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BIOLOGICAL EVALUATION OF MALLOW LEAVES AND TOMATO WASTES AS A SOURCE OF NATURAL FOOD COLORANTS

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ABSTRACT

Now a day the colors play an important role in food and drug industries. In this investigation, synthetic dyes which are used in food industry (Tartrazine/Brilliant Blue and Sunset yellow) either singly or as a mixture of the natural color (dry mallow leaves and dry tomato wastes) with the synthetic dyes at ratio (1:1) were used to avoid the harmful effect of synthetic dyes alone on the health of mankind. Natural colors, synthetic colors and their mixture (1:1) were exposed to gamma rays at different doses (0, 10 and 15 KGy) to produce healthy product. Nutrition experiments were conducted to reveal the effect of natural, and synthetic colors, and their mixtures that added to macaroni product on some biological and biochemical parameters of serum rat groups (total protein, albumin, globulin, A/G ratio, total lipid, total cholesterol, glucose, creatnine, alkaline phosphates activity, transaminases enzyme activity "ALT & AST", hemoglobin and hematocrate); in addition to rat organs weight (liver, kidney, spleen and gain in body weight). From the results in this investigation it can be concluded that, the natural pigments (colorants) in the diet of natural and synthetic food colorant mixture can reduce the toxic influences of the synthetic ones.

Keywords: Mallow leaves, Tomato waste, serum analysis, Natural colorant, Synthetic colorant

INTRODUCTION

Coloring substances play an important role in the enjoyment of foodstuffs and in the assessment of their quality. They are usually added to foods to be more attractive to the purchasers or to the consumers or to replace natural color that may be deteriorated during processing (Rizk, 1997). In Egypt, colors in the developing food industry had available vast array of synthetic colors. This led to colors being added for decorative purposes and unfortunately to disguise low quality foods. There was no control over this use of color and so inevitably legislation came into force. Food colorants may come from natural sources or may be a synthetic product. Of all the food additives, perhaps the addition of color is the hardest to justify. However, 90% of the colors used in food come from a small group of synthetic colors, the diverse group of natural color sources is used in about 10% of foods only (Ensminger *et al.*, 1995). Ramadan and El-Damhogy (1994), Abdel-Rahim *et al.*, (1995), Abdou *et al.*, (1997) and Salah *et al.*, (1999) reported that, all the synthetic food colorants were liable to rise to potentially toxic degradation products, either by their metabolic transferrations or by the action of intestinal microorganisms. Synthetic food colorants were more effective than the natural one. Moreover, the natural pigments in the ingestion of natural and synthetic food colorant mixture reduced the toxic influences of ingested synthetic dyes.

The intake of foods rich in carotenoids appears to be associated with optimal health, and a reduction in the risk of cancer, cardiovascular disease, macular degeneration and cataract formation. Specific dietary carotenoids may be responsible for these specific protective effects. Hydrocarbon carotenoids such as alpha, beta-carotene's and lycopene may reduce the risk of cancer and heart diseases, whereas oxygenated carotenoids, such as lutein and zeaxanthin, may be important for the protection of the eye. Dietary carotenoids, such as lutein, cryptoxanthin, alpha-carotene, beta-carotene and lycopene can be readily obtained from the diet. Green leafy vegetables, such as spinach and broccoli, contain both oxygenated and hydrocarbon carotenoids. Yellow or orange vegetables, such as carrots, have high levels of alpha-carotene and beta-carotene, and tomatoes contain high amounts of lycopene. Besides, being important vitamin A sources, provitamin A carotenoids, such as alpha-carotene, beta-carotene and cryptoxanthin, participate in cell defense systems that are associated with radical quenching. Non-provitamin A carotenoids, such as lutein and lycopene, major carotenoids in human plasma, have also been reported to possess strong antioxidant capability. The alteration of dietary sources of carotenoids can modify their levels in the circulation and target tissues, and thus prevent or delay the onset of these chronic diseases (Yeum 1996).

In this respect, Abdel-Rahim *et al.* (1987) found that, when rats were administered chlorophyll or tartrazine /green–s mixture at doses of 2.35/0.1 and 4.7/0.2 mg/kg body weight dye for 4 weeks, significant increases, in liver soluble proteins, and plasma AST enzyme activity (higher dose), and liver AST and ALT enzyme activities (both doses) were obtained. Ibrahim *et al.* (1988 a & b) administered chlorophyll orally to adult male albino rats in a single dose of 8 gm/kg diet for only one day, and multiple dose of 4gm/kg diet for 3 weeks. They found that AST and ALT enzymes activities in plasma, and liver homogenate, as well as, plasma glucose were significantly higher than the control; while liver glycogen was significantly lower than the control. They also reported that total soluble protein in plasma, and in organ tissues were stimulated by pigment administration. Abdou *et al.*, (1997) observed that, the natural colorants (curcumin, chlorophyll and anthocyanine) decreased the level of total lipids and cholesterol content of blood and different tissues. In addition, increases were recorded for plasma bilirubin as well as plasma and liver soluble protein, Hb, RBC and WBC contents. GOT and GPT activity in both plasma and liver were stimulated by natural pigments. The effect of food colorants on plasma transaminases activity was less than its effect on liver. Furthermore, they reported that, pronounced increase in serum and liver transaminases activity of rats by ingestion of synthetic colorants. The load and species of food colorants ingested into animals for assimilation at any time may alter the activity of GOT and GPT followed by changes of over all protein metabolism.

Abdel Aziz and El-Ashmawy (1993) found that, tartrazine affected on hemoglobin content, hematocrate percentage and the number of red and white blood cells. In addition hemoglobin and hematocrate percentage decreased in a highly significant manner after the treatment for 21 days. Also the number of red blood cells was also significantly decreased after treatment for 14 and 21 days, while, the number of white blood cells was significantly increased. On the other hand, El-Sherbeny (1993) mentioned that, the body weight gain of rats fed chlorophyll and Green-S (higher dose) was significantly lower than the control group. The food consumption of rats fed both dyes was slightly lower than the control and the difference was non-significant. Also the activity of serum and liver homogenate AST enzyme was significantly higher than the control group. Serum urea, and creatnine in rats fed either Green-S or chlorophyll were higher than the control.

Macaroni mixed with industrial 10% vegetable by-products (carrot, pea and spinach) as hypolimic and hypocholesterolemic agents reduce the hyper effects, but values still more than that of negative control rats (normal) (Ibrahim, 1998). The tomato wastes (TW) was irradiated at doses of 0.75 and 100 K.Gy, and then incorporated into the diets. No significant differences in feed intake were observed between animals fed on the control diet and those fed on diets containing 10% raw TW, irradiated TW. (Hamza, 2001).

