolamine (2 mg/kg) dissolved in saline daily. Group 3 received rivastigmine tartrate (standard) at an oral dose of 1 mg/kg, followed by scopolamine (2 mg/kg) after 40 minutes and group 4 was given aqueous extract of Convolvulus pluricaulis at an oral dose of 150 mg/kg, followed by scopolamine (2mg/kg) after 40 minutes. The treatment was continued for 4 weeks. Scopolamine is known to produce amnesia due to blockade of the cholinergic neurotransmission. The study investigated the potential of Convolvulus pluricaulis to alleviate the neurotoxic effect of scopolamine. Western blot and reverse transcriptase polymerase chain reaction (RT-PCR) analysis were used to evaluate the levels of protein and mRNA of amyloid precursor protein (AβPP) and tau in rat cortex, which were increased due to the administration of scopolamine. ELISA was used to measure
the amyloid β (Aβ) levels, also increased by scopolamine. Histopathology was also performed on cortical section of all groups. Oral administration of Convolvulus pluricaulis extract (150 mg/kg) to scopolamine treated rats reduced the increased protein and mRNA levels of tau and AβPP levels followed by reduction in Aβ levels compared with scopolamine treated group. The potential of Convolvulus pluricaulis to prevent scopolamine neurotoxicity was reflected at the microscopic level as well, indicative of its neuroprotective effects. The study concluded that Convolvulus pluricaulis might be useful in the treatment of Alzheimer’s disease.

Dhuna, Dhuna, Bhatia, Singh, and Kamboj (2012) conducted an experimental study. The study was aimed to investigate the neuroprotective and antioxidant effect of methanolic, ethanolic, and water extracts of Convolvulus pluricaulis (CP-MEx, CP-EEx, and CP-WEx) on human IMR32 neuroblastoma cell line under oxidative stress induced by hydrogen peroxide (H₂O₂). Firstly, cytotoxic dose of H₂O₂ and non-toxic dose of methanolic, ethanolic, and water extracts of Convolvulus pluricaulis (CP-MEx, CP-EEx, and CP-WEx respectively) was determined by MTT assay. Protective effect of CP-MEx, CP-EEx, and CP-WEx was determined using quercetin as a positive control. The expression of IMR32 cytoskeletal marker, neurofilament (NF-200) and stress markers, heat shock protein (HSP70), and glucose regulated protein 75 (Grp75) mortalin studied by immunofluorescence and RT-PCR results. The level of antioxidant enzymes catalase, superoxide dismutase, glutathione peroxidase, direct scavenger of free radicals, glutathione, and lipid peroxidation were analysed by their standard procedures. The results showed that quercetin, CP-MEx, CP-EEx, and CP-WEx displayed cytoprotective activity in IMR32 cells. Out of tested extracts, CP-MEx significantly decreased hydrogen peroxide-induced cell death. Significant decrease in NF-200, HSP70, and mortalin expression was observed in CP-MEx+H₂O₂ treated cultures as compared to H₂O₂ treated. Catalase, superoxide dismutase, glutathione peroxidase, and glutathione levels significantly increased in quercetin and CP-MEx treated cultures. Lipid peroxidation was significantly decreased in both quercetin and CP-MEx treated cultures. This study established the protective effect of CP-MEx on IMR 32 human neuroblastoma cell line which was as much as by quercetin. The cytoprotective effect of CP-MEx was due to induction of antioxidant machinery of the cell hence holds
therapeutic value in the treatment and/or prevention of neurodegenerative disorders of oxidative stress.

Mathew and Subaramanian (2012) conducted a study to investigate the effect of methanolic extracts of 13 plant species which are known to be brain boosters in Ayurvedic system of medicine. Their study addressed the influence of these extracts on (i) prevention of aggregation of Aβ and (ii) dissociation of preformed Aβ fibrils. The aggregation status was monitored by thioflavin T fluorescence assay. The results showed that almost complete inhibition of aggregation was obtained by extracts of Nardostachys jatamansi, Coriandrum sativum, Glycyrrhiza glabra, Convovulus pluricaulis, Bacopa monniera, Centella asiatica, Withania somnifera, and Tinospora cordifolia whereas moderate inhibition was exhibited by Terminalia chebula, Saussauria lappa, and Punica granatum. Similarly, Glycyrrhiza glabra, Convovulus pluricaulis, Bacopa monniera, Centella asiatica, Nardostachys jatamansi, and Emblica officinalis showed considerable effect on the dissociation of aggregates. Extracts of Glycyrrhiza glabra, Convovulus pluricaulis, Bacopa monniera, Centella asiatica, and Nardostachys jatamansi inhibited aggregation as well as dissociated the preformed aggregates to a considerable way. The study offered direct evidence on the influence of the extracts from Glycyrrhiza glabra, Convovulus pluricaulis, and Nardostachys jatamansi in favour of Aβ-centric therapy for Alzheimer’s disease.

