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RESEARCH ARTICLE

Green chilli : A memory booster from nature

MILIND PARLE AND SUSHILA KAURA

ABSTRACT

Green chilli forms an excellent combination of healthy ingredients and essential nutrients. Apart from its traditional and culinary uses, its therapeutic and pharmacological actions are noteworthy. This study was designed to investigate the memory enhancing potential of green chilli in mice. A total of 125 Swiss Albino mice divided in 25 groups were employed for the study. *Capsicum frutescens* (CF) paste was administered daily for 10 successive days in 3 different concentrations (2 %, 4% and 8%w/w) along with diet. CF paste significantly ($p<0.01$) reduced the transfer latency of mice in Elevated Plus maze model. CF paste significantly ($p<0.01$) enhanced the discrimination index in Object Recognition Task. Amnesia induced by scopolamine (0.4mg/kg, i.p) and diazepam (0.1mg/kg, i.p) was reversed by green chilli in the present study. Memory enhancing effect of green chilli was comparable to that of standard drugs *viz.*, piracetam (nootropic agent) and donepezil (acetylcholinesterase inhibitor). Brain AChE activity was reduced significantly by green chilli, thereby indicating enhanced cholinergic transmission. Brain GSH levels were markedly increased, thereby suggesting enhancement in scavenging of free radicals. Thus, the net effect of green chilli appears to be resulting in improvement of memory reversal of memory, deficits and enhanced scavenging of free radicals.

Key words : *Capsicum frutescens*, Memory, Green chilli

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INTRODUCTION

Memory forms one of the most complex functions of the brain and involves multiple neuronal pathways and neurotransmitter systems. Principally, memory processes involve perception, registration, consolidation and retrieval/ process of recalling (Smith, 1988). There are different types of memory such as short term, long term, semantic, episodic, flash bulb and autobiographical memory. In laboratory animals short term memory is measured using Elevated Plus Maze. Recently recognition of novel objects is used as a learning task for testing recognizing ability of the laboratory animals. Age, stress and emotions are the conditions that may lead to memory loss, amnesia, anxiety, high blood pressure, dementia, or other threats like Schizophrenia and Alzheimer's disease (AD) (Parle and Vasudevan, 2007). Nature provides wonderful remedies to restore one's fitness. A number of herbs traditionally employed in Indian system of medicine "Ayurveda," have yielded positive results. Therefore, herbal therapies should be considered as alternative/complementary medicines. Green chilli is a fruit of the flowering plant *Capsicum frutescens*. It is a combination of healthy ingredients and essential nutrients. It is a good source of vitamins (A, C, B, E and P), minerals (iron, magnesium and potassium), dietary fibres and macronutrients. Apart from its traditional and culinary uses, its therapeutic and pharmacological actions are worth mentioning. Medicinally, green chilli plays a prominent role as an immunity booster and possesses anti-cancer, anti-ulcer, analgesic, anti-inflammatory, anti-epileptic and anti-obesity properties. It has proved helpful in diabetes, burns, psoriasis and chronic migraine. It is quite beneficial for heart and lungs. Green chilli is famous for its

MEMBERS OF THE RESEARCH FORUM

Address for correspondence :
MILIND PARLE, Department of Pharmaceutical Sciences, Guru Jambeshwar University of Science and Technology, HISAR (HARYANA) INDIA
Email : mparle@rediffmail.com

Coopted auhors :
SUSHILA KAURA, Department of Pharmaceutical Sciences, Guru Jambeshwar University of Science and Technology, HISAR (HARYANA) INDIA

intense pungent taste, which is provided by its active constituent capsaicin (Parle and Kaura, 2012). However, there are no concrete reports about psychopharmacological actions of green chilli. Therefore, the present study was undertaken with an objective to assess the potential of green chilli.

Objectives :

The present study was undertaken to explore the memory enhancing potential of green chilli using various exteroceptive and interoceptive behavioral models. Effect of green chilli was studied on brain acetylcholinesterase activity and brain glutathione levels to determine the underlying mechanism of action.

MATERIALS AND METHODS

Plant material :

The fresh green chilli was purchased from local market of Hisar and got authenticated from Raw Materials Herbarium and Museum, National Institute of Science Communication and Information Resources (NISCAIR), New Delhi (Ref. NISCAIR/RHMD/Consult/-2011-12/1895/195). Fresh green chilli paste was administered in different concentrations (2, 4, 8% w/w with diet) daily for a duration of 10 days to mice.

