Evaluating possible spatial memory enhancement and psychosomatic balance using *Daucus Carota* juice in wistar rats

ABSTRACT

Daucus carota (carrot) is one of the main vegetable crop cultivated worldwide. They are good sources of carbohydrates, minerals, dietary fiber, and phytochemicals like carotenes and phenolic compounds. In this study, the effect of carrot juice on memory impairment and anxiety-like behaviour was investigated. The study was carried out using memory and anxiety tasks such as passive avoidance test, navigation and elevated plus maze. This test involved three trials per week for a total period of three weeks. Twenty wistar rats of weight 120-150g were used. The animals were divided to four groups having five animals each group. Group one served as the control and was given feed and saline water. Group two was administered low dose of carrot juice (1ml/100g) orally. Group three was given an intermediate dose of 2ml/100g orally. The fourth group was administered a high dose (3ml/100g) of carrot juice orally. Elevated plus maze test was used to observe anxiety in the rat. Elevated plus maze usually used as a screening test for putative anxiolytic or anxiogenic compounds in neurobiological anxiety research. Navigation and passive avoidance test were used to test for memory impairment. Navigational maze is employed in behavioral neuroscience to study spatial stated that the test could be a very precise study of learning memory and spatial working and is also capable of accessing damages to cortical regions of the brain. The passive avoidance test is useful for evaluating the effect of novel chemicals entities on learning and memory as well as studying the mechanism involved in cognition. The study revealed that carrot juice has significant effects ($p<0.05$) in memory improvement but has no anxiolytic significance.

Keywords: *Daucus carota, wistar rats, Elevated Plus maze, Navigation maze, Passive avoidance test*

Introduction

Neurobiological studies of the brain, has accomplished a common theoretical scaffold that expands from molecular and cell biology, on the one hand, to psychology and brain system biology, on the other [1]. The molecular and cellular foundation of learning and memory is an issue that has captivated neuroscientists for decades. The absolute intricacy of how we construe, remember, and forget our incidents seem impossible to understand at the cellular and molecular level. Through the use of many different learning and memory paradigms in different model organisms, we are beginning to have a basic understanding of the molecular changes that allow neurons to create and store memories. Learning is the incidence-reliant attainment of skills and knowledge, whereas memory is the preservation and retrieval of events or facts composed of experiences [2]. Memory, as calculated by modifications in an animal's behavior sometime after learning, mirrors various processes including acquisition, consolidation, retention, retrieval and

performance [3]. Molecular mechanisms of memory have focused mainly on the roadways that underlie acquisition. This emphasis is due, in large part, to the success of in vitro models of learning, including forms of synaptic plasticity such as long-term potentiation (LTP) [4] [5] Based on experimental and clinical evidences, acetylcholine (ACh) is considered the most important neurotransmitter involved in regulation of cognitive functions. [6] Alzheimer's disease (AD) is the most common agerelated neurodegenerative disorder characterized by cognitive dysfunction with memory impairment and behavioral disturbances [7]. Besides the neuropathological hallmarks of the disease, neurofibrillary tangles and neuritic plaques, AD is characterized by a consistent deficit in cholinergic neurotransmission particularly in basal forebrain [8].

According to Centre for Disease Control and Prevention memory decline has become a public health issue. It can have implication for living with and managing chronic disease, or performing everyday activities like cooking and cleaning. It is one of the earliest noticeable symptoms of Alzheimer's disease and related dementias [9]. Some memory decline can occur as adult age, but frequently forgetting how to perform routine tasks, for example, is not a normal part of aging and can affect a person's ability to live and function independently 10]. This research addresses the problem of memory impairment and anxiety-like behavior.

Materials and Methods

Collection of Carrot

The carrot carrots used were purchased from Aluu market, Aluu, River State. The root of the carrot was blended to juice for use in the study.

Collection of Experimental Animals

The experimental animals (Albino Wistar rat) used were collected from the animal house of the Physiology Department, in the University of Port Harcourt. The rats were kept to acclimatize for two (2) weeks. The rats were kept in cages with enough ventilation and sawdust was used to make beddings for them, they were fed with feed and water *ad libitum*. The animal handling,

care and procedure were carried out on the specification of the University of Port Harcourt Ethical committee in line with the International Committee on Laboratory Animals

Animal Grouping

The animals were grouped in four groups, with five animals in each group:

Group 1: Control, administered *ad libitum* water and feed

Group 2: 1ml/100g of carrot juice was administered to each animal in this group

Group 3: 2ml/100g of carrot juice was administered to each animal in this group

Group 4: 3ml/100g of carrot juice was administered to each animal in this group

Research Design

The carrot juice was administered orally, using a cannula during the period of acclimatization and in the course of the study.3 trials were done for each experimental group for 3 weeks duration.