Besides all these properties, Shankhapushpi is claimed to have anti-diabetic, anti-ulcerogenic, anti-epileptic, anti-obesity, anti-bacterial, anti-inflammatory, anti-analgesic, and hepatoprotective properties. Following is the review of such studies which claim these effects:

Mulchandani, Barve, Gokhale, and Kshirsagar (1995) conducted a study to understand the mechanism of the anti-epileptic effect of Convovulus pluricaulis. In vitro incubation of rat brain cortical slices and veratrine induced amino acid release were used as a model. Veratrine acts on Na+ channels causing the release of amino acids. Amino acids were separated using a reversed phase HPLC and quantified using fluorescence detection. Incubation with veratrine caused the release of aspartate and glutamate. The increase from the basal concentration was significant 391% and 115%
respectively. Treatment with PHT (postulated to act by blocking Na channels) significantly lowered the veratrine induced release of amino acids. The inhibition was 133% and 33% respectively. In the Convolvulus pluricaulis pretreated group, veratrine induced release was significantly lower; 121% and 44% over the basal value for glutamate and aspartate respectively. The study concluded that there is a possibility that Convolvulus pluricaulis acts through decreasing the release of amino acids possibly by acting on Na+ channels.

Sairam, Rao, and Goel (2001) conducted a study to evaluate the anti-ulcerogenic effect of juice of fresh whole plants of Convolvulus pluricaulis (CP) against various experimental gastric ulcer models induced by ethanol, aspirin, 2 hr cold resistant stress, and 4 hours pyloric ligation in rats. Albino rats of either sex weighing between 150-180 gms were selected. The drug was given orally twice daily for five days in the doses of 375 and 750 mg/kg body weight. Convolvulus pluricaulis showed anti-ulcerogenic effect at both doses in all the experimental gastric ulcer models and was comparable to the reference drug, sucralfate (250 mg/kg). Gastric juice secretion and mucosal studies were undertaken to find out the possible mechanism of action of antiulcer effect by studying its effects on both offensive and defensive mucosal factors. The antulcerogenic effect was found to be due to augmentation of mucosal defensive factors like mucin secretion, lifespan of mucosal cells, and glycoproteins rather than on the offensive factors like acid-pepsin.

An investigation was made to evaluate the role of Convolvulus pluricaulis root extract in the regulation of hyperthyroidism in female mice by Panda and Kar (2001). The experiment was carried out on colony – bred swiss albino female mice weighing 28 ± 2 g (about 3 months old). After an acclimation of 7 days, mice were divided into four groups of 7 each and the initial body weight of each one was recorded. While group I animals received 0.1 ml of suspending reagent (Tween 80 and water) served as control, group II mice were injected (i.p.) daily with 50 µg/100g body weight of L. thyroxine. Group III received (i.p.) the plant extract of 0.4 mg/kg body weight along with the equivalent dose of thyroxine, and the group IV animals were treated only with the same amount of plant extract as used in group III. The drug was administered every day between 10 – 11 h to avoid circadian interference, and the treatment was continued for
30 days. On the last day of the experiment, final body weight of each animal was recorded. Estimation of hepatic 5’ – monodeiodinase (5’DI), LPO, SOD, CAT activities, thyroid hormone concentrations, Glucose - 6 – phosphatase activity, and protein concentration was also done. For statistical evaluation of the data, one way analysis of variance and student’s t-test were employed. Co-administration of thyroxine and Shankhpushpi root extract caused a significant decrease in T3 concentration (p<0.001) and 5’DI activity (p<0.01). Animals administered only with the plant extract also exhibited a significant decrease in serum T3 concentration and 5’DI activity (p<0.001 and p<0.05 respectively). A significant decrease in G-6-pase activity was found after Shankhpushpi treatment (p<0.05) as compared to the control group. The activity of an antioxidant enzyme, SOD, increased significantly in T4+ Shankhpushpi and only Shankhpushpi treated groups (p<0.01 for both as compared to the control values). The lipid peroxidation remained unchanged in all groups. The study indicated the possible regulation of hyperthyroidism by the plant extract.