Animals :

A total of 125 Swiss mice were divided into 25 groups. Each group comprised of a minimum of 5 animals. Adult (6 months old) mice, of either sex, weighing around 20-25g were procured from the Disease Free Small Animal House, Lala Lajpat Rai University of Veterinary Sciences, Hisar. The experimental protocol was approved by the Institutional Animals Ethical Committee (IAEC) and the care of animals was taken as per guidelines of CPCSEA, Ministry of Forests and Environment, Government of India (Registration number 0436).

Drug protocol :

Normal saline (vehicle, p.o), piracetam (400mg/kg), donepezil (1mg/kg) and *Capsicum frutescens* {(CF) 2%, 4% and 8% w/w)} were administered for 10 successive days to mice. Scopolamine (0.4mg/kg) and diazepam (1mg/kg, i.p) were administered on 9th day. Biochemical studies were carried on 10th day after drugs/vehicle/CF administration.

Experimental design :

Exteroceptive behavioural models :

Elevated plus maze :

The elevated plus maze served as the exteroceptive behavioral model (where in stimulus existed outside the body) to evaluate learning and memory in mice. The experimental protocol and design was as per (Parle and Vasudevan, 2007).

Object recognition task :

Object recognition task is a convenient model used to evaluate the object recognition memory in mice. The experiment was performed according to (Dere *et al*., 2007).

Interoceptive behavioral models :

Scopolamine induced amnesia and diazepam induced amnesia were used as interoceptive behaviour models for the present study (Rahman *et al*., 2011).

Collection of brain samples :

The animals were sacrificed by cervical decapitation under light anesthesia on the 10th day, 90 min after administration of the last doses of CF or standard drugs or vehicle. Then, whole brain was carefully removed from the skull. The whole brain was weighed and transferred to a glass homogenizer and homogenized in an ice bath after adding 10 volumes of sterile normal saline injection. The homogenate was centrifuged at 3000 rpm for 10 min and the resultant cloudy supernatant liquid was used for biochemical estimations (Dua *et al*., 2009).

Biochemical estimations :

Estimation of brain acetylcholinesterase :

Brain acetylcholinesterase was estimated using Ellman method (Ellman *et al*., 1961).

Estimation of brain reduced glutathione level :

Ellman method was used for measuring glutathione spectrophotometrically (Ellman, 1959).

Statistical analysis :

All the results were expressed as mean standard error (S.E.M.). Data were analyzed using one-way ANOVA followed by Dunnett's *t*-test. $P < 0.05$ was considered as statistically significant.

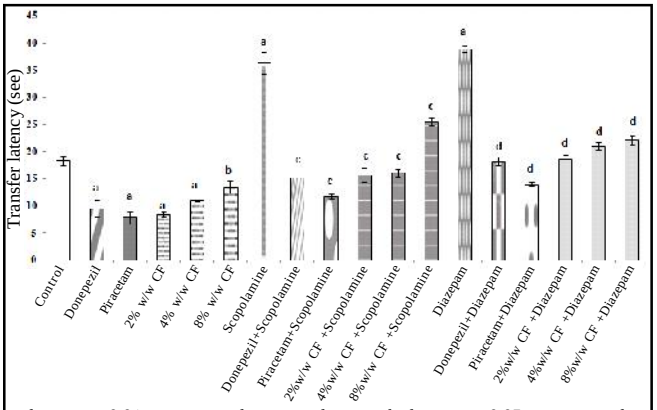
RESULTS AND DISCUSSION

The findings of the present study as well as relevant discussion have been presented under following heads :

Effect on transfer latency (TL) :

In Elevated Plus Maze, transfer latency of first day represented learning ability of animals, whereas the transfer latency of second day indicated memory. TL is defined as the time taken by the mice to move into one of the covered arms with all its four legs. *Capsicum frutescens* (CF) paste reduced the transfer latency (TL) of mice remarkably ($p<0.01$) in comparison to control group, when administered at 2 and 4 per cent w/w concentrations (Fig. 1) along with diet for 10 successive days. Reduced TL indicates better memory performance of mice. Scopolamine (0.4mg/kg, i.p) and diazepam (1mg/kg, i.p) increased the TL significantly ($p<0.01$), showing memory impairment.