Navigation Test

Overall, maze learning has been widely used to probe for the role of the hippocampus in rodent learning and memory. It's is a box with an entrance and exit, with a complicated maze. The animal is place at the entrance of the maze, and allowed to find its way to the exit within a five minute time frame.

Passive Avoidance Test

This test is based on the innate aversion of rodents to brightly illuminated areas, and on the spontaneous exploratory behavior of rodents in response to mild stressors, ie, novel environment and light [11]. This model permits rat to freely explore two interconnected compartments that vary in size (2:1), color (white:black) and illumination (bright:dim). The white, brightly lit compartment is free of aversive stimulation whereas the black, dark compartment is equipped

with shock capability. Its measures the basic ability to learn and remember the presence and place of a shock stimulation.

Individual rats are place in the light compartment, with the rat facing the door leading to the dark compartmentand observed in five minutes.

Elevated Plus Maze Test

The elevated plus maze is in the form of a plus-sign, with two open elevated arms facing each other and separated by a central square and two arms of the same dimensions, but enclosed by walls. The maze is raised off the ground so that the open arms combine elements of unfamiliarity, openness, and elevation. The EPM is based on the natural aversion of rodents to open spaces, and uses conflict between exploration and this aversion, [12] .Each rat was placed in the center of the plus-maze, facing one of the closed arms and observed for five minutes. The number of entries into the closed or the open arms, as well as the time spent in each type of arms was recorded. The entry with all four feet into one arm was defined as an arm entry. At the end of each trial the maze was wiped clean.

Statistical Analysis

Results of the study were analyzed using ANOVA and Post Hoc LSD using SPSS version 23.