Hamouda (1994) studied the biological and biochemical effects of natural (chlorophyll) and synthetic (Green-S and sunset yellow) colorants as well as its mixtures feeding on rats. He found that the body weight gain of synthetic and natural food colorants fed rats was lower than that of control. However; synthetic colorants were more effective than natural ones. The mixtures of synthetic + natural food colorants (1:1) fed rats had more gain in body weight similar to the check, and the food consummation of the tested rats during the time course of the experiments were slightly increased for rats administrated either natural or synthetic or its mixture food colorants relative to the check. Also, the food efficiency under the effect of natural food colorants was higher than that of synthetic one, but both were less than the check. The ingestion of colorants mixtures (natural + synthetic) disappeared these decreases effect. Also, the liver weight/body weight ratio was reduced in rats fed either synthetic or natural food colorants, but in case of synthetic dyes, it was lower than that of natural colorants that means that synthetic dyes ingestion caused emaciation in liver tissues. In contrast, the administration of synthetic + natural colorants mixtures unchanged the ratio relative to control.

Abdel-Rahim *et al.* (1995) studied the hypo intensive effects of natural food colorants (curcumin, carotene and chlorophyll) on synthetic dyes (yellow 2GG, tartrazine and green-s) toxicity in their mixtures and found that the rate of body weight gain of rats ingested either synthetic food colorant or natural pigments, as well as, their mixtures were lower than the control. The liver/ body weight ratio was increased in rats ingested synthetic dyes (enlargement or tumefaction) unlike rats ingested the naturals or mixtures relative to control.

Salah *et al.*, (1999) determined the total hemoglobin; plasma total soluble proteins, GOT and GPT activities; and. GPT and GOT activities in liver to study the effects of carotene as a natural food colorant on the toxicity of tartrazine (Synthetic food colorant) when used as food additive in albino rats. The obtained results indicated that no mortality was observed under the ingestion of tartrazine, carotene and their mixture in rats. Synthetic and natural colorants as well as their mixture changed all the above determinations compared to the normal control animals. Effects of the synthetic dye as food additive had the highest effects compared with the natural one or the mixture of synthetic and natural food colorants. On the other hand, the mixture of carotene and tartrazine showed around normal values,. In this respect, total Hb content of blood decreased total soluble protein content of plasma but still more than that of control. In addition GOT and GPT activities of plasma and l iver w ere s timulated b y t he i ngestion o f synthetic or natural food colorant and their mixture. They also, showed that carotene acts as antagonistic factor in the toxicity of tartrazine in animal tissues for a ll e xperimental a nalysis. T his m eans t hat n atural f ood c olorant reduced the toxicity of synthetic food colorants when the natural pigment was ingested together with the synthetic dye used as food additives.

In the present study, γ-radiation was used as an attempt to inhibit pathogenic organisms and poisonous molds in the used materials. In this respect, raw materials (leaves mallow, tomato wastes flour and semolina wheat flour), synthetic colors (tartrazine/brilliant blue "green" and sunset "yellow") and their mixtures (1:1) were exposed to γ-radiation at 0, 10 and 15 K.Gy. Different mixtures of macaroni supplemented with colors were made, in order to be used in a set of feeding experiments to investigate the effect of toxic residues in mixtures (natural color and synthetic color (1:1)) after exposure to radiation on the biochemical parameter of serum rats.

MATERIALS AND METHODS

Materials:

Two species of vegetable obtained from local markets were used as a source of natural colors, mallow leaves (*Malta parviflora*) and Tomato wastes (*Lycopersicon esculentum L.*). While the synthetic colors were, green (code No 404) and sunset yellow (code No 500) were obtained from Kamina Co., Egypt. Hard wheat flour (*Triticum aestivum*) was obtained from the cylinder mills of south Cairo Company.

Methods:

Preparation of the natural and mixture colors:

Washed mallow leaves and tomato wastes were dehydrated in oven at 65^0C for 24 hr, then milled to fine powder by using a laboratory disc pass 20-mesh (Bahnassy *et al.*, 1986.). All samples (natural, synthetic and their mixture (1:1) were packed under nitrogen in metalized polypropylene bags and irradiated at 10 and 15 K.Gy. using Co^{60} gamma cell (at dose rate of 6.776K.Gy/h) which located at the National Center for Radiation Research and Technology, (NCRRT) Naser City, Cairo.

Preparation of different blends of macaroni:

Different blends of macaroni were prepared by partial replacement of semolina with powdered dehydrated mallow or tomato waste and their mixture of them (1:1) as shown in Table (1). Then, the different blends of substituted macaroni were processed according to Dexter *et al.*, (1990).

Table (1): Different blends of macaroni supplemented with the colors under investigation.

Ingredient	Flour g.	Water ml	Natural color g.	Synthetic color g.	Net weight g.
Dry mallow leaves	1000	300	107.0	-	1057.41
Synthetic green	1000	300	-	0.1	947.69
Mixture green	1000	300	107.7	0.1	1054.74
Dry tomato wastes	1000	300	292.5	-	1234.6
Synthetic yellow	1000	300	-	0.1	949.89
Mixture yellow	1000	300	293.2	0.1	1230.96
Semolina	1000	300	-	-	960.2

Animals experiment:

192 male albino rats obtained from Helwan station, Cairo, with an initial body weights approximately 50-60g were used for biological experiment. Rats were kept on standard diet (according to Lane-Peter and Pearson (1971), for two weeks (adaptation period), and then transferred to experimental diets for 90 days (experimental period). The rats were divided according to the feeding treatment into the following groups. Group (1) is a control animals and fed on normal diet, group (2) negative control animals and maintained on macaroni without colors; groups (3 to 11) animals were maintained on diets containing green color and groups (12 to 20) animals were m6565aintained on diets containing yellow color, Table (2). At the end of the experimental period, body weight gain was, calculated. The serum samples were collected and kept at $-10^{o}C$ for biochemical analysis. Rats were killed by decapitation; the organs liver, kidney and spleen were separated from each rat and weighted.

Biochemical analysis:

Serum total protein was determined calorimetrically using Biuret method according to Henry (1964). Serum albumin was determined according to the method of Doumas *et al.*, (1971). Globulin was calculated by difference between total soluble protein and albumin. Serum lipids including both free fatty acids and cholesterol were determined as mentioned by (Schmit, 1964). Total cholesterol was determined by the enzymatic method described by Richmond (1973). Serum glucose was determined according to the enzymatic method of Trinder (1969). Aspartate and alanine transaminases (AST and ALT) activities were determined colorimetrically according to the method of Reitman and Frankel (1957). Serum alkaline phosphatase activity was determined according to the method of Roy (1970). Creatnine was determined using the kinetic method of Henry (1974). Hemoglobin concentration (HB) and Hematocrate were estimated according to the method of Dacie and Lewis, (1991).

