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Functional Food and Nutraceutical in the Alleviation of Oxidative Stress-induced Depression in Experimental Animal Model

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ABSTRACT: *Oxidative stress induces imbalance between prooxidant and antioxidant level, which results in production of reactive oxygen species (ROS). The ROS in excess react with macromolecules of the cell- fatty acid, DNA, protein, and thus, cause damage the macromolecules surpassing the natural antioxidant defense mechanisms and thus, contributing several chronic diseases. Reserpine (0.38mg/kg body weight) was injected intraperitoneally in Wistar Albino rats to develop depression. The stressed rats were treated with orange fleshed sweet potato (OFSP) and carrot, and the nutraceutical- vitamin C. Depression alleviation was evaluated by analysis of plasma stress marker malondialdehyde (MDA), superoxide dismutase (SOD) and nitrous oxide (NO). The functional food and nutraceutical reduce oxidative stress indicated by biochemical stress markers- MDA level decline and SOD and NO rise significantly. Hence, the functional food and nutraceutical having antioxidant potential- phenols and carotenoids, may be effective in alleviation of stress induced depression.*

KEYWORDS: Functional food, Nutraceutical, Oxidative stressed depression, Alleviation, Oxidative markers

INTRODUCTION

Oxidative stress is induced due to biochemical imbalance between prooxidant and antioxidant level, which results in production of reactive oxygen species (ROS) surpassing naturally antioxidant defence mechanisms[1]. Antioxidants have a crucial role in maintenance of this balance[2]. Depression has been reported to be associated with oxidative stress[3].

Mitochondrial oxidative processes generate highly reactive free radical species, which, in excess, react with macromolecules of the cell- fatty acid, DNA, protein, and thus, cause damage the macromolecules. Functional foods and nutraceuticals (provide medical or health benefit)[4] are highly nutritious and are associated with a number of health benefits contributing to prevention and reduction of risk factors for several diseases or enhancing certain physiological functions[5,6]. It is because of containing high content of physiologically active antioxidant polyphenols, B-carotene[7]. It has been reported that the functional food- orange fleshed sweet potato (OFSP), carrot and vitamin C contained antioxidant nutrients[8-10], which can strongly scavenge the reactive free radical species. The present study, in order to reduce the oxidative stress induced by free radical species, attempted to evaluate the effect of the functional food and nutraceutical in alleviation of oxidative stress induced depression in rat model.

MATERIALS AND METHODS

Experimental Animal

The experiment was conducted on 30 healthy Wistar albino rats of age 50-60 days and weight ranged between 90-140 g collected from Pharmacy department, Jahangirnagar University, Savar. The animals were adapted for 7 days with basal diet and water in the animal house at the Institute of Nutrition and Food Science (INFS), University of Dhaka. Ethical permission was taken from the Ethical Committee of the Faculty of Biological Sciences, University of Dhaka

Depression Development

An intraperitoneal injection of 0.38mg reserpine/kg body weight was given to 25 rats to induce oxidative stressed depression. This dose of reserpine has been reported to induce depression. The animals were grouped into A, B, C, and D containing 5 rats each group, the remaining 5 rats was treated as normal control F. Group A and B animals were fed with 25 g of boiled OFSPs and carrot respectively, and group C received 5 mg vitamin C. Group D was given an antidepressant- clomipramine 12.65 mg/kg body weight /day, which was treated as positive control. The group E was used as negative control and group F was control for basal diet.On the 15th day of experiment, the animals were sacrificed. Blood samples were collected and processed to obtain plasma to freeze at -20^{o}C to be used for analysis biochemical stress markers.

