Protective effect of red cabbage and garlic extracts against Fumonisin B1 induced hepatotoxicity in male mice

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Abstract - Red cabbage and garlic extracts have protective effect against liver damage induced by fumonisin B1 (FB1) in male mice was studied. Randomly sixty mice have been divided in to six groups. Group one are the healthy mice, Group two are mice received oral dose of only FB-1 (100 µg/kg.b.w) once on daily for 1 month, Group three: mice received with red cabbage extract (500 mg/kg.bw) plus FB1, Group four: mice receiving just red cabbage extracts, Group five: mice receiving garlic extract (500mg/kg.bw) plus FB1, group 6: mice received only garlic extract. After finished the experiment, samples of blood were used for biochemical examination. The results indicated that group (2) mice treated with Fumonisin B1 had significant increased (p less than 0.05) regarding the liver enzymes namely LDH, ALP, AST, GGT, as well as ALT and also in this work there has been significant increase (p less than 0.05) in lipid profile, T.ch, TG, HDL, VLDL but significantly decrease in reduction of LDL. Oral administration related to red cabbage as well as the garlic extracts produced significantly reducing the level related to serum of the VLDL, TG, LDH, ALP, AST, ALP, GGT, T.ch, ALT as well as HDL and cause increase significant in LDL.

Keywords— Red cabbage, Garlic, Fumonisin B1, Liver function.

1. Introduction

Fumonisins have been defined as secondary metabolites which are created in the cereals through the pathogenic fungi, referred to as Fusarium verticillioides, Fusarium proliferatum, in addition to certain associated species[1]. Furthermore, the Aspergillus niger is producing the fumonisins in crop plants that are related to grape, maize as well as peanuts [2]. Also, maize as well as the maize-based products have been majorly infected with the fumonisins in addition to their existence in a lot of other grains (millet, rye, barley, rice, wheat, maize, as well as oat), also the grain products (chips, corn flasks, as well as tortillas) [3,4], that have main impact on health. Over fifteen fumonisin homologues were specified as fumonisin A, B, C, as well as P [5]. Also, among fumonisin B, FB-1, FB-2, as well as FB-3 have been major abundant with the FB-1 being major toxic form which might be coexisting with the other fumonisin’s forms, such as FB-3 and FB-2 [6].

Elucidation related to fumonisin’s chemical structure has been indicated through [7]. FB-1 has been diester of the propane-1, 2, 3 tricarboxylic acid in addition to the
pentahydroxyeicosane where C-14 as well as C-15 hydroxy groups have been esterified with terminal carboxy group that is related to the propane-1, 2, 3-tricarboxylic acid (Fig. 1).

Figure 1. Chemical structure related to fumonisin mycotoxin types

Helene, [8].

Studies have shown that fumonisins have been competitive inhibitors regarding the sphingolipid biosynthesis as well as metabolism. Also, fumonisins have been structurally comparable to the sphingoid bases like sphingosin, that is considered to be component related to sphingolipid molecule, also has the ability of inhibiting the sphingosin-sphinganine-transferase as well as the ceramide synthase [9].