The statistical analyses were performed according to Daniel, (1991).

Table (2): Different animal groups according to the tested diets

Group No,	Content	Casein	Corn 0il	Cellulose	Salt mixture	Vit.. Mixture	Starch	Whole macaroni
1	Control	20	10	5	4	1	60	-
2	N. Control	20	10	5	4	1	-	60
3	N.M.	20	10	5	4	1	-	60
4	M.M.	20	10	5	4	1	-	60
5	Sy.G.	20	10	5	4	1	-	60
6	N.M. 10 k.Gy	20	10	5	4	1	-	60
7	M.M. 10 k.Gy	20	10	5	4	1	-	60
8	Sy.G. 10k.Gy	20	10	5	4	1	-	60
9	N.M. 15 k.Gy	20	10	5	4	1	-	60
10	M.M. 15 k.Gy	20	10	5	4	1	-	60
11	Sy.Y. 15 k.Gy	20	10	5	4	1	-	60
12	N.T.	20	10	5	4	1	-	60
13	M.T.	20	10	5	4	1	-	60
14	Sy.Y.	20	10	5	4	1	-	60
15	N.T. 10 k.Gy	20	10	5	4	1	-	60
16	M.T. 10 k.Gy	20	10	5	4	1	-	60
17	Sy.Y. 10k.Gy	20	10	5	4	1	-	60
18	N.T. 15 k.Gy	20	10	5	4	1	-	60
19	M.T.15 k.Gy	20	10	5	4	1	-	60
20	Sy.Y. 15 k.Gy	20	10	5	4	1	-	60

N. control = Negative control (macaroni without color); N.M.=Natural mallow leaves; M.M.=Mixture (dried mallow leaves and synthetic green color (1:1); Sy.G= synthetic green color; N.T.= Natural dry tomato waste; M.T.= Mixture (dried tomato waste and the synthetic sunset yellow color (1:1); Sy.y.= synthetic yellow color.

RESULTS AND DISCUSSIONS

Coloring that is added to food may come from natural sources or may be a synthetic product. In this respect, raw materials (mallow leaves, tomato waste flour and semolina wheat flour) , synthetic colors (tartrazine / brilliant blue "green" and sunset "yellow") and their mixtures (1:1) were exposed to γ-radiation at 0, 10 and 15 k.Gy., and used as different mixtures of macaroni colors supplementation. Then, were biologically evaluated in animal experiment.

There are a few investigators observed the healthy effects of natural colorants, which have hypo intensive influences on the toxic effects of synthetic dyes used as food additives. However these experiments were carried out to evaluate the relationship between chlorophyll and carotenoids as natural food additives and tartrazine / brilliant blue and sunset yellow as synthetic food colorants used as foodstuff.

Effects of natural and synthetic food colorants (green color):

Different sources of unirradiated or irradiated color i.e. natural (dehydrated mallow leaves) synthetic (tartrazine / brilliant blue) and their mixtures were biologically evaluated (Tables 3-5).

The results in Table (3) showed that, the highest values in serum total protein, serum total lipid, A/G ratio, hemoglobin and hematocrate were found in rats fed on diet contained natural mallow leaves (N.M.) being 7.33, 4.78, 1.87, 15.57 and 43.10 g/dL, respectively, relative to control. Also, rats fed on natural mallow leaves at 15 K.Gy (N.M 15 k.Gy) showed the highest levels of aspartate aminotransferase (AST) activity, alkaline phosphates (ALP) activity, creatnine and glucose being 139.94 U/ml, 157.37 U/ml, 0.96 mg/dL and 111.41 mg/dL, relative to control. While the lowest values were recorded in case of globulin, total lipid (T.L.), triglyceride (T.G.) and cholesterol for rats fed on diet contained N.M.15K.Gy being 2.51 g / dL , 3.08 g / dL , 87.58 mg / dl and 162.26 mg / dL, relative to control . On the other hand , no change was observed in alanine aminotransferase (ALT) value in all feeding groups, relative to control.

Diets supplemented with natural food colorants only had slight stimulation's in serum analysis. The results showed that, the lowest reduction in ALP activity, T.L, T.G and cholesterol was in the serum of rats fed on diets with natural food colorants (N.M.15k.Gy.).

Data in Table (4) revealed that, rats which fed on the diets containing mixture color (dehydrated mallow leaves with tartrazine / brilliant blue (M.M) either unirradiated or irradiated showed some changes in rat serum constituents. Results showed that , values ranging between 6.60 – 6.80 g/dL for total protein, 4.00 – 4.20 g/dL albumin, 2.50 – 2.90 g/dL globulin, 1.40 – 1.70 A/G ratio, 129 – 150 U/ml AST activity, 25 – 29 U/ml ALT activity, 135 – 165 U/ml ALP activity, 0.90 – 1.00 mg/dL creatnine, 3.10 – 3.30 g/L T.L, 105 – 116 mg/dL T.G, 170 – 203 mg/dL cholesterol, 81 – 100 mg/dL glucose, 13 – 16 g/dL hemoglobin and 37 – 48 g/dL hematocrate. Natural food colorants in their mixture with synthetic ones decreased the stimulation influences of the present dyes used as food additives .

From the results in Table (5) it could be noticed that, all diets with synthetic green color were varied in their effects on the different serum constituent's values. A significant increase was observed in rats fed on diets either unirradiated or irradiated (Sy.G) in AST, ALT and ALP activities; and glucose values. In addition to the creatnine value in case of irradiated diet (Sy.G.15 K.Gy). Meanwhile, the values of serum T.L, T.G and cholesterol were decreased in rats fed on irradiated diets (Sy.G.15 K.Gy); being 2.42 g/L, 83.88 mg/dl and 137.17 mg/dl, respectively, relative to their control values. While, serum T.P, albumin, globulin, A/G ratio, hemoglobin and hematocrate had slight changes relative to control.

Effects of natural and synthetic food colorants (dry tomato waste and sunset yellow color):

Different sources of unirradiated or irradiated color i.e. natural (dehydrated tomato waste), synthetic (Sunset yellow) and their mixtures were biologically evaluated. The results are presented in Tables (6-8).

Table (3): Effect of natural food colorants (dehydrated mallow leaves) on some serum constituents..

