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Serum and Tissue Lipid Profile in Albino Rats Administered Food colors

Beenam Saxena*

Department of Zoology, Pest and Parasite Research Lab II, Bareilly College, Bareilly - 243005, Uttar Pradesh, India; beenam_1972@yahoo.co.in

Abstract

Objectives: Lipids are the most important structural component of various biological membranes. Some studies showed different effects of food colors on lipid level. Some food colors were given to albino rats to observe the *in vivo* effect on liver tissues and serum lipids in experimental rats. **Materials and Methods:** Twenty-four albino rats were randomly divided into four groups. Three groups were administered with different doses of the food colors in low protein diet for 30 days. Control group received low protein diet and drinking water *ad libitum*. Lipid profile in serum and liver of the experimental animals was measured and compared with the control animals. Blood serum was also analysed for total protein and glucose content. **Results:** High dose of food colors caused significant increase of serum Low-Density Lipoprotein (LDL) ($p<0.01$), more significant increase ($p<0.001$) of serum triglycerides and total cholesterol, while serum High-Density Lipoprotein (HDL) was significantly decreased. There was also a significant increase in the level of triglycerides, total cholesterol and LDL in the liver tissue. Although all lipid parameters in serum except HDL elevated, the maximum increase was seen in total triglycerides and the lowest elevation was observed in LDL. The serological studies revealed a significant increase in serum glucose, whereas a significant decrease was recorded in the levels of serum protein. **Conclusion:** The administration of food colors in albino rats induced liver damage hence, changes incurred in the lipid metabolism.

Keywords: Albino Rat, High-Density Lipoprotein, Low-Density Lipoprotein, Metanil Yellow, Sunset Yellow

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1. Introduction

The human beings have been using color additives for a very long time to hide the poor quality of spoiled food products. The use of natural color dyes has largely been suppressed by the use of synthetic dyes which are much cheaper and provide better coloration. Sunset yellow and tartrazine are the azo dyes and permitted food colors in India. These are widely used in food industry, pharmaceutical and cosmetics, while metanil yellow is the frequently used nonpermitted color in the food products (Dixit *et al.*, 2011). It is found that the foods manufactured by unorganized private sectors and small vendors may contain much high concentration of these colors than permitted range. Many researchers studied the metabolic and toxicological disorders induced by the administration of specific food colorant additives to rats and other mammals (Sharma *et al.*, 2009; Sharma *et al.*, 2010; Shinnawy and Elkattan, 2013; El-Malky *et al.*, 2014; Sharma *et al.*, 2006; Ashour and Abdelaziz, 2009). There is ample evidence that continued use of synthetic food color led to deleterious effects on humans. A blend of two or more dyes may produce an altogether different response than that observed with individual content. Hence, the present study was conducted to elucidate the effect of oral ingestion of blend of food colors for 30 consecutive days to normal albino rats there by evaluating changes in glucose, protein and lipoprotein fractions in serum and liver tissues.

2. Materials and Methods

2.1 Animals and Treatment

Twenty four albino rats, weighing 140-150 g were used in this study. All rats were housed in ventilated cages

* *Author for correspondence*

and maintained under experimental conditions of light, temperature and humidity-controlled room (12-h light/dark cycle; 25 ± 3°C, 60 ± 5% humidity). The animals were divided into four groups (n = 6/groups). The blend of sunset yellow, tartrazine and metanil yellow was prepared by mixing them in equal ratio and given orally with low protein diet at different dose for 30 days.

Grroup I: Control rats fed low protein diet and drinking water *ad libitum.*

Group II: Rats fed a dose 25 mg/kg body weight (b.w.) with low protein diet and drinking water *ad libitum.*

Group III: Rats fed a dose 50 mg/kg b.w. with low protein diet and drinking water *ad libitum.*

Group IV: Rats fed a dose 75 mg/kg b.w. with low protein diet and drinking water *ad libitum.*

2.2 Sample Preparation

At the end of experimental period (30 days), the rats were anesthetized and euthanized by decapitation. Blood samples were collected and centrifuged at 3000 rpm for 15 min. The serum was used for determination of several biochemical parameters. Tissue sample of the liver was dissected, washed with ice cold saline solution and homogenized with 0.01 M sodium phosphate buffer (pH- 7.4), using a tissue homogenizer. Thereafter, the homogenate was centrifuged at 10,000 rpm for 15 min and then supernatant was collected and processed for biochemical analyses (Heikal *et al.,* 2013).