Result and Discussion

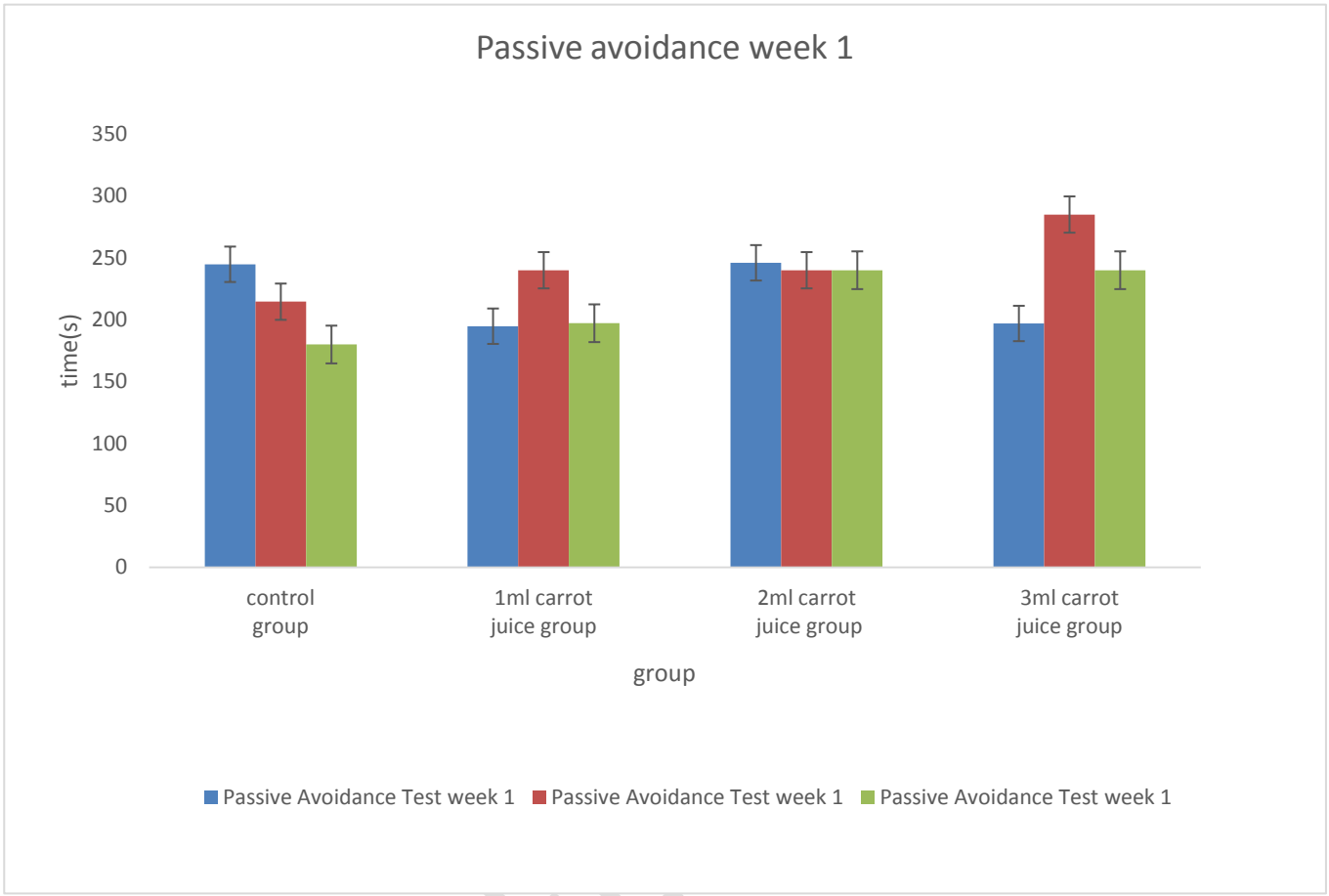

Figure 1 Spatial memory evaluation using passive avoidance test on the test groups' week 1

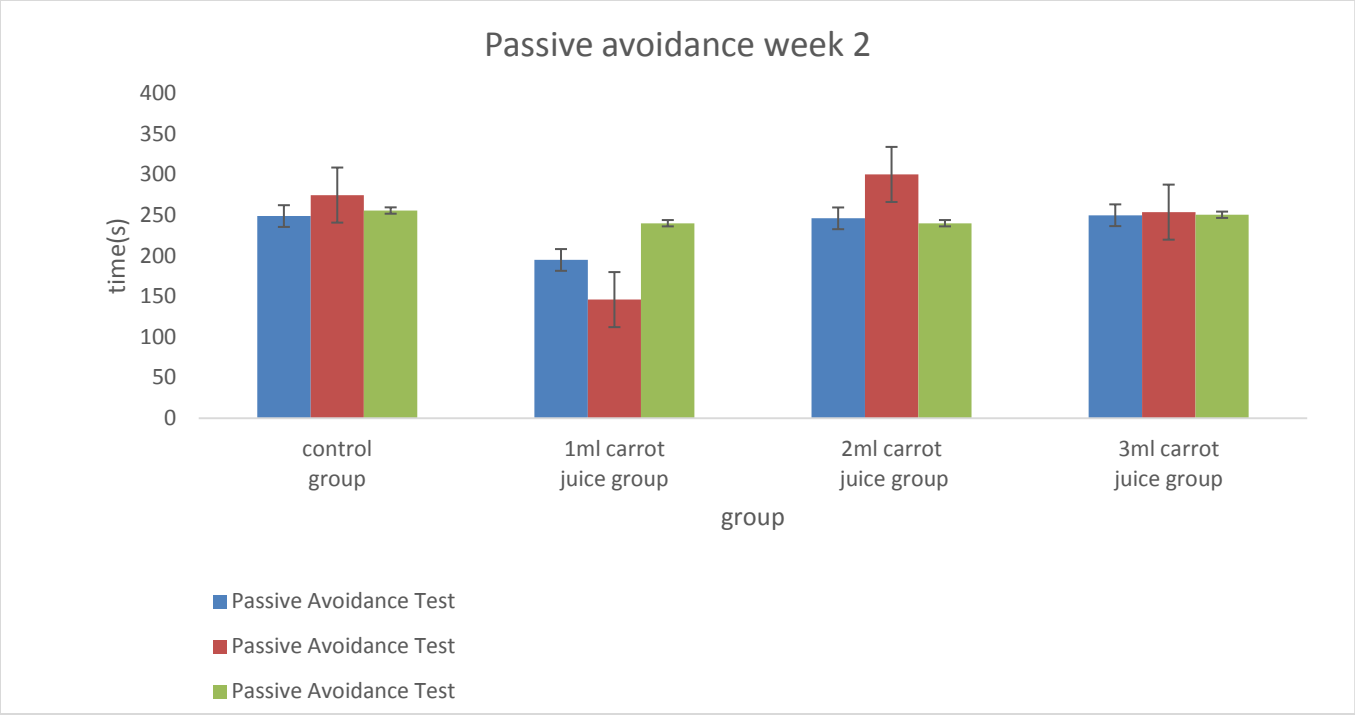

Figure 2 Spatial memory evaluation using passive avoidance test on the test groups' week 2