In a study conducted by Verma, Sinha, Singh, Tanwar, and Godara (2011), the antibacterial activity of methanolic extract of whole plant of Convolvulus pluricaulis was tested against Gram-negative bacteria like Escherichia coli ATCC 8739, and Gram positive bacteria Staphylococcus aureus ATCC 6538, using cup plate method with standard Tetracycline. The findings suggested that the methanolic extract exhibited prominent antimicrobial activity against two bacterial strains viz. E.coli and S.aureus used in this study. The zone of inhibition of methanolic extract was found to be 7.63 and 6.56 mm against E.coli and S.aureus respectively. This was comparable with the standard drug Tetracycline. Convolvulus pluricaulis was found to be more active against E.coli in comparison to S.aureus. From the study, it was also concluded that bioactive substances from this plant could therefore be employed in the formulation of antimicrobial agents for the treatment of various bacterial and fungal infections including gonorrhoea, pneumonia, eye infections, and mycotic infections.

Patel, Chandola, Baghel, and Joshi (2012) conducted a study to examine the clinical efficacy of Shankhpushpi and a herbomineral compound (HMC) in type-II diabetes. Total 93 patients of type-II diabetes, attending the IPD/ODP, whose blood glucose level were found high and fulfilled the criteria of selection, were randomly distributed in two
therapeutic groups. 48 patients of group A were treated with HMC in a dose of 3g/day in three divided doses in pill form for the duration of 8 weeks with lukewarm water before meal. HMC as above with Medhya Rasayana-Shankhapushpi in a dose of 1.5g/day in three divided doses were administered to 45 patients of group B for 8 weeks. After completion of therapy, patients were advised to visit OPD every week for follow-up up to 1 month. 60.52% of patients in group A reported relief in all the symptoms of type-II diabetes whereas in Shankhapushpi + HMC treated group, better relief (71.13%) was obtained. In group B, highly significant improvement (p<0.001) was obtained in symptoms of polyuria, polyphagia, loss of weight, leg cramps, fatigue, weakness, dryness in mouth, excessive sweating, numbness in palm-foot, burning sensation in palm-foot, and polydipsia. On positive manasabhava, Group B showed highly significant improvement in cheerfulness, happiness, fearlessness, and stability (p<0.001 respectively). Significant improvement was obtained in beginning of work and good attitude symptoms (p<0.05 respectively). On negative manasabhava, highly significant decrease (p<0.001) was obtained in symptom of worry, depressed mood, fear, impact, apprehension, anxiety, anger, and sorrow. On all disturbed manasabhavas, group A demonstrated only 8.27% improvement, whereas group B demonstrated 29.16% improvement. On all the parameters of BPRS (Brief psychiatric rating scale), group A showed 14.59% relief while group B showed 38.28% relief. Group B therapy showed highly significant relief (p<0.01) in the symptoms of fear of physical illness of somatic concern, worry, fear, and over concern for present and future of anxiety, thought process confusions of conceptual disorganization, over activation and tension, slow motor retardation, unusual thought content, heightened emotional tone, and increased reactivity of excitement. Strange thought content, reduced emotional tone, and reduction in normal intensity of feeling of blunted affect were also significantly reduced (p<0.05). Biochemical investigation showed a significant decrease (p<0.05) in serum cholesterol and LDL, insignificant reduction in serum triglyceride and VLDL, while HDL insignificantly increased in Shankhapushpi+ HMC treated group. Renal profile showed highly significant (p<0.001) decrease in fasting blood sugar and post prandial blood sugar. Urine sugar was found to be insignificantly decreased with better percentage relief. On comparison of overall therapeutic efficacy, only 16 patients of group A showed improvement, whereas 31 patients in group B improved, indicated that group B was more effective with highly significant x2 (15.50).
Ravichandra, Ramesh, and Sridhar (2013) conducted a study to evaluate the hepatoprotective potentials of aqueous extracts of Convolvulus pluricaulis leaves against thioacetamide induced liver damage in rats. Animals were divided into six groups. Hepatotoxicity was induced in the animals of all groups except normal control by single dose administration of thioacetamide (100mg/kg) at first day of the study followed by treatment of the animals daily with standard drug sylimarine and aqueous extract of Convolvulus pluricaulis (200mg/kg, 400mg/kg, and 600mg/kg) to respective groups for 21 days. Variations in biochemical parameters like alanine transferase (ALT), aspartate transferase (AST), alkaline phosphatase (ALP), total bilirubin, direct bilirubin, albumin, total protein, ions, and others parameters like clotting time and weight of the liver were considered to determine beneficial effect of the extract. At the end of the study, liver samples were collected and subjected to histopathological evaluation. In control animals treated with thioacetamide alone, variations were observed in the above-mentioned parameters. But in the animals treated with aqueous extract and standard drug silymarine, all the parameters were found to be normal possibly due to their beneficial property in protecting the liver against thioacetamide induced hepatotoxicity. The study concluded that the aqueous extract of Convolvulus pluricaulis posses significant hepatoprotective activity.