Analysis of stress markers

Stress makers malondialdehyde was determined by thiobarbituric acid assay method[11]. Briefly, 1.0 ml of serum was added to 2.0 ml of TCA-TBA-HCl reagent, mixed and heated in boiling water for 15 minutes. Cooling and separating the precipitate by centrifugation at 3000 rpm for 15 minutes, the supernatant was read at 535 nm (UV-1201 UV-VIS, Shimadzu, Japan) and the result was calculated and expressed as nmol MDA/ml serum. Serum superoxide dismutase activity was estimated spectrophotometric method[12], where 25 µl of serum was added to 500µl of Tris-EDTA buffer, read absorbance at 420 nm at zero time and, 500 µl of pyrogallol solution (0.2mM) was added and after 1 minute, absorbance was measured. Deionized water instead of serum was used in blank. Result was expressed in U/ml. Serum nitrous oxide (NO) level was also analysed spectrophotometric method[13]. In short, 100 µl Griess Reagent was added to 300 µl serum sample and 2.6mL of deionized water and incubated for 30 minutes at room temperature. The mixture was incubated for 30 minutes at room temperature and absorbance was read at 548 nm against reference blank sample. The result was presented in mmol/dl

Statistic

SPSS software (22.0 version) was used for statistical analysis. Quantitative data were presented as mean±SD. ANOVA test was conducted to find out the difference between groups and within groups. When the differences were significant between groups, Post hoc Tukey test were conducted.

RESULTS AND DISCUSSION

Reserpine is a monoamine depletory that exerts a blockade on the vesicular monoamine transporter for neuronal transmission or storage, stimulating dopamine-autoxidation which can increase dopamine levels and oxidative catabolism by monoamine oxidase (MAO)[13]. The exacerbation of dopamine metabolism in basal ganglia, which are rich in monoamines, can lead to increase production of free radicals such as highly reactive hydroxyl radicals and auto-oxidation of dopamine into dopamine quinones free radicals and superoxide anions which cause neurotoxicity[14].

The change in stress marker level is described in the table 1 and figures 1,2 and 3. One-way analysis of variance showed significant alteration of the biomarkers among the groups. Tukey test also indicated significant difference compared to negative control. The orange fleshed sweet potato (OFSP), carrot and vitamin C all made a strong reduction of malondialdehyde ($p<0.001$); OFSP and Carrot showed a significant rise of superoxide dismutase activity ($p<0.04$); and NO level was found significantly ($p<0.034$). It indicated that OFS, carrot and vitamin C have had depression alleviation potential. This finding was consistent with the finding reported elesewhere[15-18].

It is suggested that various enzymatic and non-enzymatic systems attenuate reactive oxidative species (ROS). In oxidative stress, the defense capacities against ROS becomes insufficient, which affects the antioxidant defense mechanisms, reduces the intracellular concentration of glutathione (GSH)- one of the most important scavengers of (ROS), decreases SOD activity and enhances lipid peroxidation[1]. SOD is an antioxidant enzyme capable of reducing superoxide radicals through converting superoxide radicals to H_2O_2 and H_2O [19]. In the present study, a decrease in serum SOD, which was found to rise significantly by OFSP and carrot treatment. Some trauma conditions have been reported to decrease SOD level[20,21]. The rise of SOD in OFSPs was value is unpredictable, and the data quality (SD value) was found very poor.

Increased ROS concentrations reduce the amount of bioactive NO by chemical inactivation to form toxic peroxynitrite[22], which acts as free radicals. Evidence suggests that in inflammation state, NO production increases substantially and in association with ROS contributes to oxidative stress, where NO play roles in neurodegenerative disorder and serve as neurotoxin[23]. In the study, treatment with vitamin C resulted in increase of plasma NO level significantly.
As the functional food- orange fleshed sweet potato and carrot contain a rich amount of antioxidant phytochemicals such as carotenoids, phenols as well as vitamin C[8-10], they act as strong antioxidant, and thus, reduce oxidative stress and alleviate depression.