Samir et al., [10] reported Fumonisin exposure has been shown to cause hepatic injury and/or carcinogenesis in horses, pigs, rats, mice, and others. Routine early findings of fumonisin-induced hepatic toxicity include the presence of apoptotic and necrotic hepatocytes. Consistent with early hepatic injury are elevated serum liver enzymes such as lactate dehydrogenase, aspartate transaminase, alanine transaminase, alkaline phosphatase, in addition to the elevated cholesterol and triglyceride concentrations. Progression of injury involves continuation of apoptosis and necrosis, enhanced mitosis and hepatocellular hyperplasia, cytoplasmic vacuolation, cytomegaly with variation in nuclear size, bile duct and oval cell proliferation, cholangiomatous lesions, and fibrosis. Serum gamma-glutamyltransferase (GGT) activity and bilirubin concentrations begin to rise as hepatic injury worsens. Some have also found increased hepatic lipid peroxidation and altered antioxidant status. It has been suggested that enhanced oxidative stress and lipid peroxidation may be a
causative initiating factor in hepatic carcinogenesis. Enhanced cell proliferation in response to injury may be a supporting factor in the cancer initiation by fumonisins. In summary, much data supports the role of fumonisins in causing hepatic toxicity and carcinogenesis in a variety of animals. In human body, one of the largest internal organs is the liver, it is controlling the safety and flow of substances that are absorbed from digestive system into systemic circulations. The major functions of liver including producing energy through protein, carbohydrate as well as the lipid metabolisms, synthesizing bile salts, vitamin’s storage, as well as production regarding lipoproteins, angiotensin in addition to the coagulation factors. Thus, the hepatic diseases like fatty liver diseases, cirrhosis as well as hepatitis extremely impacting body’s homeostasis [11]. Also, hepatopathies is the result of glutathione exhaustion, alcoholism, toxic chemicals, viral infections as well as drugs; therefore, a lot of animal models related to the injury of liver were utilizing for testing hepatoprotective potential regarding the natural products [12]. Anthocyanin-rich extract from the red cabbage \([B.\ oleracea\ L.\ var.\ capitata]\) was indicated to attenuate cardiac as well as hepatic oxidative stress in the atherogenic rats [13]. Similarly, genus \(Allium\) (Amaryllidaceae) containing allyl sulphides [14]. Furthermore, the biological properties related to diallyl disulphide (DADS) specified in the garlic \(Allium\ sativum\ L.)\) were extensively examined, also they involve modulations regarding the cellular oxidative stress, involved in the signal transductions as well as the post-translational modifications regarding proteins through forming mixed disulphides [15]. in addition to hepatoprotective impacts, that have been specified on model related to the CT-induced liver damages [16]. The presented work has the aim of studying the protective impact regarding red cabbage and garlic extracts on hepatocellular damage and disturbance of lipid profile induced by Fumonisin B1 in male mice.

**Material and methods**

**Plant material of Red cabbage**

The fresh Samples related to the red cabbage plants have been bought from a local market in Iraq/Baghdad. Clean tap water used to wash the samples for removing the dirt on leaves. Also, dried plant material has been powdered manually, and the powder has been kept in polyethylene bags till use.

**Preparing aqueous Red cabbage extract**

The plant materials have been prepared based on conventional approach [17]. Leaves were sliced into small pieces, then extraction has been conducted with the use of dried plant material of (100gm) as well as (800 ml) flowing solvent acidified (1 ml) of the HCL (1 molar)
increase order of the water (W) for administrating it to mice, after that it was kept on magnetic bar shaker at a temperature of 40 Celsius for a period of 12 hours. Dry plants could be of high importance for minimizing the enzymatic degradation that is related to the phenolic compounds. Following maceration for overnight, extract has been filtered via gauze after that, water has been evaporated with decreased pressure at a temperature of 50 Celsius through the use of rotary evaporator. Following evaporation, the dried samples have been placed in desiccator over the calcium carbonate for removing all remaining water. Furthermore, resulting dried violet-red pigments have been utilized for more researches. Also, dried extract has been dissolved in the distilled water to concentration (500mg/ml) prior to administrating to mice.

**Plant material of Garlic**

The fresh samples related to the garlic plant have been bought from local market in Iraq/Baghdad. Clean tap water used to wash the samples for removing dirt on pulps. After that, distilled water and running tap water used to wash the collected garlic. Also, the washed garlic has been shade dried for 3-5 days at room temperature after that subjected to grinding in to fine powder.

**Preparing aqueous Garlic extract**

The plant material has been prepared based on conventional approach via Toryali et al.,[18]

About 100 g of dried garlic powder were mixed with 800 ml of the flowing solvent acidified (1 ml) of the HCL (1 molar) increase the order of water (W). and kept on a water bath shaker for 12 h at 40 °C. Thereafter, it has been filtered via Whatman No. 1 filter paper, after that, filtrate has been collected as well as used for preliminary chemical analysis. Dried extract has been dissolved in the distilled water to (500mg/ml) concentration prior to administrating to mice.

**Determination of the median lethal dose of FB1**

**Laboratory Animals**

Thirty-Six male Swiss albino mice (4 weeks old, 24±2-gram weight), obtained from Biotechnology Researches Center / Al- Nahrain university, have been adapted for two weeks before starting the experiment. They were maintained under a laboratory environment ; diet, water and temperature at animal house in Biotechnology Researches Center/ Al- Nahrain University.

**Experimental design**

There are thirty-six mice have been divided in to 6 groups. Also, each one of the groups have been orally gavaged with various concentrations regarding FB-1 in the following way: 50µg, 100µg, 150µg, 200µg, 250µ g as well as 300µg. Following twenty-four hours, all the treated
mice have been studied for determining the concentrations that killed 50% of the animals and has been specified as median lethal dose (LD-50) [19].