Sharma, Verma, Yashwant, and Prasad (2013) investigated the anti-obesity effect of Convolvulus pluricaulis in mice. Obesity was induced in mice by feeding them a cafeteria diet daily for 41 days in addition to normal diet. Body weight and food intake was measured initially and then every week thereafter. On day 41, serum biochemical parameters were measured and animals were sacrificed using overdose of ether. The liver, kidney, heart, and spleen were removed and weighed immediately. Treatment with extracts of Convolvulus pluricaulis caused changes in the blood parameters including decrease levels of total cholesterol (TC), low density lipoprotein cholesterol (LDL-C), and TG but increased high density lipoprotein cholesterol (HDL-C). From the study, it was concluded that Convolvulus pluricaulis could be a potential source of anti-obesity phytomedicine.
Agarwal, Sharma, Jain, Fatima, and Alok (2014) reported the hypoglycemic activity of Convolvulus pluricaulis in normal and streptozocin-induced diabetic rats. Experiments were performed on adult male wistar rats (body weight range 150-200g), 10 to 11 weeks of age. The rats were divided into five groups with six rats in each group. Group I which was normal control group received 2% gum acacia solution. Diabetic control group was given freshly prepared solution of STZ at a dose of 50mg/kg body weight of rats. Diabetic rats of group III, IV, and V were given ethanolic extract of leaves of Convolvulus pluricaulis at the dose of 400 mg/kg, 600 mg/kg, and 800 mg/kg body weight. Group VI was given metformin (500mg/kg body weight). These doses were given for a period of 21 days. In addition to hypoglycemic effect, other parameters like changes in body weight, serum cholesterol, triglycerides, and total protein levels were also assessed. 800 mg/kg of Convolvulus pluricaulis produced a significant reduction in fasting blood glucose levels in the normal (p<0.05) and streptozocin induced diabetic rats (p<0.01). Acute treatment with 400mg/kg and 600mg/kg of Convolvulus pluricaulis could not bring back the sugar to normal level. However, in repeated dose treatment, 600mg/kg extract showed significant anti-hyperglycemic activity from day 14. Significant differences were observed in serum lipid profiles (cholesterol and triglycerides), serum protein, and changes in body weight by 800 mg/kg treated-diabetic animals, when compared with the diabetic control and normal animals (p<0.01). This was concluded that Convolvulus pluricaulis exhibited significant anti-hyperglycemic activity and also showed improvement in lipid profile as well as regeneration of B- cell of pancreas and so might be of value in treatment of diabetes.

Agarwal, Sharma, and Alok (2014) designed a study for screening of anti-inflammatory and anti-analgesic activity of ethanolic extract of Convolvulus pluricaulis Choisy. Experiments were performed on adult male wistar rats (body weight range 150–200 g), 10 to 11 weeks of age. After randomization into various groups and before initiation of experiment, the rats were acclimatized for a period of 7 days under standard environmental conditions. Acute toxicity studies were performed. Convolvulus pluricaulis extract were administered orally at a dose of 50 mg/kg. The dose at which mortality was observed in two out of three albino wistar rats, was considered as toxic dose. Anti-inflammatory activity was evaluated by using carrageenan-induced paw edema and cotton pellet-induced granuloma model. The anti-analgesic activity was
evaluated by hot plate method and tail-flick assay. There was no mortality amongst the graded dose groups of albino wistar rats up to a dose of 5000 mg/kg for duration of 72 hours. This finding suggested that Convolvulus pluricaulis extract were relatively safe or non-toxic in albino wistar rats at the doses used in this study. Administration of the ethanolic extract of Convolvulus pluricaulis Choisy at the dose of 800 mg/kg p.o. showed significant ($p < 0.001$) inhibition of rat paw edema. The ethanolic extract of Convolvulus pluricaulis at the dose of 750 mg/kg showed statistically significant analgesic activity compared to control and standard groups. The study concluded that ethanolic extract of Convolvulus pluricaulis has marked antipyretic and moderate anti-inflammatory activities.