Table 1: Change in stress markers (mean±SD) in different groups of animals

Groups	MDA nmol/ml)	SOD (U/ml)	NO (µM/L)
OFSP -A	1.34±0.829	3.38±3.131	0.98±0.113
Carrot-B	2.43±0.365	2.24±1.200	1.19±0.159
Vitamin C	2.75±0.625	1.97±0.245	1.26±0.398
Clomipramine- D	3.39±0.287	2.03±0.365	1.17±0.165
Negative control-E	8.29±1.073	1.29±0.342	1.54±0.072
Basal Diet-F	4.94±1.426	2.03±0.809	0.94±0.072

OFSP= Orange Fleshed Sweet Potato, MDA= Malondialdehyde, SOD= Superoxide dismutase, NO=Nitric Oxide

The rise of SOD in OFSPs was value is unpredictable, and the data quality (SD value) was found very poor

Significance

ANOVA	F (5, 24) =86.44, p=<0.001	F (5, 24) = 2.73, p=0.04	F (5, 24) =2.92, p=.034
Tukey test	F vs OFSP, Carrot, vitamin C p=0 .000, 0.000, 0.000*	F vs OFSP, Carrot, vitamin C p= 0.042, 0.034*, 0.577	F vs OFSP, Carrot, vitamin C p=0.969, .0190, 0.05*

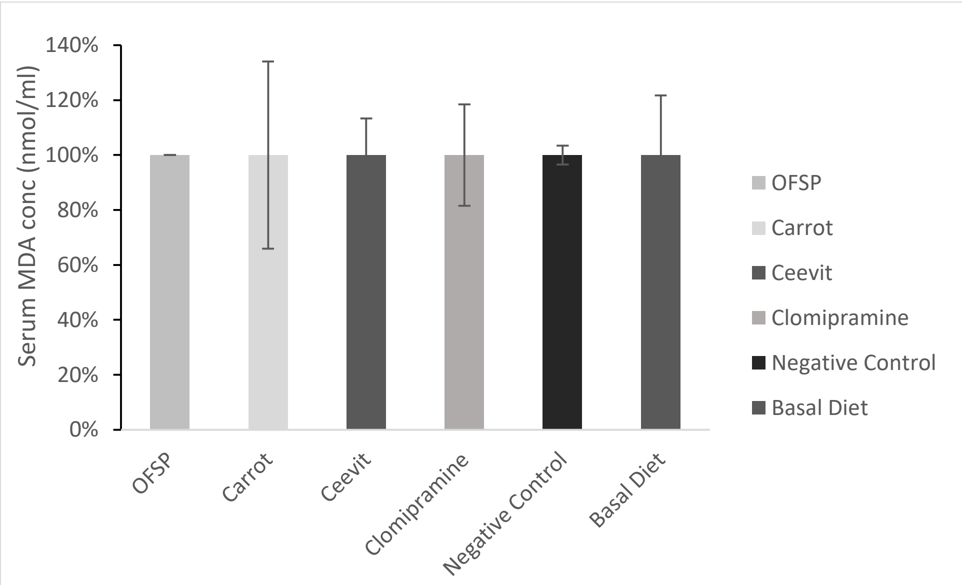

Figure 1: Serum MDA level among groups, significantly difference (p<0.05).

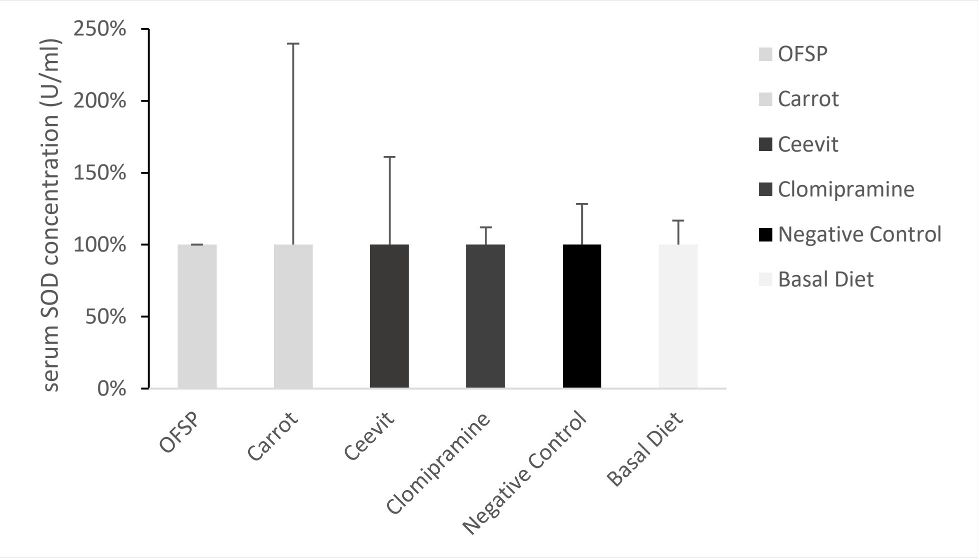

Figure 2: Serum SOD level among groups, significantly difference ($p<0.05$).