CF at 2, 4 and 8 per cent w/w concentrations reversed the memory deficits produced by these drugs. Animals treated with piracetam (400mg/kg) and donepezil (1mg/kg) showed remarkable improvement ($p<0.01$) in memory. These drugs also reversed the amnesia induced by scopolamine and diazepam. The effect of CF was found to be comparable to that of piracetam (nootropic agent) and donepezil (Acetylcholinesterase inhibitor).



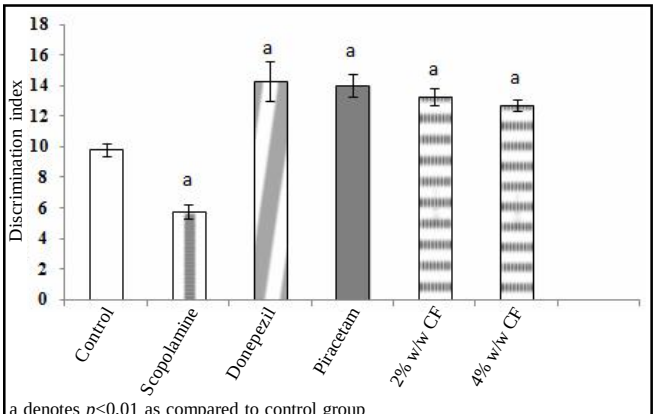
a denotes $p<0.01$ as compared to control group; b denotes $p<0.05$ as compared to control group

c denotes $p< 0.01$ as compared to scopolamine alone; d denotes $p< 0.01$ as compared to diazepam alone

Fig. 1 : Effect of *Capsicum frutescens* paste on transfer latency of mice using elevated Plus Maze

Effect on discrimination index using object recognition task :

Discrimination index (DI) is the ratio of exploration time of novel object and familiar object. CF at 2 and 4 per cent w/w increased the DI considerably ($p<0.01$), when compared to control group animals. Increase in DI indicates enhanced recognition memory (Fig. 2).

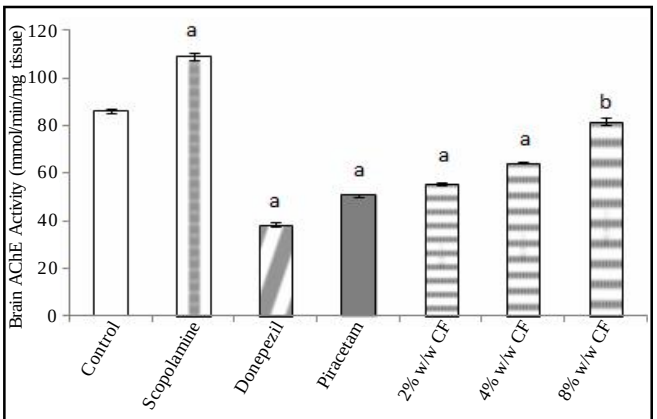


a denotes $p<0.01$ as compared to control group

Fig. 2 : Influence of *Capsicum frutescens* paste on discrimination index using object recognition task

Effect on brain acetylcholinesterase activity :

Acetylcholine is considered to be the most important neurotransmitter involved in the regulation of cognitive functions. *AChE* enzyme controls the concentrations of acetylcholine in brain by degrading acetylcholine. In the present study, inclusion of both 2 per cent w/w CF and 4 per cent w/w CF (Fig. 3) in the daily diet produced remarkable inhibition ($p<0.01$) of AChE activity, when measured spectrophotometrically. The influence of CF on AChE was similar to that of standard AChE inhibitor *i.e.* Donepezil.

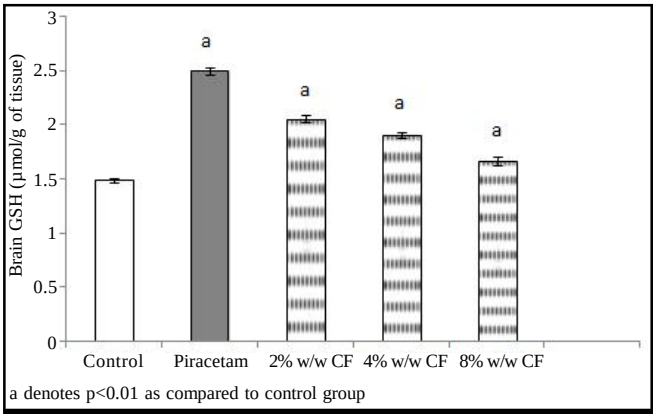


a denotes $p<0.01$ as compared to control group; b denotes $p<0.05$ as compared to control group