Group / Treatment	Control	N.M.	N.M. 10K.Gy	N.M. 15K.Gy
Total protein g/dl	6.84± 0.31	7.33± 0.51	7.20± 0.62	6.96± 0.93
Albumin g/dl	3.99± 0.41	4.78± 0.39	4.64± 0.46	4.45± 0.64
Globulin g/dl	2.86 ± 0.40	2.56± 0.51	2.55± 0.96	2.51± 0.79
A/G ratio	1.40	1.87	1.82	1.77
AST u/ml	129.38± 3.08	131.44± 3.59	132.25± 3.6	139.94± 2.46 *
ALT u/ml	25.98± 1.05	24.63± 1.95	25.33± 0.91	25.60± 1.82
ALP u/ml	135.23± 2.35	138.10±30.89	155.00±12.84	157.37±16.01
Creatnine mg/dl	0.92± 5.39E^{-02}	0.89± 6.6 E^{-02}	0.94± 7.75 E^{-02}	0.96± 0.11
Total lipid g/l	3.22± 0.26	3.29± 0.22	3.19± 0.4	3.08± 0.19
Triglyceride mg/dl	115.96± 4.92	105.77±11.02	92.81±11.83	87.58± 7.81 *
Cholesterol mg/dl	203.30± 4.78	171.23±25.98	167.92±18.5	162.26±33.58
Glucose mg/dl	81.39± 3.32	100.90± 2.61 *	102.24± 2.47 *	111.41± 4.43 *
Hemoglobin g/dl	12.85± 0.47	15.57± 1.21 *	14.67± 0.59	12.94± 0.41
Hematocrate g/dl	37.06	43.10	41.41	39.02

± = Standard error, * Significant at P $\leq$ 0.05, A / G ratio = Albumin / globulin, AST = Aspartate aminotransferase, ALT = Alanine aminotransferase, ALP = Alkaline phosphatase, N.M. = Natural leaves mallow

Table (4): Effect of food colorants mixture (leaves mallow + tartrazine/ brilliant blue) on some serum constituents .

Group / Treatment	Control	M.M.	M.M. 10K.Gy	M.M. 15K.Gy
Total protein g/dl	6.84± 0.31	6.73± 1.03	6.72± 0.98	6.64± 0.26
Albumin g/dl	3.99± 0.41	4.20± 0.49	4.05± 0.48	4.02± 0.71
Globulin g/dl	2.86 ± 0.40	2.53± 0.93	2.67± 0.77	2.62± 0.87
A/G ratio	1.40	1.66	1.52	1.53
AST u/ml	129.38± 3.08	131.94± 2.61	132.25± 2.36	152.56± 1.59 *
ALT u/ml	25.98± 1.05	25.08± 0.69	25.55± 0.87	28.80± 0.91
ALP u/ml	135.23± 2.35	161.36± 6.44	163.01± 8.66	164.89± 4.17
Creatnine mg/dl	0.92± 5.39 E^{-02}	0.97± 0.11	1.01± 0.15	1.02± 7.3 E^{-02}
Total lipid g/l	3.22± 0.26	3.33± 0.24	3.22± 0.24	3.12± 0.25
Triglyceride mg/dl	115.96± 4.92	110.13± 7.93	109.17± 4.73	105.12±14.32
Cholesterol mg/dl	203.30± 4.78	182.55±19.67	176.41±21.46	169.34±24.65
Glucose mg/dl	81.39± 3.32	96.19± 2.56	99.94± 5.7 *	100.37± 3.79 *
Hemoglobin g/dl	12.85± 0.47	16.02± 0.81*	15.66± 0.37 *	14.68± 1.25
Hematocrate g/dl	37.06	47.87	46.13	45.29

± = Standard error, * Significant at P $\leq$ 0.05, A / G ratio = Albumin / globulin, AST = Aspartate aminotransferase, ALT = Alanine aminotransferase, ALP = Alkaline phosphatase, M.M. = Mixture between mallow leaves and tartrazine / brilliant blue (1:1)

Table (5): Effect of food colorants synthetic (tartrazine/ brilliant blue) on some serum constituents.

Group / Treatment	Control	Sy.G.	Sy.G.10K.GY	Sy.G.15K.GY
Total protein g/dl	6.84± 0.31	7.64± 0.51	7.53± 0.9	7.52± 0.64
Albumin g/dl	3.99± 0.41	3.97± 0.33	3.84± 0.71	3.73± 0.5
Globulin g/dl	2.86 ± 0.40	3.67±0.58	3.69± 1.02	3.80± 0.72
A/G ratio	1.40	1.08	1.04	0.98
AST u/ml	129.38± 3.08	164.00± 5.18 *	169.56± 0.86 *	177.25± 4.73 *
ALT u/ml	25.98± 1.05	30.20± 1.07 *	30.83± 0.64 *	31.30± 0.49 *
ALP u/ml	135.23± 2.35	227.49± 5.92 *	241.88± 21.78 *	244.28± 4.84 *
Creatnine mg/dl	0.92± 5.39 E^{-02}	1.06± 4.05 E^{-02}	1.16± 9.91 E^{-02}	1.18± 6.33 E^{-02} *
Total lipid g/l	3.22± 0.26	2.74± 0.3	2.59± 0.22	2.42± 0.12 *
Triglyceride mg/dl	115.96± 4.92	93.46± 7.92	91.39± 4.18	83.88± 8.55 *
Cholesterol mg/dl	203.30± 4.78	158.49±27.63	154.72±27.53	137.17±22.5 *
Glucose mg/dl	81.39± 3.32	120.99± 7.13 *	127.52± 4.72 *	131.04± 16.4 *
Hemoglobin g/dl	12.85± 0.47	12.32± 0.69	11.56± 1.44	10.55± 0.3
Hematocrate g/dl	37.06	38.16	36.44	35.76

± = Standard error, * Significant at P $\leq$ 0.05, A / G ratio = Albumin / globulin, AST = Aspartate aminotransferase, ALT = Alanine aminotransferase, ALP = Alkaline phosphatase, Sy. G.= Tartrazine/brilliant blue

Table (6): Effect of natural food colorants (tomato waste) on some serum constituents.