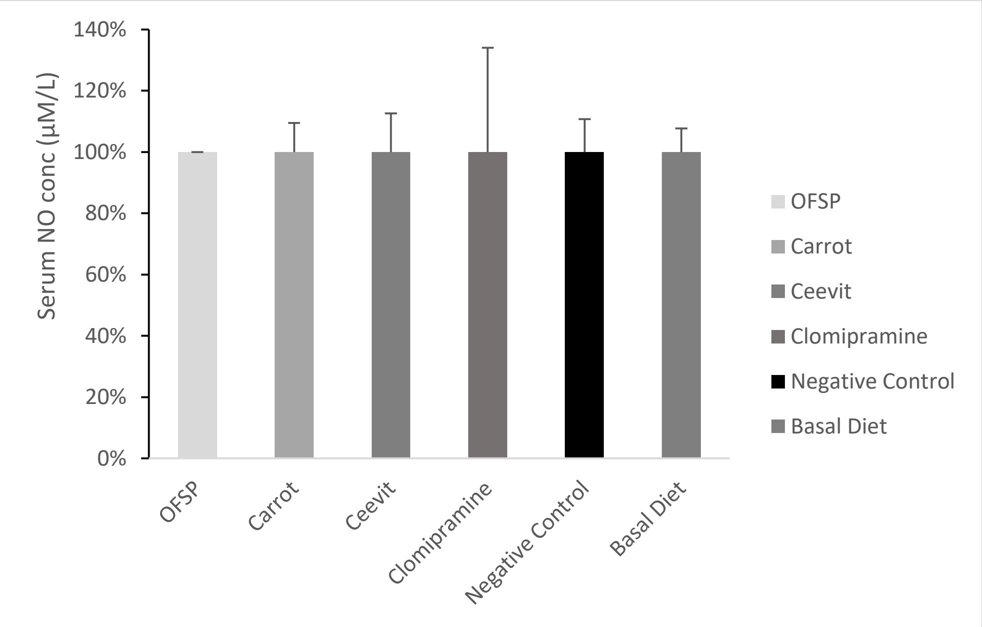

Figure 3: Serum NO level among groups, significantly difference ($p<0.05$).

CONCLUSIONS

The functional food orange fleshed sweet potatoes carrot and the vitamin C nutraceutical reduces serum malondialdehyde and increase nitrous oxide and SOD concentration, indicating relieve of oxidative stress and thus, might alleviate depression. It could be suggested that regular and effective use of orange fleshed sweet potatoes, carrots and vitamin C may benefit in depression.

Conflicts of interest
The authors declare no conflict of interest.