Besides all these disease related effects, Shankhpushpi has also been found to play a major role in cognitive abilities such as memory, learning etc. Summary of some of the studies which provide support to these findings is given below:

In an empirical study, Priyanka and Batra (2003) investigated the role of Shankhpushpi in memory enhancement. This was a pre-post, double blind, placebo-controlled, parelled-group design based study. Sixty four subjects of age group 19-26 years were treated with either Shankhpushpi or placebo for the period of 15 days and 30 days. The testing was done with the help of forward digit span task, backward digit span task, 30 words recall test, and serial learning task before and after treatment. Results indicated that Shankhpushpi enhanced short term memory, long term memory, retrieval, and storage of the treated group. The placebo group’s score was found insignificant on all the tests in both the durations. The study indicated that even 15 days were enough to see the improvement due to administration of Shankhpushpi.

Priyanka and Batra (2004) investigated the effect of Shankhpushpi on memory. In this study, a multi-group, pre-post, double blind, placebo controlled design was employed. As a sample, 200 normal adults of age group 19-25 years were selected. The participants were divided into 10 groups (5 controls and 5 experimental groups). There were 20 subjects in each group. The subjects were given either 3.5gm of Shankhpushpi or 3.5 gm of an ordinary powder with honey followed by a glass of milk for different durations (i.e. 15 days, 30 days, 60 days, 120 days, and 180 days). Forward digit span
(FDS), backward digit span (BDS), 30 words recall test, serial learning task were taken for the testing. A memory enhancement (of both STM and LTM) after the duration of 30 days was observed. Results of the treatment for 120 and 180 days were found to be the best. The improvement increased with an increasing duration of administration of Shankhpushpi. It was concluded that Shankhpushpi enhanced memory and cognitive functions such as attention, storage, retrieval capacity of short term memory and long term memory, speed of learning, and encoding of items to get registered in LTM. Residual effects were also observed. It was also important to be noted that there was found no side effects of Shankhpushpi even when used for longer durations i.e. 180 days or up to six months in a single subject.

Kapse and Nesari (2005) had done single blind control clinical trial to assess cognition enhancing (Medhya) effect of Shankhpushpi (Convolvulus pluricaulis) on 90 patients. Patients were divided into three groups. Shankhpushpi (Convolvulus pluricaulis) tablets to group A was given in dose 3 gms/day in two divided doses for the duration of six months. Group B was control group in which tablets of Shankhpushpi bheda (Evolvulus alsinoides Linn) in same dose and duration was given. The group C was placebo group which received starch powder by same manner. The scales used for assessment of the effect were- 1) Behavior profile (i) Standardized symptom checklist (SSCL) (ii) Child behavior checklist –standard version (CBCLSV), 2) Effect on cognitive function by NVIT 3) Effect on mental faculties by NIMHANS performa. Criteria of assessment were according to relief of symptoms of behavior disorders, improvement in functions of mana (mind), and reduction of manodharniya vega, and improvement in PR. In this study, Convolvulus pluricaulis type of Shankhpushpi showed significant results due to its cognition enhancing (Medhya) and manasarogahar activity. The test drug showed effective relief in symptoms of behavior disorders of adolescent age group. It had been more effective in enhancing grasping capacity and intellectual power (Dhi and dhriti).

Batra (2008) investigated the effect of Shankhpushpi on mentally retarded population. As a sample, 5 male mentally retarded subjects were selected out of 20 such subjects on single and successive command test in Dementia rating scale (DRS-2) by Steven Mattis. Those who could follow these commands, only those 5 subjects were selected. These
subjects were administered upon FDS and BDS task to assess their short term memory and Quality of life scale by Meryl Brod. Then, these subjects were given Shankhpushpi daily and retested after 10 days and 45 days. The results clearly showed an improved memory and quality of life.

A study conducted in 2008 by Batra, Kumar, Rawat, and Batra examined the effect of Shankhpushpi on short term memory and long term memory. They conducted the research on a sample of 20 subjects of class IX and X. They were given 3.5g of Shankhpushpi powder for 40 days. These subjects were tested on forward digit span (FDS), backward digit span (BDS), and serial learning task before and after the administration of Shankhpushpi. The values were computed on each task for both durations i.e. 20 and 40 days. Results indicated an improvement in both FDS and BDS. The number of trials taken in serial learning task reduced. A retention test after 24 hours of serial learning task was also taken in both pre and post testing. There was an improvement in the number of items recalled. These results indicated that the Shankhpushpi improves both the short term memory and long term memory. The rate of improvement after 20 days of consuming Shankhpushpi was higher than the rate of improvement between 20 and 40 days.