Group / Treatment	Control	N. T.	N.T. 10K.Gy	N.T. 15K.Gy
Total protein g/dl	6.84± 0.31	7.16± 0.6	7.11± 0.24	7.09± 0.49
Albumin g/dl	3.99± 0.41	3.87± 0.21	3.71± 0.4	3.66± 0.27 *
Globulin g/dl	2.86 ± 0.40	3.29± 0.64	3.40±0.33	3.43±0.48
A/G ratio	1.40	1.18	1.09	1.07
AST u/ml	129.38± 3.08	131.63± 2.57	133.44± 5.24	136.69± 4.48
ALT u/ml	25.98± 1.05	22.73± 0.9	23.90± 2.12	24.55± 0.53
ALP u/ml	135.23± 2.35	134.76± 7.22	136.09± 2.45	150.76± 7.06
Creatnine mg/dl	0.92± 5.39 E^{-02}	0.91± 6.98 E^{-02}	0.98± 0.13	1.03± 0.19
Total lipid g/l	3.22± 0.26	3.55± 6.23 E^{-02}	3.32± 0.18	3.16± 0.32
Triglyceride mg/dl	115.96± 4.92	98.15± 16.83	96.78± 7.37	83.94± 13.58 *
Cholesterol mg/dl	203.30± 4.78	150.47± 27.94	127.83±13.48 *	124.06± 15.72 *
Glucose mg/dl	81.39± 3.32	104.90± 6.6	106.71± 16.45	108.93± 11.51
Hemoglobin g/dl	12.85± 0.47	15.09± 0.19 *	14.31± 0.46 *	13.47± 0.87
Hematocrate g/dl	37.06	42.49	40.18	35.40

± = Standard error, * Significant at P $\leq$ 0.05, A / G ratio = Albumin / globulin, AST = Aspartate aminotransferase, ALT = Alanine aminotransferase, ALP = Alkaline phosphatase, N.T. = Natural color (tomato waste).

Table (7): Effect of food colorants mixture (tomato waste + sunset yellow) on some serum constituents.

Group / Treatment	Control	M.T.	M.T. 10K.Gy	M.T. 15K.Gy
Total protein g/dl	6.84± 0.31	6.65± 0.18	6.54± 0.28	6.49± 0.93
Albumin g/dl	3.99± 0.41	3.39± 0.33	3.36± 0.34	3.32± 0.27
Globulin g/dl	2.86 ± 0.40	3.26±0.51	3.18±0.32	3.17±1.19
A/G ratio	1.40	1.04	1.06	1.05
AST u/ml	129.38± 3.08	132.13± 3.44	133.63± 3.45	151.63± 0.78 *
ALT u/ml	25.98± 1.05	22.90± 2.08	24.38± 1.1	25.48± 1.12
ALP u/ml	135.23± 2.35	152.12± 5.67	154.87± 8.82	155.21± 6.48
Creatnine mg/dl	0.92± 5.39 E^{-02}	0.92± 9.47 E^{-02}	1.02± 0.23	1.03± 0.15
Total lipid g/l	3.22± 0.26	3.24± 0.12	3.00± 0.24	2.93± 0.27
Triglyceride mg/dl	115.96± 4.92	103.36± 3.67	100.12± 3.74	99.02± 3.15
Cholesterol mg/dl	203.30± 4.78	197.64± 26.4	185.71± 15.85	183.87± 29.01
Glucose mg/dl	81.39± 3.32	96.29± 15.75	101.18± 2.96	103.66± 22.73
Hemoglobin g/dl	12.85± 0.47	15.29± 0.62 *	14.47± 0.53 *	14.14± 0.4
Hematocrate g/dl	37.06	47.86	42.13	39.66

± = Standard error, * Significant at P $\leq$ 0.05, A / G ratio = Albumin / globulin, AST = Aspartate aminotransferase, ALT = Alanine aminotransferase, ALP = Alkaline phosphatase, M. T. = Mixture between dehydrated tomato waste and sunset yellow (1:1).

Table (8): Effect of synthetic food colorants (sunset yellow) on some serum constituents.

Group / Treatment	Control	Sy.Y	Sy.Y. 10 K.GY	Sy.Y. 15 K.GY
Total protein g/dl	6.84± 0.31	8.79± 0.57 *	8.76± 0.71 *	7.99± 0.57
Albumin g/dl	3.99± 0.41	3.27± 0.32	3.19± 9.75E^{-02}	3.02± 0.31 *
Globulin g/dl	2.86 ± 0.40	5.52±0.7 *	5.57±0.74 *	4.97±0.64 *
A/G ratio	1.40	0.59	0.57	0.61
AST u/ml	129.38± 3.08	156.25± 3.69 *	158.81± 0.68 *	162.00± 1.45 *
ALT u/ml	25.98± 1.05	27.13± 0.56	30.80± 0.4 *	31.28± 1.81 *
ALP u/ml	135.23± 2.35	160.76± 14.69 *	168.53± 7.75 *	172.39± 8.82 *
Creatnine mg/dl	0.92± 5.39 E^{-02}	1.07± 0.19	1.08± 0.14	1.17± 7.0 E^{-02}
Total lipid g/l	3.22± 0.26	2.86± 0.23	2.80± 0.26	2.66± 0.32
Triglyceride mg/dl	115.96± 4.92	76.36± 5.79 *	76.14± 6.21 *	60.35± 1.65 *
Cholesterol mg/dl	203.30± 4.78	120.28± 23.51 *	115.09± 4.43 *	103.68± 10.27 *
Glucose mg/dl	81.39± 3.32	131.68± 16.99 *	141.15± 16.94 *	147.02± 9.13 *
Hemoglobin g/dl	12.85± 0.47	11.57± 0.37	11.25± 0.35 *	11.25± 0.11 *
Hematocrate g/dl	37.06	35.27	32.64	31.42

± = Standard error, * Significant at P $\leq$ 0.05, A / G ratio = Albumin / globulin, AST = Aspartate aminotransferase, ALT = Alanine aminotransferase, ALP = Alkaline phosphatase, Sy. y = Sunset yellow.

Data in Table (6) showed that , the highest values in serum total protein, albumin , A/G ratio, total lipid, hemoglobin and hematocrate were found in group fed on diet contained natural tomato waste (N.T.) being 7.16 g/dL, 3.87 g/dL, 1.18, 3.55 g/L, 15.09 g/dL and 42.49 g/dL respectively, relative to their control. And followed by group fed on natural tomato waste irradiated at 15 k.Gy (N.T. 15 k.Gy) giving the values of 3.43 g/dL, 136.69 U/ml, 150.76 U/ml, 1.03 mg/dL and 108.93 mg/dL, for globulin, AST, ALP, creatnine and glucose, respectively, relative to their control values.

Meanwhile, the lowest value was recorded for ALT, T.G. and cholesterol in the group fed on diet contained N.T.15 k.Gy being 24.55 U/ml, 83.94 mg/dL and 124.06 mg/dL respectively, relative to control.

Data in Table (7) showed the serum constituents of rats fed on unirradiated or irradiated colorants mixture (dehydrated tomato waste and sunset yellow). It could be noticed that, total protein, albumin, globulin, A/G ratio, AST, ALT, ALP, creatnine, serum total lipid, serum triglyceride, cholesterol, serum glucose, hemoglobin and hematocrate of tested rats were varied. A significant increase was noticed in group fed on M.T.15k.GY (151.63 U/ml) for AST activity, relative to control value (129.38 U/ml). Also, hemoglobin had a significant increase in both groups that fed on M.T. and M.T.10 k.Gy being 15.29 and 14.47 g/dL respectively, relative to control values (12.85 g/dL).