2.3 Biochemical Assays

The biochemical parameters protein, glucose and lipoprotein fractions such as triglycerides, total cholesterol, High Density Lipoproteins (HDLs) and Low Density Lipoproteins (LDLs) were measured in serum and liver tissue and analyses were performed with commercially available kits (Beacon laboratory kit). All analyses were performed according to the instructions of the manufacturers.

2.4 Statistical Analysis

Results of biochemical analysis are presented as mean value±standard error of mean. The difference between control and test groups was analysed by using Tukey's multiple comparison test. Correlation between the investigated groups was performed using one way analysis of variance.

3. Results

A significant increase in the level of serum glucose was observed. The mean value of serum glucose was found to be 92.87±0.94, 107.9±0.89 and 119.7±1.09 mg/dl in food color ingested animals of group II,III and IV respectively, when compared to the control animal (74.99±1.56 mg/dl). Table 1 demonstrates the effect of food colors on total serum protein. All doses of food colors caused a significant decrease in serum protein as compared with the control group.

Food colors consumption was able to induce a dyslipidemic profile by increased level of triglycerides, total cholesterol, LDL and decreased level of HDL concentrations. In control rats fed on low protein diet, the mean value of serum triglycerides was 80.27 mg/dl which was raised by 54.10, 82.14 and 98.70 % in group II, III and IV respectively. The mean value of seum total cholesterol was found to be 96.78 mg/dl in group II and 134.67 mg/dl in group IV when compared with control group (90.65 mg/dl). The oral ingestion of food colors at dose 25, 50 and 75 mg/Kg b.w. significantly increased the level of serum LDL by 16.35, 23.95 and 38.28% respectively with respect to control rats (56.58 mg/dl). HDL level was decreased by 12.61, 23.08 and 22.75 % with respective dose when compared with control rats (42.28 mg/dl) (Table 2). Food color administration also increased triglycerides, total cholesterol and LDL levels with a decrease of HDL level in liver tissue (Table 3).

Table 1. Effect of blend of food colors on total protein and glucose in serum of albino rats

Biochemical Profile	Group I	Group II	Group III	Group IV
Total protein (g/dl)	8.95±0.30	8.05±0.26* (-10.06)^{a}	6.74±0.17*** (-24.69)^{a}	5.67±0.14*** (-36.65)^{a}
Glucose (mg/dl)	74.99±1.56	92.87±0.94*** (+23.84)^{a}	107.9±0.89*** (+43.89)^{a}	119.7±1.09*** (+59.62)^{a}

Each value is a mean±SEM for n=6, ^{a} : Values in parentheses represents percent change with respect to control, *p<0.05, ***p<0.001, SEM= Standard error mean

Table 2. Effect of blend of food colors on various lipoprotein fractions in serum of albino rats

Lipid Profile	Group I	Group II	Group III	Group IV
Total cholesterol (mg/dl)	90.65±2.79	96.78±3.90* (+6.76)[a]	121.2±1.47*** (+33.70)[a]	134.67±2.88*** (+48.56)[a]
Triglycerides (mg/dl)	80.27±6.01	123.7±3.59*** (+54.10)[a]	146.2±1.79*** (+82.14)[a]	159.5±1.06*** (+98.70)[a]
LDL (mg/dl)	56.58±3.11	65.83±3.26* (+16.35)[a]	70.13±3.46* (+23.95)[a]	78.24±4.12** (+38.28)[a]
HDL (mg/dl)	42.28±1.93	36.95±2.53* (-12.61)[a]	32.52±1.97** (-23.08)[a]	32.66±0.80** (-22.75)[a]

Each value is a mean±SEM for n=6, [a] : Values in parentheses represents percent change with respect to control, *p<0.05, **p<0.01, ***p<0.001, SEM= Standard error mean

Table 3. Effect of blend of food colors on various lipoprotein fractions in liver tissue of albino rats

