The Effect of Diet Carbonated Drinks and Monosodium Glutamate on the Cerebellar Cortex and the Kidney of Adult Male Albino Rats

Histological and Immunohistochemical Study

Thesis

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Dedication

To the soul of my late husband **Ahmed Maher** *and his family.*

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Noha Ali Abd El-Latif Abd El-Wahed

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List of Abbreviations

Acetyl CoA	Acetyl Coenzyme A
ALP	Alkaline Phosphatase
ANOVA	Analysis of Variance
ASP	Aspartame
AST	Aspartate aminotransferase
ß	Beta
Ca	Calcium
°C	Celsius
DAB	Diaminobenzidine tetra hydrochloride
DCT	Distal convoluted tubule
DKP	Diketopiperazine
DNA	Deoxyribonucleic acid
F	Fahrenheit
FAFH	Food away from home
γ	Gamma
G&M	Glee's and Marseland's
G6PD	Glucose-6-phosphate dehydrogenase
GABA	Gamma aminobutyric acid
GFAP	Glial Fibrillary Acidic Protein
GGT	Gamma glutamyle transferase
gm	gram
GnRH	Gonadotropin releasing hormone
H&E	Haematoxylin and Eosin

HRP	Horse radish peroxidase
K	Potassium
Kcal	Kilocalorie
Kgm	Kilogram
LH	Luteinizing hormone
LSD	Least significant difference
MDA	Malondialdehyde
mg	milligram
MGB	Medial geniculate body
ml	milliliter
MSG	Monosodium glutamate
Na	Sodium
NNS	Non nutritive sweeteners
oz.	Ounce
P value	Probability of significance value
PAS	Periodic acid Schiff's reaction
PCT	Proximal convoluted tubule
PKU	Phenylketonuria
RNA	Ribonucleic acid
SD	Standard Deviation
TB	Toluidine blue
TGF-ß	Transforming growth factor beta
US	United States of America

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Abstract

Background and aim of the study: The consumption of fast- food is increasing among children, adolescents and adults. Carbonated drinks are widely consumed with fast food that also exists in the form of diet drinks as Diet Coke. One of the thousands of chemicals used in our new high-tech foods is the monosodium glutamate (MSG).This study was conducted to investigate the effect of Diet Coke and Monosodium glutamate salt either separately or in combination on the histology of the cerebellar cortex and the kidney of adult male albino rats.

Materials and Methods: Forty adult male albino rats which were divided into four groups. **Group I**: control group (15 rats). **Group II (Diet Coke group)** included 10 rats, which were subdivided into: **subgroup IIA** in which rats received 2.5 ml of Diet Coke twice daily by oral gavage and **subgroup IIB** in which rats received Diet Coke instead of water throughout the day. **Group III (MSG group):** included 5 rats which received MSG salt solution (at a dose of 3 gm MSG / kgm) by oral gavage once daily. **Group IV (combination group)** included 10 rats which received combination of MSG solution and Diet Coke. Rats of this group were subdivided into two subgroups. **Subgroup IVA** in which rats received MSG salt solution (at a dose of 3 gm MSG / kgm rat) once daily, and 2.5 ml of Diet Coke twice daily, both by oral gavage. **Subgroup IVB** in which rats received MSG salt solution (at a dose of 3 gm MSG / kgm rat) once daily by oral gavage and Diet Coke instead of water throughout the day. At the end of the experiment (21 days) cerebella and kidneys were dissected out and processed for histological, immunohistochemical and morphometric studies.

Results: Histological examination of the cerebellum and the kidney revealed that both Diet Coke and MSG either separately or in combination resulted in degenerative changes that were more significant in the combination group. The cerebellum showed degeneration of Purkinje cells and vaculations in the molecular layer. The kidney showed pyknotic nuclei and vacuolated cytoplasm in the cells lining the renal tubules. Moreover, shrunken glomeruli with widened capsular spaces were noticed in sections of subgroup IIB, group III and both subgroups of group IV.

Conclusion: Diet Coke and MSG induced degenerative changes in both the cerebellum and the kidney that was more significant in their combination.

Keywords: Diet Coke, MSG, cerebellum, kidney.