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References
1. Delfino RJ, Staimer N, Vaziri ND. Air pollution and circulating biomarkers of oxidative stress. *Air Qual Atmos Heal*. 2011. doi:10.1007/s11869-010-0095-2
2. Alfonso Valenzuela B, Sanhueza J, Nieto S. Natural antioxidants in functional foods: From food safety to health benefits. *Grasas y Aceites*. 2003. doi:10.3989/gya.2003.v54.i3.245
3. Khanzode SD, Dakhale GN, Khanzode SS, Saoji A, Palasodkar R. Oxidative damage and major depression: The potential antioxidant action of selective serotonin-re-uptake inhibitors. *Redox Rep*. 2003. doi:10.1179/135100003225003393
4. Food Safety in the 21st Century edited by Dudeja P, Gupta RK. 2017
5. Lobo V, Patil A, Phatak A, Chandra N. Free radicals, antioxidants and functional foods: Impact on human health. *Pharmacogn Rev*. 2010. doi:10.4103/0973-7847.70902
6. Keservani RK, Kesharwani RK, Vyas N, Jain S, Raghuvanshi R, Sharma AK. Nutraceutical and Functional Food As Future Food: A Review. *Der Pharm Lett*. 2010.
7. Ferrari CKB, Torres EAFS. Biochemical pharmacology of functional foods and prevention of chronic diseases of aging. *Biomed Pharmacother*. 2003. doi:10.1016/S0753-3322(03)00032-5
8. Bozalan NK, Karadeniz F. Carotenoid Profile, Total Phenolic Content,and Antioxidant Activity of Carrots. International Journal of Food Properties,14(5):1060–1068, 2011. Doi: 10.1080/10942910903580918
9.Islam SN, Nusrat T, Begum P, Ahsan M. Carotenoids and β-carotene in orange fleshed sweet potato: A possible solution to vitamin A deficiency. *Food Chemistry* 199,628-631, 2016.
10. Alam MK, Rana ZH, Islam SN. Comparison of the Proximate Composition, Total Carotenoids and Total Polyphenol Content of Nine Orange-Fleshed Sweet Potato Varieties Grown in Bangladesh. Foods 2016;5(3):64. doi:10.3390/foods5030064
11. Buge JA, Aust SD. The thiobarbituric acid assay. In The Microsomal lipid peroxidation. Method enzymol 1978; 52:302-310.
12. Magnani L, Gadou EM, Hubaud J. Spectrophotometric measurement of antioxidant properties of flavones and flavonols against superoxide anion. Analytica Chimica Acta 2000; 411:209-216.

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13. Menaka KB, Ramesh A, Thomas B, Kumari NS. Estimation of Nitric Oxide as an Inflammatory Marker in Periodontitis. J Indian Soc Periodontol1 2009;3(2):75-78. https://doi.org/10.4103/0972-124x.55842
14. Teixeira AM, Trevizol F, Colpo G, et al. Influence of chronic exercise on reserpine-induced oxidative stress in rats: Behavioral and antioxidant evaluations. Pharmacol Biochem Behav. 2008. doi:10.1016/j.pbb.2007.10.004
15. Del Rio D, Stewart AJ, Pellegrini N. A review of recent studies on malondialdehyde as toxic molecule and biological marker of oxidative stress. Nutr Metab Cardiovasc Dis. 2005. doi:10.1016/j.numecd.2005.05.003
16. Bartolomucci A, Leopardi R. Stress and depression: Preclinical research and clinical implications. PLoS One. 2009. doi:10.1371/journal.pone.0004265
17. Sahin N, Akdemir F, Orhan C, Kucuk O, Hayirli A, Sahin K. Lycopene-enriched quail egg as functional food for humans. Food Res Int. 2008. doi:10.1016/j.foodres.2007.12.006
18. Shen CY, Jiang JG, Yang L, Wang DW, Zhu W. Anti-ageing active ingredients from herbs and nutraceuticals used in traditional Chinese medicine: pharmacological mechanisms and implications for drug discovery. Br J Pharmacol. 2017. doi:10.1111/bph.13631
19. Maier CM, Chan PH. Role of superoxide dismutases in oxidative damage and neurodegenerative disorders. Neuroscientist. 2002. doi:10.1177/107385840200800408
20. Rana S V., Kashinath D, Singh G, Pal R, Singh R. Study on oxidative stress in patients with abdominal trauma. Mol Cell Biochem. 2006. doi:10.1007/s11010-006-9210-y
21. Halici M, Öner M, Güney A, Canöz Ö, Narin F, Halici C. Melatonin promotes fracture healing in the rat model. Eklem Hast ve Cerrahisi. 2010.
22. Förstermann U. Nitric oxide and oxidative stress in vascular disease. *Pflugers Arch Eur J Physiol*. 2010. doi:10.1007/s00424-010-0808-2
23. Lubos E, Handy DE, Loscalzo J. Role of oxidative stress and nitric oxide in atherothrombosis. Front Biosci. 2008. doi:10.2741/3084