**Experimental design of study**

For the purpose of studying the possible impact regarding extracts to prevent FB1 toxic effects for 60 male albino mice that have been divided randomly in to these groups: animal receiving no FB-1 and no extract medications (G1), animals treated for four weeks with only FB-1 on daily basis dose of 100µg/Kg/day (G2). animals have been treated with FB-1 in daily basis dose of 100µg/Kg/day for a period of four weeks along with being subjected to treatment with 500mg/animal/day of the red cabbage extracts (G3). Animals have been treated for a period of four weeks on daily basis with just red cabbage extracts of 500mg/animal/day (G4). Animals have been treated with FB-1 in daily basis for four weeks for a dose of 100µg/Kg/day as well as subjected to treatment with 500 mg/animal/day of the garlic extracts (G5). Animals subjected to treatment with just 500mg/animal/day for a period of four weeks of the garlic extracts.

**Determination of serum aspartate transferase activity (AST)**
The serum AST activity has been color-metrically evaluated based on Reitman and Frankle, [20] with the use of commercially available kit (Randox).

**Determination of serum alanine transaminase activity (ALT):** The serum ALT activity has been color-metrically evaluated based on Reitman and Frankle, [20] with the use of commercially available kit (Randox).

**Determination of serum alkaline phosphatase activity (ALP):** The serum ALP activity has been color-metrically evaluated at 510nm based on Kind and King, [21] with the use of commercially available kit (bioMerieux. France).

**Determination of \(\gamma\)-Glutamyl Transferase (GGT) activity:**
The serum (GGT) activity has been color-metrically evaluated based on commercially available kit (Randox). Also, the \(\gamma\)-Glutamyl Transferase (GGT) can be specified as enzyme indicated majorly in the serum from the hepatic origin via highest levels in kidney. Increased levels ae indicated in the hepatobiliary as well as the pancreatic disease. The chronic alcoholism as well as the myocardial infarction with the secondary liver damage and diabetic. Furthermore, the GGT catalyze transfer related to the amino group between the L- \(\gamma\)-Glutamy1-3 caboxy4-nitroanlide as well as the Glycylglycine for creating L- \(\gamma\)-Glutamylglycylglycine as well as the 5-amino-2nitrobenzoate. The rate of the formation related to 5-amino-2nitrobenzoate has been evaluated as increasing in the absorbance that has been proportional to GGT activity in sample.

**Determination of Lactate dehydrogenase (LDH) activity:**
The serum (LDH) activity has been enzymatically evaluated based on commercially available kit (Xpress Bio life science products) catalog number 3460-04. LDH has been considered as
one of ubiquitously-expressed intracellular enzymes that catalyze reversible oxidation regarding the lactate to the pyruvate. Furthermore, LDH is major clinically significant protein marker in the serum due to its level change in response to some health-related states. For instance, increased LDH serum level have been sometimes resulting from kidney, liver, as well as heart disease in addition to a lot of cancer types. Furthermore, the existence of increased levels regarding enzyme in the serum following drug administration as well as experimental therapeutic agents has been related to organ toxicity. Also, such enzyme could be utilized for detecting cytotoxicity as well as cell number in in vitro cell culture systems. Thus, to monitor serum levels regarding the LDH enzyme are major mean for monitoring organ toxicity. LDH enzymatic assay kit will be measuring the LDH activity with the use of plate-based, direct, as well as colorimetric reaction. In the case when serum has been added to reaction mix, LDH in sample converting lactate as well as NAD+ in mix to the pyruvate in addition to the NADH. Furthermore, the production regarding NADH product has been monitored directly through evaluating the elevation in absorbance related to reaction at 340nm over time interval of 5 minutes. Dilutions regarding standard (involved in kit) could be utilized for constructing standard curve for calibrating assay as well as confirming linearity.

**Determination of serum total cholesterol (T.chol):**

The total cholesterol concentrations have been evaluated through enzymatic method [22] with commercially available kit (bioMerieux France). Also, the total cholesterol has been spectrophotometrically specified at 500nm.

**Determination of serum high density lipoproteincholesterol (HDL-c):**

Levels related to the HDL-c has been evaluated through enzymatic method [23] along with the commercially available kit (bioMerieux-France). The base of such approach has been precipitating chylomicrons as well as lipoproteins regarding very low-density lipoprotein (VLDL) in addition to low density lipoprotein through adding phosphotungestic acid with the existence regarding magnesium ion. Supernatant acquired following centrifugation that contained HDL from which cholesterol as well as the phospholipids could be specified. HDL has been specified spectrophotometrically at 500nm.