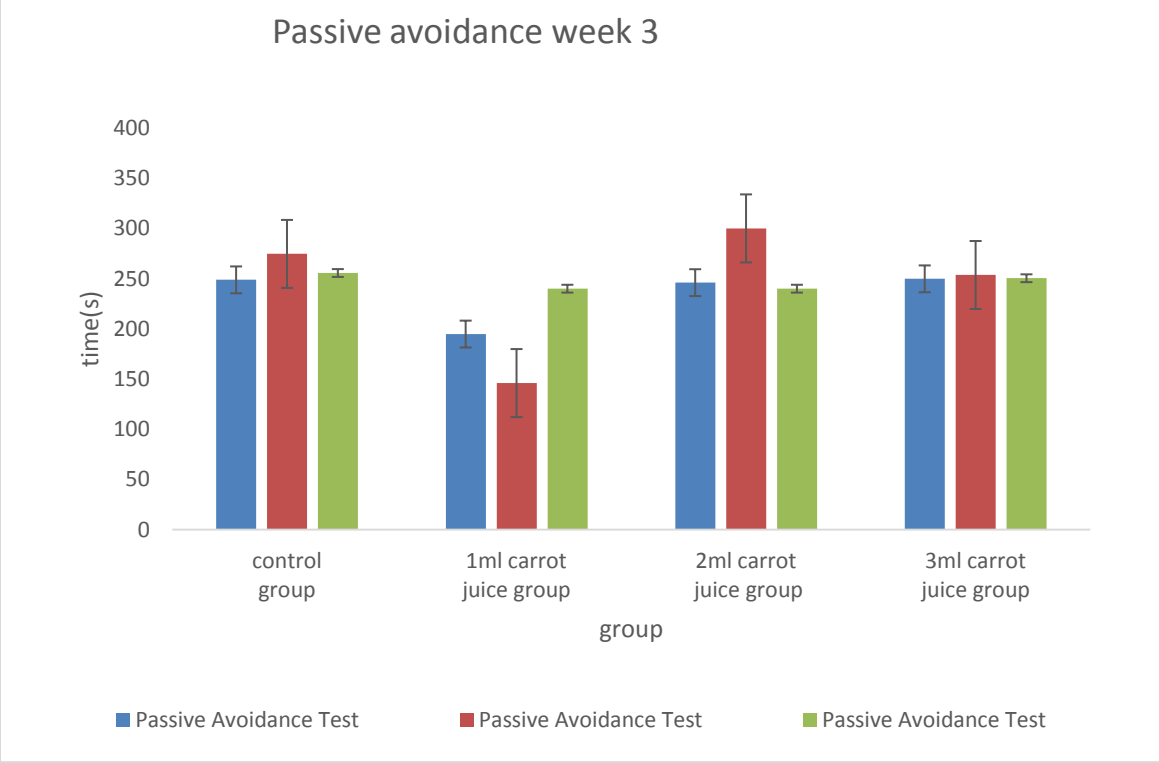

Figure 3 Spatial memory evaluation using passive avoidance test on the test groups' week 3

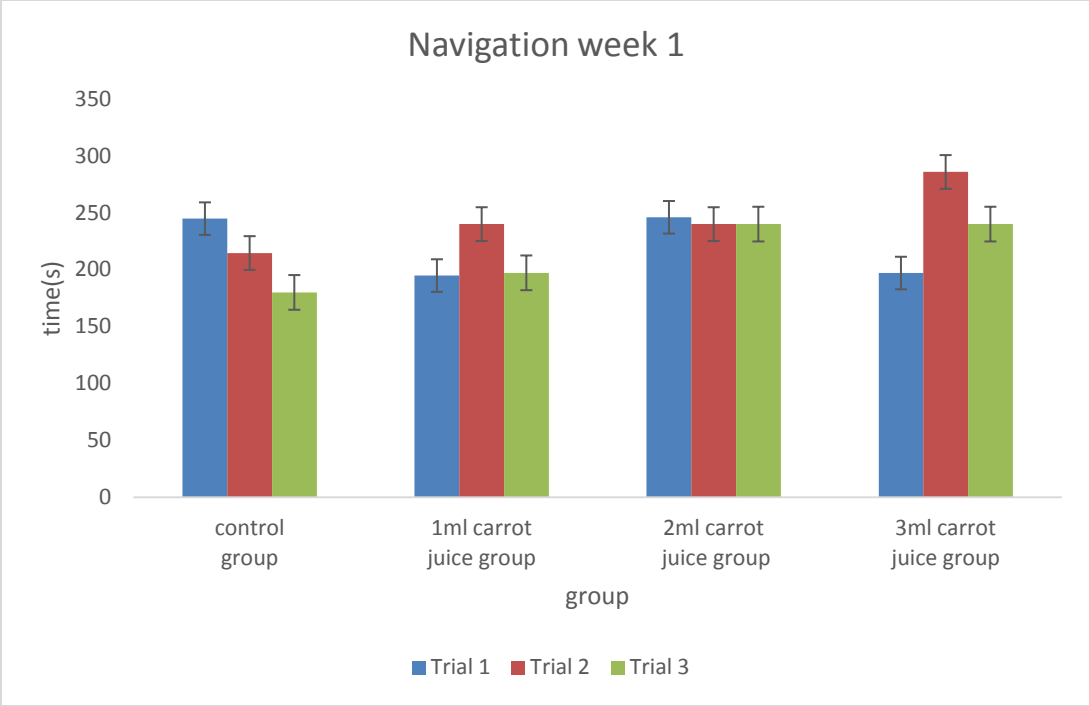

Figure 4 Evaluation of adaptive locomotion using Navigation maze Task in the test groups In week 1