From the results in Table (8) it was found that the diet of radiated synthetic color (15 k.Gy) caused lowest decrease in A/G ratio, serum total lipid and hematocrate which were 0.61, 2.66 g/L, 31.42 g/dl respectively, relative to control. While, unirradiated and irradiated diet with synthetic color (Sy.Y) showed a significant increase in serum total protein, globulin, AST, ALT, ALP, and glucose. Also, the diet Sy.Y.15 k.Gy revealed a significant decrease in serum albumin, triglyceride, cholesterol and hemoglobin being 3.02 g/dl, 60.35 mg/dl, 103.68 mg/dl and 11.25 g/dl respectively, relative to control.

As it well known that, serum protein consists mainly of albumin and globulin. It is obvious that, experimental food colorant diets might stimulated albumin biosynthesis relative to that of control animals. In the same time the present treatments may be inhibited or unchanged the biosynthesis of globulin. Natural pigments in their mixture improved the ratio of A/G. It means that natural food colorants may be stimulated the process of protein biosynthesis to reduce kind of protein that decreased the toxicity of synthetic dyes used as food colorants. These results are in agreement with those of Hamouda (1994), Abdel- Rahim *et al* .(1995); Salah *et al.* (1999) and Mohamed (1999). They found that, food colorants stimulated the transaminase activity but synthetic colorants were more effective than natural ones. Meantime, natural colorants in mixture with synthetic dyes inhibited the toxic influences of synthetic dyes in the animal. Salah (1994) found that synthetic dyes significantly stimulated ALP activity in experimental rat plasma. The present study indicated that the load and kind of synthetic and natural food colorants inducted into animals for assimilation at any time might alter the activity of enzymes such as AST, ALT and ALP followed by changes in over all protein metabolism. Accordingly, some of the amino acids were dominated and converted to glucose. These were confirmed by data of blood glucose in the present study. In connection, the amino nitrogen was excreted as urea and creatnine. These also were confirmed by the results of kidney function partly reported in the present study. On these bases, a relation might exit between protein metabolism and feeding on food colorants. Also animals in protein biosynthesis via feeding on food colorants needed a high amount of rich phosphate stimulation of ALP for that stimulation of ALP was important to supply inorganic phosphate required for ATP synthesis.

The present work agreed with Salah (1994) and Mohamed (1999) who found that kidney function of rats fed on synthetic dyes used as food additives were changed in which the plasma levels of creatnine was significantly increased relative to those of control animals. The present results are also in the line with those of Ramadan and El-Damhogy (1994), Hamouda (1994) and Mohamed (1999). Who found that, some decreases were observed in total lipids in serum of rats fed on food colorants which may be attributed to the nature of their chemical structure and to fatty acids biosynthesis precursor (Acetyl CoA) which was transferred toward energy metabolism. The rate of lipids biosynthesis may be reduced on the rate their catabolism was stimulated by the additive induction. However the food colorants had a powerful hypolipimic effect, and an important role in the lipid.

Natural food colorants acted as antagonistic agents against synthetic one. These findings are in agreement with those of Hamouda, (1994), Abdel-Rahim *et al.* ,(1995), and Mohamed (1999) who found that natural pigments reduced the high level of blood glucose which produced by synthetic dyes (food additives). Also blood glucose levels were increased in rats feed on diets with either natural or synthetic food colorants. However, liver glycogen was decreased by the same treatments. The increase of blood glucose in the present work may be due to the glucose production after food colorants induction by glycogenolysis and glucogensis processes. This result was in agree with Salah *et al.* (1999) who reported that is in the toxic effects of synthetic dye diets may reduce or disappear by natural pigment application alone or with synthetic dye. With other words natural food colorants had antagonistic effects on the synthetic dyes used as food additive influences.

Effects of food colorants on gain in body weight:

The body weight gain of rats fed on diets containing natural and synthetic food colorants and their mixture was estimated during the experimental periods (Tables 9-14). The data showed that, the gain in body weight of rats fed normal diets (control) reached the value of 210.04 g.

Table (9): Effect of unirradiated and irradiated diets containing natural food colorants (dehydrated mallow leaves) on body and organs weight of rats

Group / Treatment	Control	N.M.	N.M.10 k.Gy	N.M.15 k.Gy
Initial body weight (g)	50.81±0.35	55.27 ±1.53	53.54 ±0.78	53.84 ±1.83
Final body weight (g)	260.85±7.21	252.14 ±4.07	239.67 ±7.38	237.63 ±2.57
Gain of body weight (g)	210.04±6.92	196.37 ±5.20	186.13 ±6.67	183.79 ±3.39*
Liver weight (g)	9.51±0.52	11.04 ±1.03	10.96 ±0.92	10.14 ±0.54
Kidney weight (g)	1.96±4.99 E^{-02}	2.02 ±0.13	1.94 ±8.38 E^{-02}	1.86 ±0.11
Spleen weight (g)	0.71±2.77 E^{-02}	0.59 ±3.49 E^{-02}	0.65 ±3.07 E^{-02}	0.67 ±5.02 E^{-02}

The diets containing (M.M.) showed the maximum gain in body weight followed by rats fed on diets containing M.M. (10 k.Gy), N.M, M.M (15k.Gy), N.M. (10k.Gy), N.M.(15k.Gy), Sy.G., Sy.G.(10k.Gy), and then Sy.G. (15k.Gy) diets, respectively. Their values were about 227.67, 214.91, 196.37, 193.16, 186.13, 183.79, 182.09, 172.81 and 163.77 g, respectively. In contrary, the synthetic green color in the diet caused a decreased in body gain weight compared with the control. It means that natural colorants supplemented with synthetic ones in the animal diet reduced the toxic effects of synthetic dyes (Tables 9 -11).

Table (10): Effect of unirradiated and irradiated diets containing food colorants mixture (dehydrated mallow leaves + tartrazine/brilliant blue) on body and organs weight of rats.