Introduction

Children and adolescents are increasingly consuming food away from home (FAFH), particularly from fast sources. The upward trends in fast-food consumption have paralleled increasing obesity rates among children and adolescents. In addition, fast food consumption has been associated with greater total energy intake and poorer nutrient intake **(Powell, 2013).**

The carbonated drinks are the second most consumed beverages in the world. Coca-Cola, the first cola drink was invented in Atlanta by John Pemberton in 1886. Today products of the Coca-Cola Company are consumed at the rate of more than one billion drinks per day **(Fahim et al., 2015)**

Carbonated drinks are widely consumed with fast food. These carbonated drinks also exist in the form of diet drinks, for example Diet Coke® and Diet Pepsi®. Diet Coke contains non-nutritive sweeteners (NNS), which provide the desired sweet taste without the calories. Non-nutritive sweeteners afford individuals the experience of eating/ drinking something sweet without the consequence of adding to total daily energy intake. It is a non-caloric beverage that is sweetened with aspartame **(Lutsey et al., 2008).** Non-caloric beverages are less-well studied than sugar-sweetened beverage although their intake has been associated with progression of kidney diseases **(Lin and Curhan, 2011).** Moreover, as they are sweetened with aspartame they might result in memory loss and behavioral changes **(Erbaş et al., 2018)**.

Monosodium glutamate (MSG) is one of the most applied food additives in the modern food all over the world. It is the sodium salt of glutamic acids which is used as a flavor enhancer **(Afeefy et al., 2012).** Kikunae Ikeda (1908)

was the first person found glutamic acid in seaweed Laminaria Japonica; he extracted glutamic acid and discovered its unique flavour enhancing property **(Singh et al., 2015).**

Monosodium glutamate is added either as a purified monosodium salt or as a component of a mix of amino acids and small peptides. Glutamate is the main excitatory neurotransmitter in the mammalian central nervous system and a major neurotransmitter in the cerebellum **(Gallo et al., 1982).** Although many Food and Drug Control Agencies have certified MSG to be safe for human consumption without any specified dosage **(Eweka and Om 'Iniabohs, 2008)**, experimental findings have linked the intake of MSG with disorders of the central nervous system, a number of neurodegenerative and neurobehavioral changes. It also has neurotoxic effects resulting in depression, dizziness, anxiety, panic attacks, insomnia, migraine headache, slurred speech and seizures **(Win, 2008).**

Dietary MSG increases the urinary pH in rats **(De Groot et al., 1988)** and alkaline urine may influence the kidney capacity to secrete or reabsorb metabolites that contribute to stone formation **(Wagner and Mohebbi, 2010).**

Aim of the Work

Aim of this work was to investigate the effect of Diet Coke and monosodium glutamate salt either separately or in combination on the cerebellar cortex and kidney of adult male albino rats.

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Review of Literature

Children, adolescents and adults are increasingly consuming food away from home (FAFH), particularly from fast-food sources. From 1999 to 2004, fast-food consumption increased from 19% to 27% for females and from 24% to 30% for males. Upward trends in fast-food consumption have paralleled increasing obesity rates among different age groups, and consumption has been associated with greater total energy intake and poorer nutrient intake **(Guthrie et al., 2002) & (Poti and Popkin, 2011).**

1-Diet carbonated drinks:

Diet soda contains non-nutritive sweeteners (NNS), which provide the desired sweet taste without the calories. NNS afford individuals the experience of eating/drinking something sweet, presumably without the consequence of adding to total daily energy intake **(Fowler et al., 2008).**

❖ Ingredients:

According to company specifications, Coca Cola™ is a carbonated water solution containing in 100 ml:

Carbohydrate 10.6 g, sodium 7 mg, caffeine 11.5 mg, caramel, phosphoric acid, citric acid, vanilla extract, natural flavorings (orange, lemon, nutmeg, cinnamon, coriander), lime juice and fluid extract of coca.

The only difference between regular gives (43 kcal/100 ml) while, light cola (0 kcal) through replacement of carbohydrates with non-nutritive sweeteners (aspartame 24 mg/100 ml). This explained the relation of aspartame intake to Diet Coke intake in rats of this study.

Minerals in Diet Coke include sodium, potassium and phosphorus.