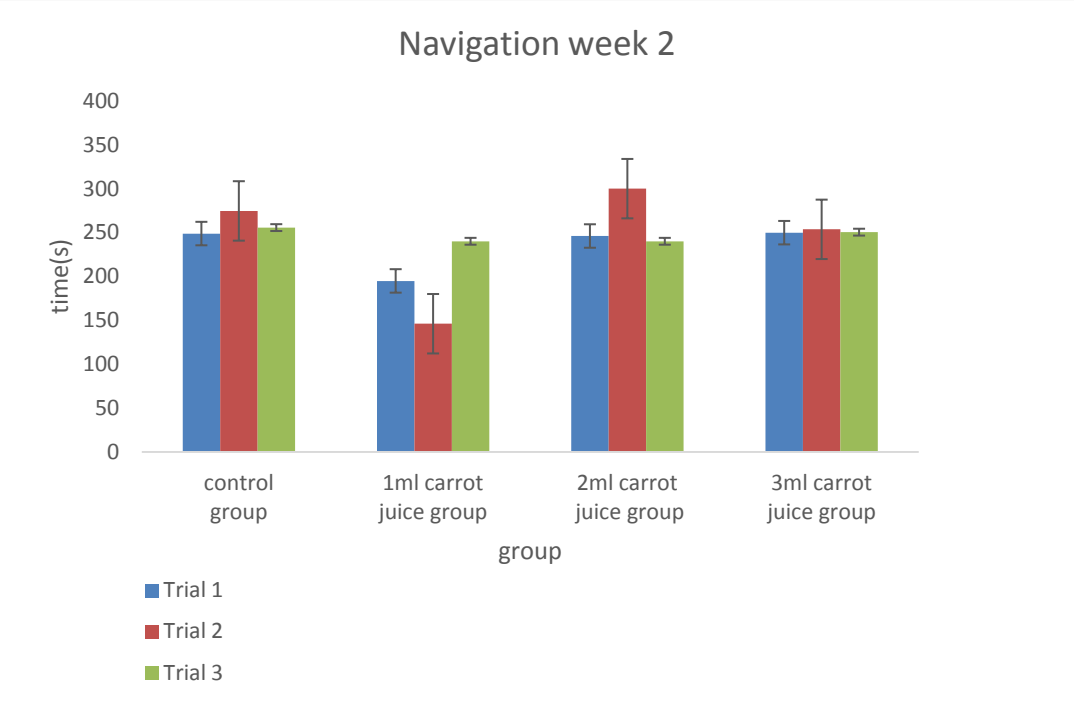

Figure 5 Evaluation of adaptive locomotion using Navigation maze Task in the test groups In week 2