Group / Treatment	Control	M.M.	M.M.10k.Gy	M.M.15k.Gy
Initial body weight (g)	50.81±0.35	55.59 ±1.27	55.14 ±0.77	54.01 ±1.89
Final body weight (g)	260.85±7.21	283.26 ±9.77	270.04 ±7.50	247.17 ±8.97
Gain of body weight (g)	210.04±6.92	227.67 ±9.16	214.91 ±8.00	193.16 ±7.24
Liver weight (g)	9.51±0.52	12.82 ±0.50*	12.14 ±0.90*	11.38 ±1.05
Kidney weight (g)	1.96±4.99 E^{-02}	1.89 ±5.19 E^{-02}	1.87 ±0.11	1.85 ±0.11
Spleen weight (g)	0.71±2.77 E^{-02}	0.74 ±0.10	0.74 ±5.08 E^{-02}	0.75 ±2.53 E^{-02}

Table(11): Effect of unirradiated and irradiated diets containing synthetic food colorants (tartrazine/brilliant blue) on body and organs weight of rats

Group / Treatment	Control	Sy.G	Sy.G. 10k.Gy	Sy.G. 15k.Gy
Initial body weight (g)	50.81±0.35	52.85 ±0.83	51.60 ±1.24	55.47 ±1.43
Final body weight (g)	260.85±7.21	234.93 ±12.20	224.41 ±13.46	219.24 ±0.88
Gain of body weight (g)	210.04±6.92	182.09 ±12.09*	172.80 ±12.33*	163.77 ±1.51*
Liver weight (g)	9.51±0.52	8.92 ±0.60	8.68 ±0.50	7.74 ±0.39
Kidney weight (g)	1.96±4.99 E^{-02}	1.81 ±0.16	1.78 ±0.15	1.69 ±0.19
Spleen weight (g)	0.71±2.77 E^{-02}	0.79 ±2.32 E^{-02}	0.84 ±8.24 E^{-02}	0.86 ±0.14

Table (12): Effect of unirradiated and irradiated diets containing natural food colorants (dehydrated tomato waste) on body and organs weight of rats

Group / Treatment	Control	N.T.	N.T. 10k.Gy	N.T. 15 k.Gy
Initial body weight (g)	50.81±0.35	50.90 ±0.85	50.69 ±0.89	51.20 ±0.95
Final body weight (g)	260.85±7.21	298.45 ±9.78	294.64 ±8.30	290.60 ±5.39
Gain of body weight (g)	210.04±6.92	247.56 ±9.23*	243.79 ±7.41*	239.41 ±4.50*
Liver weight (g)	9.51±0.52	13.20 ±1.05*	12.14 ±0.9*	10.61 ±1.05
Kidney weight (g)	1.96±4.99 E^{-02}	2.17 ±0.11	2.15 ±0.11	2.12 ±3.87 E^{-02}
Spleen weight (g)	0.71±2.77 E^{-02}	.0.54 ±6.38 E^{-02}	0.62 ±5.91 E^{-02}	0.70 ± ±4.94 E^{-02}

Table (13): Effect of unirradiated and irradiated diets containing food colorants mixture (dehydrated tomato waste + sunset yellow) on body and organs weight of rats.

Group / Treatment	Control	M.T.	M.T. 10k.Gy	M.T. 15 k.Gy
Initial body weight (g)	50.81±0.35	51.16 ±1.0	50.73 ± 0.30	50.42 ±0.84
Final body weight (g)	260.85±7.21	305.85 ±8.10	301.16 ±7.10	298.64 ±3.46
Gain of body weight (g)	210.04±6.92	254.70 ±7.11*	250.43 ±7.26*	248.22 ±2.69*
Liver weight (g)	9.51±0.52	11.[illegible] ±0.76	10.76 ±0.74	10.48 ±0.80
Kidney weight (g)	1.96±4.99 E^{-02}	2.14 ±0.18	2.05 ±0.19	2.05 ±0.29
Spleen weight (g)	0.71±2.77 E^{-02}	0.65 ±8.71 E^{-02}	0.68 ±8.08 E^{-02}	0.74 ±0.11

Table (14): Effect of unirradiated and irradiated diets containing synthetic food colorants (sunset yellow) on body and organs weight of rats .

Group / Treatment	Control	Sy.Y	Sy.Y. 10k.Gy	Sy.Y. 15 k.Gy
Initial body weight (g)	50.81±0.35	50.40 ±0.52	50.45 ±0.77	50.58 ±1.0
Final body weight (g)	260.85±7.21	264.98 ±5.06	254.99 ±7.55	246.41 ±4.85
Gain of body weight (g)	210.04±6.92	214.59 ±5.27	204.55 ±6.92	195.83 ±4.28
Liver weight (g)	9.51±0.52	8.51 ±0.67	8.30 ±0.45	7.99 ±0.63
Kidney weight (g)	1.96±4.99 E^{-02}	2.04 ±0.14	1.92 ±5.89 E^{-02}	1.90 ±5.66 E^{-02}
Spleen weight (g)	0.71±2.77 E^{-02}	0.71 ±8.00 E^{-02}	0.75 ±8.34 E^{-02}	0.83 ±0.12

Results in (Table 12-14) showed that, the synthetic yellow color in diets decreased the gain in body weight compared to the control. The maximum decreased value was observed in case of Sy.Y.15 K.Gy (195.83 g.) and the highest increase value was in the treatment of M.T (10K.Gy) 254.70 g., relative to control (210.44 g.). It means that natural colorants supplemented with synthetic ones in the animal diet reduced the toxic effects of synthetic dyes used as foodstuff. The present results are in agreement with those of Abdel-Rahim *et al.* (1995). They found that, rats fed on synthetic green dyes as food colorants characterized by low growth rats at control but the mixture of natural and synthetic green color and B-carotene reduced the toxic effect of synthetic food colorants. It means that food colorants have significant antagonistic effect of synthetic ones. Also, the results are in harmony with Hamouda (1994) who reported that, the decrease of the body weight gain may be due to the complex between the food colorants and lipids of basal diet and the effective enzymatic for growth (Abdel-Rahim *et al.*, 1989). In addition the natural yellow color was carotene that produced vitamin "A" that is needed for growth in body. Suharno and Muhilal (1996), West (1996), and Salah *et al.* (1999) .

Effects of food colcrants on rat organs weight:

The liver is the organ, which concerned with lipid metabolism like other organs, which has an effect on lipid content of the liver of most animals ، averages about 5%, but it depends on the diet and animal health under the influence of various pathological and physiological disturbances. Its lipid content under the influence of different diets might be due to the accumulation or decline of fats (Hamouda, 1994).

Results in (Table 9-14) showed that organs weights were changed by increasing or decreasing relative to that of control rats. Data of the liver, kidney and spleen weight of the experimental rats fed on normal and up graded different supplements are presents in Tables (9-11). From the results, it could noticed that, liver weight like other organs were increased with the increasing in body weight. The weight values of liver were 11.04, 12.82, 8.92, 10.96, 12.14, 8.68, 10.14, 11.38 and 7.74 g. relative to control for N.M., M.M., Sy.G., N.M.10k.Gy, M.M.10k.Gy, Sy.G.10k.Gy, N.M.15k.Gy, M.M.15k.Gy and Sy.G.15K.Gy, respectively. Also diets of synthetic dyes were more effective than natural pigments diets moreover natural pigments in mixture of natural and synthetic colorants diets reduced the influences of synthetic dyes in liver weight. The average values of liver weights were lower (Sy.G.15k.Gy) in some tested rats relative to control. The increases produced by feeding on M.M. were more than that observed for all other treatments for tested rats.