**Determination of serum triglycerides (TG):**

The total serum triglycerides concentrations have been evaluated through enzymatic method of Fossati and Prencipel, [24] along with the commercially available kit (BioMerieux France). Also, the total serum concentrations related to triglycerides have been specified at 500nm.

**Determination of serum very low density lipoprotein cholesterol (VLDL-C):**

Very low density lipoprotein was determined according to the conventional [25] equation. VLDL-c (mg/dl) = 0.2 x TG (mg/dl).
**Determination of serum low density lipoprotein cholesterol (LDL-c):**

The serum low density lipoprotein has been specified based on Friedewald equation:

\[ \text{LDL-c} = \text{T-Chol.} - (\text{HDL-c} + \text{VLDL-c}) \]

**Results and discussion**

**Determination of LD50 of fumonisin B1**

LD50 of FB1 was detected by determining the dose that caused 50% of death in laboratory animals. When oral gavaging of FB1 toxin to mice, death occurred at 200 Mg, and no death was observed in male mice in concentration 50 Mg and 100Mg as show in table (1), therefore, 100 Mg used for studying all biochemical and immunological parameters.

Table (1): percentage of died mice after orally gavaging with FB1

| Groups | FB1 concentration Mg | No. of mice | No. of death after 24 hr. | Percentage of death % |
|--------|----------------------|-------------|--------------------------|-----------------------|
| 1      | 300                  | 6           | 6                        | 100                   |
| 2      | 250                  | 6           | 5                        | 83.3                  |
| 3      | 200                  | 6           | 3                        | 50                    |
| 4      | 150                  | 6           | 1                        | 16.7                  |
| 5      | 100                  | 6           | 0                        | 0                     |
| 6      | 50                   | 6           | 0                        | 0                     |

Mycotoxins are classified into three classes: extremely toxic (with lethal dose below 1ppm), very toxic (lethal dose between 1-10 ppm) and toxic (lethal dose between 10-100 ppm) [19]. According to this classification, the LD50 of FB1 obtained in this study is located within the very toxic group to the mice used in this study.

**Effect of red cabbage and garlic extracts on liver enzymes activity**

The data in the Table (2) showing that the experimentally mycotoxicosis in the mice which have been induced through orally FB-1 daily intake had significant increase (p less than 0.05) in the AST serum levels, ALP as well as ALT in comparison to the normal mice. The oral administrations related to the red cabbage plus FB-1(G3), also alone (G4) or the garlic plus FB-1 (G5) and alone (G6) extracts resulted in significant decrease (p less than 0.05) in the AST’s serum levels, ALP and ALT in comparison to mice subjected to treatment with the FB-1 alone group (G2). Furthermore, the oral administration related to the red cabbage plus FB-1 or the garlic plus FB-1 resulted in significant decrease (p less than 0.05) in the serum ALP in comparison to the mice subjected to treatment with just FB-1 and significant increase (p less than 0.05) in comparison to control group. Furthermore, there have been significant reduction (p less than 0.05) in the ALP serum levels to the mice subjected to treatment with the red cabbage alone (G4) or the garlic alone (G6) in comparison to the control group. The oral administrations regarding FB-1 alone in the (G2) had significant increase (p less than 0.05) in
the serum levels related to LDH in comparison to control as well as the other groups. Also, the mice subjected to treatment with the red cabbage plus FB-1 (G3), red cabbage alone (G4) as well as the garlic plus FB-1 (G5) had significant decrease (p < 0.05) with mice treated FB1 alone and increased significant (p<0.05) with control group. Oral administration of mice treated with FB1 alone (G2) had increased significant in serum level of GGT compared to control and other groups.

Table 2: Impact of red cabbage as well as the garlic extracts on serum levels of liver enzymes in mice given orally FB1 (100µg/kg body weight) for 4 weeks (mean ± SD).