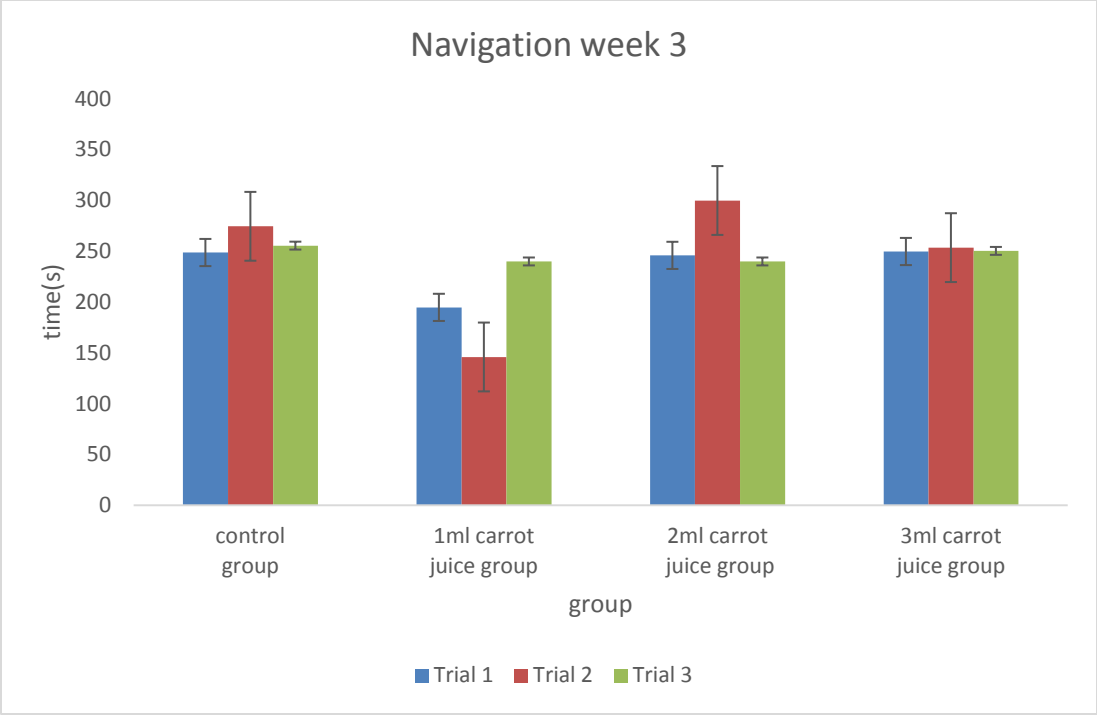

Figure 6 Evaluation of adaptive locomotion using Navigation maze Task in the test groups In week 3

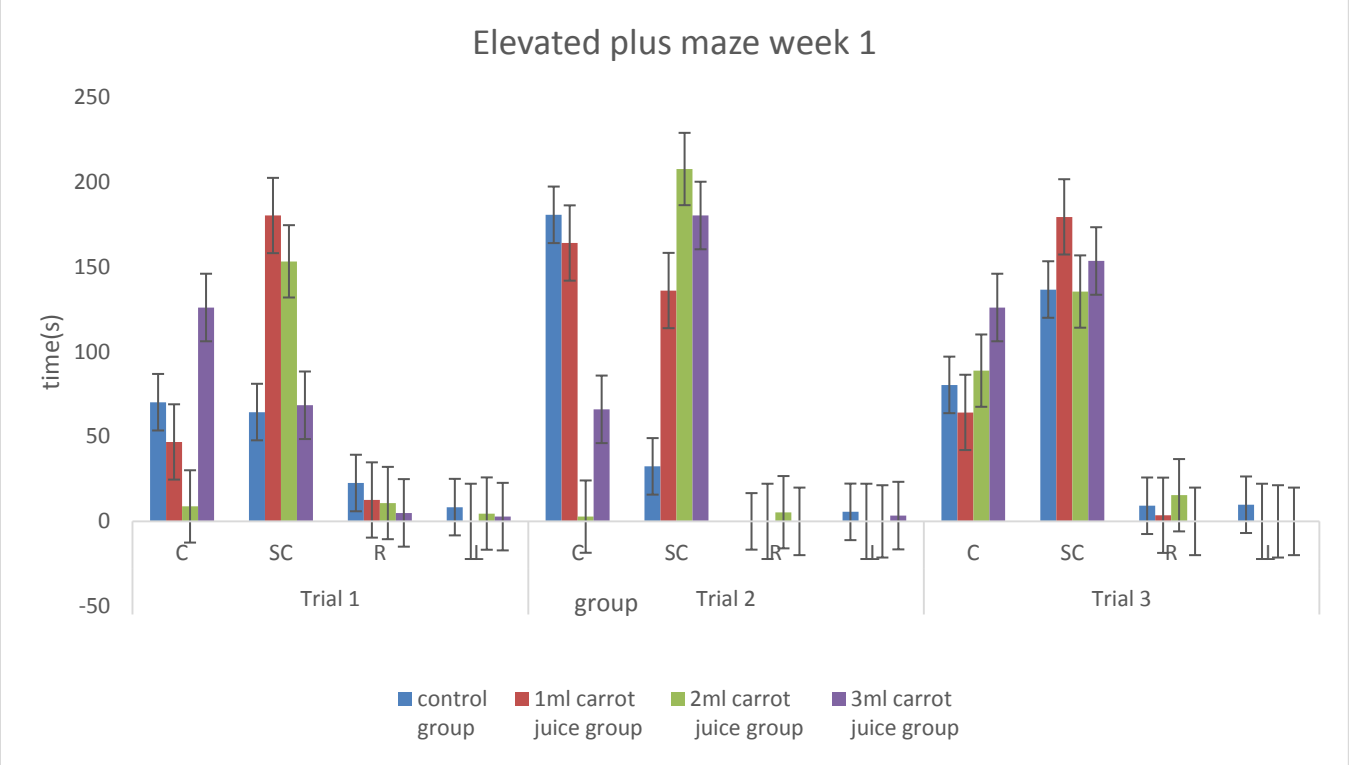

Figure 7 Evaluation of psychic response and anxiety using Elevated Plus Maze in the test and control group in week 1
(C= close arm, SC= semi close, R= right arm, L= left arm)