Fig. 3 : Influence of *Capsicum frutescens* paste on brain acetylcholinesterase activity

Effect on brain glutathione levels :

GSH is a free radical scavenger. There was a significant ($p<0.01$) rise in the levels of GSH in the brains of CF treated mice, which indicate the inhibition of free radical generation (Fig. 4).



a denotes $p<0.01$ as compared to control group

Fig. 4 : Influence of *Capsicum frutescens* paste on brain GSH level

Learning and memory are two fundamental cognitive functions that confer us the ability to accumulate knowledge from our experiences (Liu *et al.*, 2009). There are different types of memory such as short term, long term, semantic, episodic,

flash bulb and autobiographical memory. Learning is the acquisition of any new information and skill about the events occurring in surroundings. Subsequent retrieval/application of this information/skill is referred to as memory. The cognitive dysfunctions include those behavioral disorders, where organic personality defects are observed e.g. dementia, AD, Schizophrenia, OCD and major depression (Parle and Vasudevan, 2007). Dementia is a chronic mental disorder of intellectual functioning caused by brain degenerative disease, or destruction of brain tissue through physical trauma such as stroke. Presently, there are no satisfactory diagnostic procedures and therapeutic regimens available for the management of AD. Therefore, neuroscientists all over the world are busy exploring the usefulness of alternative systems of medicine (e.g. Nature cure, Ayurveda, Homeopathy etc). In the present study, we have focused upon the effects of green chilli on memory. In laboratory animals, short term memory is measured using Elevated Plus Maze. Scopolamine and diazepam induced amnesia are the interoceptive behavioral models that were utilized to evaluate the memory enhancing potential of green chilli. Piracetam (a nootropic agent) and donepezil (an AChE inhibitor) were used in the study for the comparison as standard memory enhancers. Administration of *Capsicum frutescens* (CF) paste for 10 successive days in different concentrations showed memory enhancement in mice as reflected by reduced transfer latency using Elevated Plus Maze and increased discrimination index using object recognition task. Since, green chilli produces consistent improvement in memory in all the exteroceptive memory models, it appears to be a promising memory enhancing agent. Furthermore, pretreatment of animals with CF for 10 days, protected the animals from amnesic effect of scopolamine and diazepam. These findings suggest the neuroprotective role of green chilli in brains of mice. Inflammation plays a prominent role in AD.

Cognitive functions are thought to be regulated by acetylcholine, which is an important neurotransmitter in brain (Bartus *et al*., 1982). The slow death of brain cells particularly cholinergic neurons appears to be the main cause for the development of Alzheimer's disease. Impairment of cholinergic function is linked with cognitive dysfunction and facilitation of central cholinergic activity is found to be associated with improved cognition. In the present study, green chilli produced significant inhibition of AChE activity. AChE is an enzyme, which terminates the action of Ach by degrading Ach into Acetyl CoA and choline. Green chilli inhibited the AChE activity leading to increased accumulation of Ach at the synapse and facilitation of cholinergic transmission.

GSH (Glutathione) is a major endogenous antioxidant produced by the cells. It prevents damage to important cellular components by participating directly in the neutralization of free radicals and reactive oxygen compounds. Thus, Glutathione (GSH) is the major free radical scavenger in the brain. Increase in its level indicates neuroprotection. In the current study, there was a significant rise of GSH levels in the brain of CF treated mice. This observation suggests the neuroprotective effect of green chilli. Thus, green chilli can be looked upon as a memory enhancer in view of its multiple beneficial actions.

Conclusion :

Green chilli is a promising memory enhancer. The underlying mechanism of action of green chilli appears to be dependent on- i) improvement of memory in exteroceptive models ii) reversal of memory deficits iii) enhanced scavenging of free radicals and iv) inhibition of AChE enzyme. Therefore, it is worthwhile to explore the usefulness of green chilli in the management of various cognitive disorders.

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Scientific paper, "Green chilli : A memory booster from nature" won prize in poster presentation at the International Conference on Pharmaceutical Drug Discovery and Development Future Perspective, held on 28th and 29th July, 2012 at Sirsa.

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