Sharma, Bhatnagar, and Kulkarni (2010) studied the comparative effect of Convolvulus pluricaulis choisy. and Asparagus racemosus wild on learning and memory in young and old mice, with a specific aim to evaluate their possible efficacy in treatment of memory disorders. Mice were divided into two main groups- pre-trial and post-trial groups. In pre-trial group, animals were again subdivided into acute study group, sub-chronic study group, and chronic study group. The acute study group mice were further divided into six groups I to VI. Sub-chronic study group mice were further divided into six groups VII to XII. Chronic study group mice were further divided into six groups XIII to XVIII. In case of post-trial group, mice were divided into six groups XIX to XXIV. Each group consisted of a minimum of five to seven animals. Separate animals were used for each experiment. In all groups, the mice were treated with the same dose of distilled water as control, piracetam (10mg/kg) as standard, and test extracts of Convolvulus pluricaulis (100, 200 mg/kg), and Asparagus racemosus (100, 200mg/kg). The elevated plus maze task was used for evaluation of learning and memory. Transfer
latency (TL) was taken as the time taken by the mouse to move into anyone of the closed arms with all its four paws in. In all acute study groups, TL was noted 60 minutes after drug administration and again after 24 hours. In all sub-chronic study groups, TL was noted on third day and again after 24 hours. In all chronic study groups, TL was noted after 60 minutes of administration on the 7th day and again after 24 hours. In post-trial group, TL was noted on the first day and again after 24 hours on second day. Chronic study was conducted on aged mice whereas in all other studies, young mice were taken. All the values were expressed as mean ± SE. The data was analyzed by using ANOVA followed by Dunnett’s test. Significance of the data was accepted at p<0.05. A dose dependent enhancement of memory was observed with Asparagus racemosus and Convolvulus pluricaulis treatment (p<0.05) as compared to control group when tested on second day. Asparagus racemosus and Convolvulus pluricaulis at the dose of 200 mg/kg, showed significantly higher percent retentions (73.2% and 81.42% respectively) than piracetam, 48.7% (p<0.05). Multiple treatment with Asparagus racemosus and Convolvulus pluricaulis for three days also demonstrated significant dose dependent increase in percent retentions as compared to control group (p<0.05). The effect was more prominent with Convolvulus pluricaulis (84.2%) as compared with piracetam and Asparagus racemosus. A significantly lower percent retention (3.7%) in aged mice was observed as compared to young mice (18.3%). Aged mice (18-20 months) showed higher transfer latency (TL) values on first and second day (after 24 hours) as compared to young mice, indicating impairment in learning and memory. Pre treatment with Asparagus racemosus and Convolvulus pluricaulis for 7 days enhanced memory in aged mice, as significant (p<0.05) increase in percent retention as compared to control aged mice was observed. Significantly higher retention (55.3%) was observed with Convolvulus pluricaulis (200mg/kg) as compared with piracetem (10mg/kg) which was 42.84%. Post-trial administration of Asparagus racemosus and Convolvulus pluricaulis extract demonstrated significant decrease in latency time during retention trials. Hippocampal regions associated with the learning and memory functions showed dose dependent increase in AChE activity in CA 1 with Asparagus racemosus and CA 3 area with Convolvulus pluricaulis treatment. It was concluded that both plants had shown a promising memory enhancing effect and the underlying mechanisms of these actions of these extracts might be attributed to their antioxidant, neuroprotective, and cholinergic properties.
Rawat and Kothiyal (2010) conducted a study to investigate and compare the neuropsychopharmacological effects of various reported species of Shankhpushpi-Evolvulus alsinoides Linn., Convolvulus pluricaulis Sieb, and Clitorea ternatea Linn. on learning and memory processes by Morris water maze paradigm. Wistar albino rats (80-110 gm body weight) of either sex were selected. Rats were grouped into 8 groups of 6 animals each. Groups I animals served as control and received the vehicle only. Group II animals received standard drug piracetam (200 mg/kg body weight). Group III, IV, and V received ethanolic extracts of Convolvulus pluricaulis, Evolvulus alsinoides, and Clitorea ternatea respectively at 250 mg/kg body weight. Group IIIa, Group IVa, and Va received ethanolic extracts of Convolvulus pluricaulis, Evolvulus alsinoides, and Clitorea ternatea respectively at 500 mg/kg body weight. Morris water maze was employed to evaluate learning and memory parameters. The animals were subjected to training for 8 days. During the training session, the animals were released into the water and allowed 120 seconds to find the platform. Each animal received four trials on day one and subsequently eight trials per day for eight days. The trial sessions had a five minute inter trial interval. The test extracts were administered sixty minutes prior to the first trial daily. 24 hours after the last training trial, the animals were subjected to spatial memory test whereby the time spent in the target quadrant was measured and taken as an indicator for spatial memory. The results were reported as a mean ± SEM and were analyzed by one way ANOVA followed by Tukey-Kramer multiple comparisons test. All the three species of Shankhpushpi at both doses i.e. 250 mg/kg and 500 mg/kg body weight exhibited an increase in time spent in target quadrant which was statistically significant (p<0.01) when compared to control. An increase in dose exhibited a corresponding increase in the time spent in target quadrant. It was concluded that all the three species of Shankhpushpi have the potential to improve spatial memory in animals.