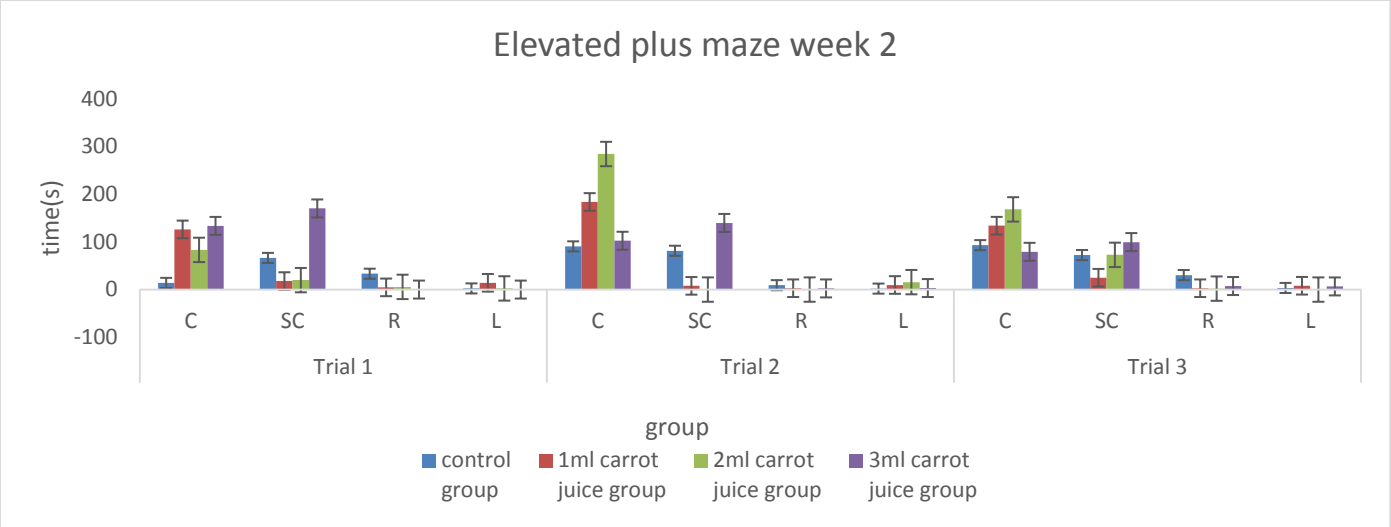

Figure 8 Evaluation of psychic response and anxiety using Elevated Plus Maze in the test and control group in week 2.
(C= close arm, SC= semi close, R= right arm, L= left arm)