| parameters | G1 (n=10) | G2 (n=10) | G3 (n=10) | G4 (n=10) | G5 (n=10) | G6 (n=10) | P value |
|------------|-----------|-----------|-----------|-----------|-----------|-----------|---------|
| AST (U/L)  | 216.86 (47.48)a | 527.26 (110.20)b | 268.05 (83.97)a | 268.89 (9.54)a | 187.16 (19.42)a | 226.46 (37.63)a | 0.00 |
| ALT (U/L)  | 31.68 (1.78)a | 71.84 (23.84)b | 36.05 (1.79)a | 41.91 (2.95)a | 40.78 (3.22)a | 40.78 (3.22)a | 0.00 |
| ALP (U/L)  | 45.39 (3.54)ad | 81.19 (15.36)b | 38.41 (1.52)d | 52.84 (1.90)c | 64.30 (4.90)c | 64.30 (4.90)c | 0.00 |
| LDH(IU/L)  | 2583.39 (95.69)a | 3837.03 (91.45)b | 3012.02 (347.17)c | 3452.42 (330.94)bd | 3085.32 (125.74)cd | 2906.29 (265.88)ac | 0.00 |
| GGT(IU/L)  | 0.57 (0.18)a | 2.48 (0.88)b | 0.22 (0.06)a | 0.30 (0.03)a | 1.72 (0.51)b | 0.75 (0.17)a | 0.00 |

Different small letter(s) denote significant differences. $P<0.05 = $ Significant.

The impact related to single dose of FB1 on groups of mice that treated with doses 100 µg/Kg by gavage route, then animals were sacrificed after four weeks of the treatment. This study observed the effect of this toxin on tested liver enzymes. The results showed elevation of ALT, AST and ALP in comparison with control group, and this elevation was good indicator for occurring histopathological changes in liver such as a significant increase in degenerative changes and apoptotic cells. These findings are similar to results observed in other studies on mice. This indicates that FB1 is hepatotoxic in mice. Similarly, several studies reported that increase in liver enzymes indicated severe liver damage. This effect may be related to FB-1 biotransformation which provide rise to different metabolites, that might covalently bind to the protein as well as DNA, resulting in enzymatic process alterations, like the glyconeogenesis, kreb's cycles, or the fatty acid synthesis [26]. Other researches
indicated that the FB-1 induced the organs lesions in the rabbits, rats, as well as broiler chick that have been characterized through the cell loss (necrosis and apoptosis) as well as proliferation (mitosis), also because of imbalance between the cell loss as well as the replacement develop, which will make desirable conditions for the carcinogenesis [27]. A study conducted by Loiseau et al.,[25], increased AST as well as ALT activity values have been comparably indicated in the case when purified FB-1 has been administered i.p. to the piglets following nine days as well as 1.5mg/kg BW FB-1. Furthermore, the accumulating researches indicated that a lot of natural products, involving the garlic, had hepatoprotective impacts [28]. Furthermore, the combination regarding the garlic as well as the ascorbic acid protected against liver toxicity which has been induced through Cd in the albino mice [29]. Also, the single clove garlic has strong protective impact in comparison to the multi-clove garlic on the CCl4-induced acute liver injury in the male rabbits [30]. Also, the vegetable like cabbage belong to cruciferous family exerting protective impact against various chronic degenerative diseases[31]. The glucosinolates have been especially abundant in the cabbage, also bioactive compounds responsible for a lot of biological impacts which have been to them. Yet, the cabbage has been significant source regarding other major compounds like phytosterols, polyphenols, as well as carotenoids exerting anti-oxidant as well as anti-inflammatory impacts [32], also the flavonoids as well as the alkaloids which have been indicated for having antioxidant impacts. Liver has been specified as main organ related to metabolism. Also, liver enzymes (ALT), (AST) as well as the have been specified as biomarkers regarding the toxicity of liver and utilized in evaluating hepatic disorders. The results indicated that elevating the levels of ALT, AST, as well as ALP have been specified in group (G2) related to the mice induced through FB-1. The cabbage extracts which have been supplemented group indicated considerable change when compared to control rats [31]. The research specified that the red cabbage have protective impact against the against hepatocellular damages in the mycotoxicoses animals induced through FB-1 and such results are in accordance with results indicated via Menak et al.,[33]. A study by Wang et al.,[34] indicated oral administrations regarding allicin from the garlic considerably reduced damage indexes related to LDH, ALT, as well as AST.

**Effect of red and garlic extracts on lipid profile**

Table (3) showing comparisons related to serum concentrations that are related to the total serum cholesterol (TC), LDL, HDL, VLDL and TG in healthy and mycotoxicoses in mice, there has been significant increase (p less than 0.05) in the serum total cholesterol, TG, HDL and VLDL in mice treated with FB1 alone (G2) in comparison to control group as well as the other groups. Also there were decreased significant in TC (p<0.05) in mice treated red
cabbage alone (G4) and garlic alone (G6) with control group. In serum triglyceride (TG) there were decreased significant (p<0.05) in mice treated red cabbage plus FB1 (G3), red cabbage alone (G4), garlic plus FB1 (G5) and garlic alone (G6) compared with control group. Also, in this table, the data shows decreased significant (p<0.05) in serum VLDL in mice G3, G4, G5 and G6 compared with control group. There were decreased significant (p<0.05) in serum LDL in mice treated FB1 alone compared with control group and other groups.