Kothiyal and Rawat (2011) conducted a study to compare the two plant sources of Shankhpushpi- Evolvulus alsinoides and Convolvulus pluricaulis for their nootropic effects using two different models for memory evaluation. Adult albino wistar strain rats (80 ± 20 gms) of either sex were procured and randomly assigned into four groups, each containing 6 animals in number. Group I which was control group was treated with
1 ml of vehicle. Standard group was treated with piracetem (200 mg/kg body weight). Group III and IV received alcoholic extracts of Evolvulus alsinoides and Convolvulus pluricaulis respectively, at a dose level of 250 mg/kg body weight. Treatment was given for seven consecutive days, one hour prior to the evaluation of behavioral parameters. Elevated plus maze and jumping box were used for memory evaluation. In jumping box paradigm, the alcoholic extract of Evolvulus alsinoides exhibited a significant increase in avoidance response which was comparable to the standard, found to be superior to Convolvulus pluricaulis and control groups. In the plus maze test, the rats treated with alcoholic extract of Evolvulus alsinoides and Convolvulus pluricaulis showed nootropic effect in terms of significant increase in the time spent in enclosed arm than open arm after their training sessions. This was found comparable to the standard drug and very significant (p<0.0001) as compared to the control group. However, the number of entries in the enclosed arm was less for Evolvulus alsinoides when compared with the groups treated with alcoholic extract of Convolvulus pluricaulis.

Shweta and Batra (2012) investigated the effect of Shankhpushpi on cognitive abilities. A pre-post, placebo controlled, double blind, parallel group design was used. As a sample, 30 students of age group 23-25 years were selected. They were administered either Shankhpushpi or placebo for a period of 20 days and 40 days. The subjects were tested on the following tests-abstract reasoning test, digit symbol test, vocabulary test, arithmetic test, and intellectual processing scale before and after treatment. Results indicated that Shankhpushpi improved performance on abstract reasoning test and digit symbol test. On arithmetic and intellectual processing scale, no significant differences were found in the scores of control and experimental groups for both durations.

A number of studies were also conducted on this plant by researchers to investigate the underlying mechanism behind the action of this plant. Biochemical investigations were done and review of such studies is given below:

Singh, Mehta, Sarkar, and Udupa (1977) conducted an experimental study on Shankhpushpi to study the psychotropic effect of this drug. 60 young growing male albino rats weighing 100-110g each were selected. All these animals were individually trained with a simple T-maze upto a criterion of mastery. After optimum training, the
rats were divided in three equal and uniform groups keeping equal number of animals with uniform body weight in each group. Group 1 was treated with the total alcoholic extract of the whole dry plant of Shankhpushpi in the dose of 50mg of dry extractive/100gm body weight suspended in water orally through a stomach tube, once a day for 10 days. Group 2 was given a standard psychotropic drug, triflupromazine in the dose of 2mg/110gm body weight suspended in water orally. Group 3 was given no treatment except 1ml water orally through the stomach tube and served as control. On 10th day, the activity of the animals of different groups was evaluated by repeating their movement in the T-maze in respect of the task for which they were trained before starting the experiment. The activity was graded in terms of the time consumed by the individual animal to reach their goal and the number of mistakes made by them during their movements. At the end of the experiment, a standard barbiturate hypnosis potentiation test was applied. Later on, the animals were sacrificed and neurochemical substances such as catecholamine, histamine, acetylcholine, and 5-hydroxytryptamine were also determined. Results revealed a reduction in the activity of the animals treated with Shankhpushpi in terms of increased time (p<0.01) and mistake score (p<0.05) while traveling in the T-maze. A significant (p<0.05) barbiturate hypnosis potentiation effect was seen in Shankhpushpi, though it was relatively less as compared to triflupromazine. The biochemical studies showed an increase in the level of histamine and 5-Hydroxytryptamine in animals of the treated group as compared to the controls. The acetylcholine and catecholamine contents of the whole brain tissue were reduced in treated group of animals as compared to controls, however, the values were statistically not significant. It was concluded that the plant appeared to produce its psychotropic action through an appropriate modulation of the neurochemistry of the brain.