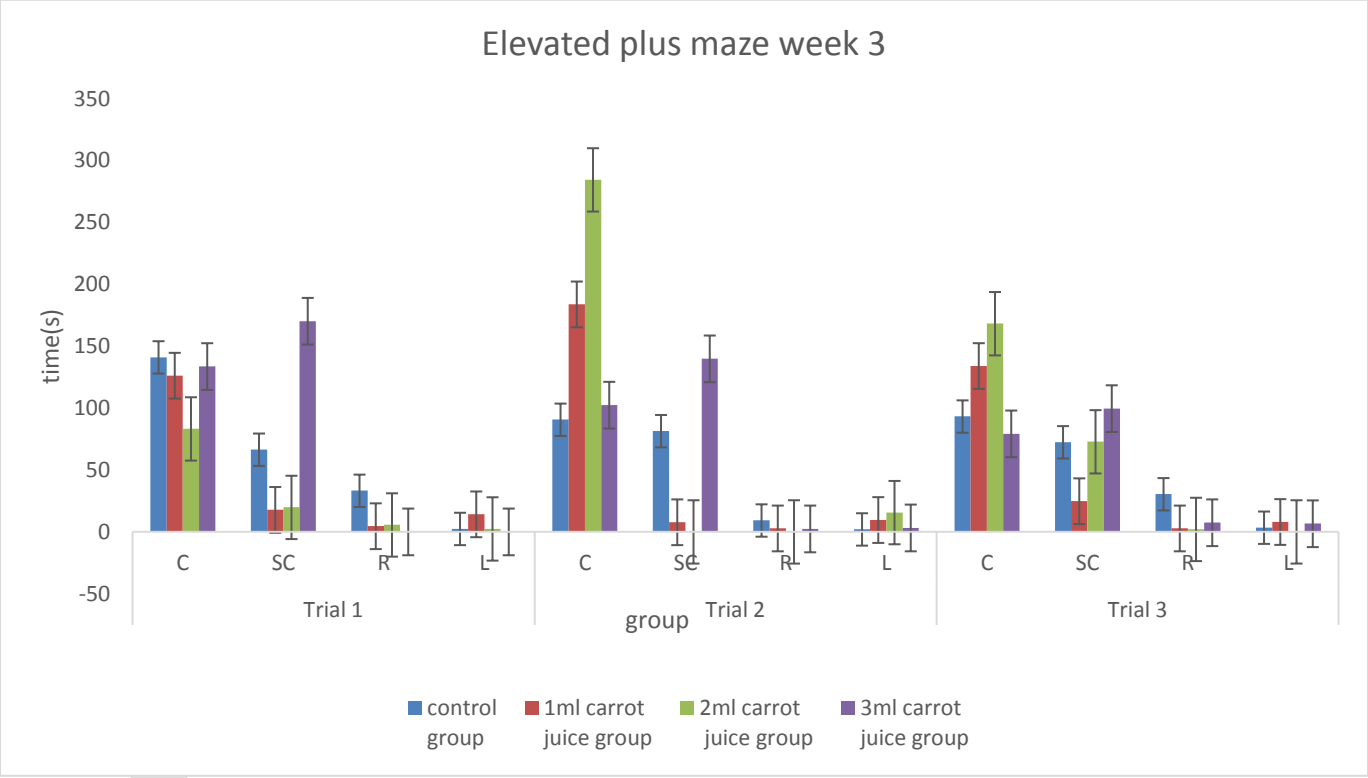

Figure 9 Evaluation of psychic response and anxiety using Elevated Plus Maze in the test and control group in week 3
(C= close arm, SC= semi close, R= right arm, L= left arm)

DISCUSSION

The present study was designed to evaluate the possible effect of carrot juice on memory enhancement or impairment and psychic behavior in albino wistar rats. The extrapolations from the study revealed that the juice could be potentially be viable in spatial memory up regulation enhanced psychic response as demonstrated in the study. The administration of the juice after the second week produced some levels of significant $p < 0.05$) spatial tasks evaluated to be successful exponentially as the observations progressed. The positive results obtained from the various maze tasks showed a dose-dependent and time-dependent evidence of the intrinsic potency of the carrot juice. For instance**,** as expected, from figure 1 no significant effect was observed from week 1 to week 3 at control group across the whole trial in the study. Across the weeks of group two which was administered1ml of carrot juice, a difference was observed¸ though not significant. Group 3 which was administered 2ml of carrot juice showed significant ($p< 0.05$) difference. At 3ml carrot juice administered, significant difference could also be seen in this group. Overall, the result of the passive avoidance test showed that small quantity of carrot juice produce no significant different but with increase in dose administration, it produced a significant difference in most of the trials, showing an increment in memory function in terms of retention and retrieval. This observation agrees with previous similar study carrot out using carrot seed extract which improved memory [13].

Navigational maze is employed in behavioral neuroscience to study spatial stated that the test could be a very precise study of learning memory and spatial working and is also capable of accessing damages to cortical regions of the brain. Figure 2 reported the result obtained for navigation test from week 1 to week 3. At control group, no significant effect was observed across the week and trials. At 1ml administration in group two, significant difference was

recorded. Group three and four with treatment of 2ml and 3ml respectively, showed no difference. This study showed that with lesser dose of the treatment there was an improvement in memory, and higher doses did not make the memory any better, as observed in group three and four. This study agrees with similar study that where there was a reduced ability in the high dose group [14]. Memory consolidation improved the adaptive locomotion in the test groups. There was active communication proceeding from the memory circuit towards the motor component of the body that enabled the animals to complete the process of navigation faster than the control group. The proprioceptive component of the peripheral nervous system that sub serves the cerebellum was well modulated and tht accounted for the quality of motor performance observed in the test groups. Poverty of movement was adjudged to be very low in the groups that received the carrot juice. The general assessment of motor performance using the maze showed that the juice could be a good stimulator in certain aspects of motor functions.

Elevated plus maze usually used as a screening test for putative anxiolytic or anxiogenic compounds in neurobiological anxiety research. (Figure 3) reported the result obtained for elevated plus maze test from week 1 to week 3. In the control no significant difference was observed. Group two which was administered 1ml of carrot juice showed no significant difference. Group 3 which was administered 2ml of carrot juice also showed no significant difference, as well as group four, which was administered 3ml of carrot juice. This study showed that carrot juice had no effect in ameliorating anxiety in albino wistar rat. This study agree with similar study as rodents tend to remain on the open arms for less time compared with the closed arms [15].

Conclusion

Carrot juice has demonstrated a significant effect on improving memory in wistar rat. The significant psychomotor effect from the juice was observed to be useful especially in unfamiliar scenarios and seemingly complex task. The effective quantity of the juice has be commensurate to the level of mental task and challenges since the pattern of potency follows dose concentration and period of administration.

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