Table 3: Effect of red cabbage and garlic extracts on lipid profile in mice given orally FB1 (100µg/kg body weight) for 4 weeks (mean ± SD).

| Parameters | G1 (n=10) | G2 (n=10) | G3 (n=10) | G4 (n=10) | G5 (n=10) | G6 (n=10) | P value |
|------------|-----------|-----------|-----------|-----------|-----------|-----------|---------|
| TC (mg/dl) | 140.86 (4.26) | 182.34 (6.73) | 154.39 (15.43) | 104.84 (14.54) | 125.93 (12.06) | 119.86 (4.13) | 0.00 |
| TG (mg/dl) | 289.85 (45.10) | 302.40 (9.90) | 161.90 (39.03) | 170.27 (3.53) | 220.39 (40.71) | 225.31 (98.04) | 0.00 |
| HDL-C (mg/dl) | 80.44 (10.78) | 96.95 (16.22) | 77.63 (16.55) | 54.69 (16.74) | 79.52 (12.58) | 73.85 (4.40) | 0.001 |
| VLDL-C (mg/dl) | 54.63 (1.43) | 60.45 (1.98) | 32.35 (7.82) | 31.56 (6.46) | 34.44 (11.62) | 34.56 (13.76) | 0.00 |
| LDL-C (mg/dl) | 24.55 (5.59) | 11.28 (1.92) | 38.23 (9.94) | 18.50 (3.84) | 16.15 (2.83) | 23.29 (1.84) | 0.00 |

Different small letter(s) denote significant differences. P<0.05 = Significant.

This work estimated the capability regarding red cabbage as well as the garlic extracts for protecting laboratory animals from toxic as well as the clastogenic impacts related to FB-1. The increase in the HDL, TG, as well as cholesterol along with decrease in the LDL levels in FB1-treated group specified necrosis or the hepatocellular injury. Also, treatment with the FB plus extracts caused in considerable enhancement in the lipid profile toward normal values regarding control. Aziza et al., [35] ingestion related to the FB-1 and/or the zearalenone (ZEN) induced considerable increase in the HDL, cholesterol, as well as triglycerides levels, also significant decrease in the LDL levels. Such change has been seen in the animals which ingested FB-1plus ZEN. Currently, implications regarding Fusarium mycotoxins in animal or human health disorders has been effectively established [36]. Even though that such mycotoxins have been typically exist in feed or food, the combined impacts remain not more researched [36]. With regard to this work, protective role related to GE and RCE has been estimated against toxicity induced through FB-1 in the mice. The elevated levels regarding
the lipid profile (HDL, triglycerides, cholesterol, as well as VLDL) specified necrosis or the hepatocellular injury [38]. Also, it has been indicated that FB-1 induced disturbance in lipid profile that has positive correlations with severity related to the liver damage as well as FB-1 has impact on disturbance related to the sphingolipid biosynthesis through inhibiting the rate-limiting enzyme, ceramide synthase[39]. Also, the impact regarding FB-1 on the clinical-biochemical parameters, indicating possible damage to the organs like, kidneys, liver, as well as the lipid profile, has been specified in this work. This work indicated that the statistical elevations related to the total blood cholesterol might be resulting from FB1-induced liver tissue damages, that has been specified in literature [40]. Also, the impact regarding fumonisins on the cholesterol was specified formerly: Dilkin et al., [39] indicated significant elevation in the cholesterol 96h following oral dosage of 5mg FB-1/kg BW. Other work, the Anthocyanin-rich red cabbage extract (ARCE) induced inhibition regarding the HMG CoA reductase activity [41]. Therefore, it might be indicated that hypocholesterolaemic property related to ARCE has been mediated through inhibition regarding the de novo cholesterol biosynthesis as well as subsequent catabolism in to the bile acids. Certain researches showing that the garlic might be lowering the blood lipids in people and animals. Also, a work indicated that the high temperatures as well as the high-pressure processing might be removing pungency regarding garlic, also such garlic efficiently decreased the levels related to total cholesterol, low-density lipoprotein cholesterol, and triglyceride in high-cholesterol diet-fed Sprague–Dawley rats [42].

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