Mudgal, Rai, Singh, and Udupa (1977) examined the neurohumoral changes which occurred under the influence of Shankhpushpi. Twenty four young albino rats weighing 100 ± 10 g were chosen as experimental animals. Two types of experiments were conducted. In short term experiments, control group received only distilled water. Group II was given single injection of water soluble alcoholic extract of leaves and flowers of Shankhpushpi in the dose of 300 mg/kg body weight intraperitoneally one hour earlier to sacrifice. In long term experiments, control group was given only distilled water, whereas Shankhpushpi treated group was given the drug in the dose of
1.20 g/kg orally once in a day, for a period of 10 days. These rats were sacrificed on the 10th day of experimentation. The acetylcholine, catecholamines, and histamine content per g of brain tissue were thereby determined. In short term experiments, Shankhpushpi treated groups showed significantly lower levels of acetylcholine and histamine (p<0.05). Statistically, there is no significant difference in the level of catecholamine in control and treated ones. In long term experiments, Shankhpushpi treated groups showed significantly (p<0.05) lower levels of all three neurohumors as compared to control group, indicated a definite psychoneurotropic action of this drug.

Singh, Sinha, Sarkar, and Udupa (1979) conducted a comparative biochemical study to examine the effect of four Medhya Rasayana drugs on some central neurotransmitters in normal and stressed rats. The drugs taken were Shankhpushpi, Mandukaparni, Yastimadhu, and Guduci for the investigation. Two series of experiments were conducted, one in young growing normal albino rats and other in simultaneously stressed albino rats. In each series, a desired number of rats of either sex weighing 100-120 g each were selected. They were divided in six groups. Group 1 served as control and received no treatment except 1.0 ml water fed orally through a gastric tube daily for 15 days. Group 2 was given 0.5 mg diazepam/100 gm body weight. Group 3, 4, 5, and 6 were treated with Shankhpushpi, Mandukaparni, Yastimadhu, and Guduci respectively at the dose of 50 mg/ 100 g body weight orally. Besides these drugs, all the animals in stressed series were simultaneously put to swimming stress one hour daily throughout the experiment. The experiments were continued for 15 days. On 15th day, the animals were sacrificed by decapitation. Their brain tissues were collected for estimation of acetylcholine, catecholamine, histamine, and serotonin. The results were computed to see the pattern of biochemical changes in brain under the influence of different test drugs. These drugs decreased the ACh content of the whole brain homogenate but notably raised the ACh content in the cortex. The catecholamine and 5 HT contents were also found raised. The histamine content was lowered in the whole brain homogenate while it was found raised in the cortex. The changes were more pronounced in stressed rats. It was concluded that the raised level of Ach in the cortex and increased 5 HT content in the whole brain tissue indicated that these drugs might have tranquilizing and sedative effect. On the other hand, the increased brain content of catecholamine indicated the antidepressant action of these drugs. Thus, these drugs
might improve the mental functions by a proper balance of the biochemical activities in
the brain.

Joshi, Balasinor, and Nayampalli (1995) conducted a study to investigate the effect of
Convolvulus pluricaulis chois on biogenic amine levels in rat brain. Estimation of
biogenic amines like norepinephrine (NE) and dopamine (DA) was carried out in rat
brain following Convolvulus pluricaulis choisy (CPC) ethanol extract treatment. Albino
rats were divided into 2 groups. One group was given Convolvulus pluricaulis ethanol
extract suspended in CMC continuously for 21 days and other group received only 0.5%
CMC suspension. At the end of study, rats were killed and estimation of biogenic
amines in limbic region was carried out on HPLC with electrochemical detector.
Norepinephrine showed statistically significant decrease (p < 0.001) but dopamine did
not show any marked alteration. It was concluded that norepinephrine decrease in
limbic region of rat brain after CPC treatment can be suggestive of its memory
enhancing effect.