Meanwhile the result obtained from Table (12-14) revealed that liver weight ranged from 7.99 g. to 13.20 g. The values were 13.20, 11.63, 8.51, 12.14, 10.76, 8.30, 10.61,10.48 and 7.99 g. relative to control respectively for N.T., M.T., Sy.Y., N.T. 10 kGy, M.T. 10k. Gy, Sy. Y. 10k. Gy, N.T 15k. Gy, M.T. 15 k.Gy. and Sy.Y. 15k.Gy.

Results in Tables (9-11) revealed the effects of natural and synthetic food colorants on kidneys weight of experimental male adult's albino rats. Some treatments decreased the weight such as rats fed on Sy.G15k.Gy., the value was 1.69 g. relative to control., and also other treatments changed the kidney weight. Data in Tables (12-14) 31 to 33) showed that kidney weight ranged between 1.9 g. and 2.2 g., also the values were 2.17, 2.14, 2.04, 2.15, 2.05, 1.92, 2.12, 2.05 and 1.90 g. for N.T., M.T., Sy.Y., N.T.10 k.Gy, M.T.10 k.Gy, Sy.Y., 10 k.Gy, N.T. 15 k.Gy, M.T.15 k.Gy. and Sy.Y.15 k.Gy, respectively.

The same trend was observed in case of spleen weight relative to that of control animals. The data in Tables (9-11) showed that the spleen weight values were 0.59, 0.74, 0.79, 0.65, 0.74, 0.84, 0.67, 0.75 and 0.86 g. for the animals fed on the diets N.M., M.M., S.G., N.M.10 k.Gy, M.M. 10 k Gy, S.G.10 k.Gy, N.M.15 k.Gy, M.M.15 k.Gy and S.G.15 k.Gy, respectively.

Results in Tables (12-14) showed the spleen weight values relative to control, it appeared that the highest level was 0.83 g. in case the diet Sy.Y.15 k.Gy but N.T. has the lowest value 0.54 g., relative to control. In addition spleen weight of experimental treatments were 0.54, 0.65, 0.71, 0.62, 0.68, 0.75, 0.70, 0.74 and 0.83 g. relative to control from N.T., M.T., Sy.Y., N.T. 10k.Gy, M.T.10 k.Gy , Sy.Y.10 k.Gy, N.T.15 k.Gy, M.T.15 k.Gy and Sy.Y. 15 k.Gy, respectively.

The induction of natural and synthetic colorants and their mixture changes the body functions but natural colorant in the mixture was able to overcome impaired caused function by synthetic ones, it caused also improvements in the appetite to food and increased the daily food intake which followed by readjustment in the gain in body weight. The present results are in tendency with those obtained by Abdel-Rahim *et al.* (1995) and Mohamed (1999), they found that natural food colorants reduced the toxic effects of synthetic one in organs tissue. Also, Abdou *et al.* (1997) and Salah *et al.* (1999) found similar results in which natural pigments reduced the toxic effects of synthetic ones. The increase or decrease of liver weight relative to control under the influence of different diets might be due to the accumulation or reduction of fats. The abnormal effects were noticed on relative organs weight, of the liver and kidneys when rats fed natural or synthetic food colorants. It can be concluded that , the increase in the average liver weight by colorants ingestion may be attributed to that colorants appeared a tumeric effects. These effects were reduced in case of natural and synthetic colorants mixtures as antagonistic effect. Also, might be attributed to that colorants appeared a hypolipimic and hypocholesterolemic effects.

Many published information are available on the use of irradiation to extend the shelf- life of perishable food time and ensure their hygienic quality. However, little is known about the effect of radiation on natural or synthetic colorants. It showed be emphasized that no or very little data are available in the literature about this influence of interaction between gamma radiation and natural or synthetic color as well as storage on different c onditions. T hese items need more investigation and more research.

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التقييم الحيوى لكل من أوراق الخبيزة ومخلفات الطماطم كمصدر للألوان الغذائية الطبيعية

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تلعب الألوان دورا هاما فى كثير من الصناعات الغذائية، وصناعة الأدوية. وقد استهدفت هذه الدراسة التقييم الحيوى لاستخدام الألوان الصناعية (الترترازين مع الأزرق اللامع وأصفر غروب الشمس) سواء بمفردهم أو فى خليط مع الألوان الطبيعية (أوراق الخبيزة الجافة، ومخلف الطماطم الجاف) بنسبة (١:١) وذلك لتقليل التأثير الضار الذى قد ينشأ أو يصيب الإنسان من جراء الاستخدام المتكرر للون الصناعى. تم تشعيع كل من المواد الخام (الألوان) الطبيعية والصناعية والخليط بينهم على جرعات مختلفة (١٠، ١٥ كيلوجراى) للحصول على منتج آمن صحيا. تم عمل تقييم حيوى لدراسة تأثير كل من الألوان الطبيعية والصناعية سواء بمفردها أو فى مخلوط بينهم عن طريق إدخالهم فى منتج غذائى هو المكرونة التى استخدمت فى تجربة تغذية للفئران الألبينو مع وجود مجموعة الكنترول الخالية من الألوان. وبعد انتهاء مدة التجربة التى استمرت ٩٠ يوما تم تم حساب الزيادة فى وزن الفئران ووزن كل من أعضاء الفئران (الكبد والكلى والطحال) مقارنة بالكنترول. كذلك تم عمل التقديرات الحيوية المختلفة فى سيرم مجاميع الفئران المختلفة تحت الدراسة، حيث تم تقدير كل من البروتينات الكلية وبروتينات الألبيومين والجلوبيولين ونسبة الألبيومين الى الجلوبيولين والدهون الكلية والكوليستسرول والجلسريدات الكلية وسكر الدم، كذلك تم تقدير نشاط الانزيمات الناقلة للأمين بالإضافة لنشاط انزيم الفوسفاتيز القاعدى، أيضا تم كل من نسبة الهيموجلوبين والهيماتوكريت بالدم. وقد أوضحت النتائج أن وجود الألوان الصناعية بمفردها ادى الى حيود معظم القيم التى تم تقديرها عن الكنترول بينما أدى وجود الصبغات الطبيعية عند خلطها مع الصبغات الصناعية الى تقليل ذلك الحيود واقتراب النتائج من الكنترول، مما يدل على أن الألوان الطبيعية قد أدت الى تقليل التأثير السام الناتج من الألوان الصناعية بمفردها.