Lipid Profile	Group I	Group II	Group III	Group IV
Total cholesterol (mg/dl)	29.62±0.28	32.89±0.29*** (+11.04)[a]	39.28±0.32*** (+32.61)[a]	46.95±0.53*** (+58.51)[a]
Triglycerides (mg/dl)	25.07±0.23	34.60±0.18*** (+38.01)[a]	42.17±0.67*** (+68.20)[a]	50.97±0.37*** (+103.31)[a]
LDL (mg/dl)	21.90±0.43	23.32±0.22* (+6.48)[a]	30.06±0.14*** (+37.26)[a]	37.72±0.73*** (+72.24)[a]
HDL (mg/dl)	18.84±0.28	17.98±0.34* (-4.56)[a]	14.69±0.51*** (-22.03)[a]	11.50±0.41*** (-38.96)[a]

Each value is a mean±SEM for n=6,[a]: Values in parentheses represents percent change with respect to control, *p<0.05, ***p<0.001, SEM= Standard error mean

4. Discussion

The present study showed that rats which were administered different doses of blend of sunset yellow, tartrazine and metanil yellow exhibited a significant elevation in serum glucose. The elevation of glucose level may be due to stimulation of glycogenolysis by the liver. This observation is in accordance with that reported by Shinnawy and Elkattan (2013), where noticeable increase in serum glucose level was found in rats treated with the high dose of tartrazine. El- Malky *et al.* (2014) also reported an increase in glucose level in rats treated with sunset yellow. Sharma *et al.* (2010) also showed an increase in serum glucose treated with a dye blend. Similar results have also been reported in mice fed with apple green (a blend of tartrazine and brilliant blue) Sharma *et al* (2006).

In this study, serum protein exhibited a significant decrease in rats which received food colors. Sharma *et al.* (2010) recorded a decrease in the level of serum protein in mice fed with low and high dose levels of kesari powder. Similar results have been reported in rats with fast green (Ashour and Abdelaziz, 2009) and in mice fed with malachite green (Chakravarty *et al.,* 2005). The depletion in serum protein might be attributed to impaired protein synthesis due to toxicity of food colors.

The elevation of serum lipid profile in the experimental group might be associated with increased hepatic triglycerides and cholesterol. Triglycerides are a form of fat carried through the blood stream and in the fat tissues of body and most of the body's fat is stored in the form of triglycerides (Heit, 2011). The changes in the lipid profile obtained in the present study were in agreement with those mentioned earlier (El-Malky *et al.,* 2014; Sarhan *et al.,* 2014). They mentioned that significant changes have occurred in the level of serum total protein and total cholesterol of rats treated with sunset yellow. On the contrary, Shinnawy and Elkattan (2013) reported that tartrazine showed hypocholesterolemic and hypolipidemic effects and observed decrease in serum total lipid and total cholesterol. The marked discrepancies observed between our results might be attributed to dose variation as well as blend of food colorant intake. The serological studies revealed a significant increase in lipoprotein fractions except HDL in albino mice due to toxicity of a dye blend, kesari powder (Sharma *et al.*, 2010), which is in accordance to present study.

Similar results have been seen in mice fed with apple green (a blend of tartrazine and brilliant blue) (Sharma *et al.,* 2006). Mathur *et al.* (2005) also found significant elevation in various constituent of lipids in serum and liver tissue in mice fed with sunset yellow. Like food colors, Monosodium Glutamate (MSG) is used as food additive. Singh *et al.* (2011) showed that the oral ingestion of MSG also caused a significant increase in cholesterol, triglycerides, LDL and a significant decrease in HDL level in serum of wistar rat. The oral ingestion of MSG along with alcohol increased the level of various lipid fractions in arterial tissue (Singh *et al.,* 2012). In the present study also, oral ingestion of food colors increased the level of various lipid fractions in the liver tissue. Significant increase in total cholesterol, triglycerides, LDL of plasma and a significant decrease in HDL in nicotine-treated rats were also reported (Chattopadhyay and Chattopadhyay, 2008). Hence, like food color other food additives also affect the lipid profile effectively.

5. Conclusion

Food color consumption significantly alters cholesterol metabolism, leading to serum dyslipidemia. Increase in cholesterol concentration is an indication of membrane structure and function disruption thus may influence its fludity and permeability. Serum hyperlipidemia can cause high risks for developing cardiovascular disease such as atherosclerosis. The use of overdose of these colorants for a long time may lead to dramatic alteration in the liver in addition to dysfunction of the organ.

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