Biological Studies On the Effects of Chia Seeds (Saliva hispanica L) On the Healthy Status of Rats with Liver Cirrhosis

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Abstract :

The present study investigated the effects of chia seeds on CCl_4 induced hepatotoxicity in rats . Thirty male albino rats were divided into (5) groups (6) rats in each group. Two groups were controls, one fed on basal diet only as a negative control and the other one fed on basal diet after injection with CCl_4 as a positive control. The other groups were injected by CCl_4 then received basal diet containing chia seeds at the levels of 2.5, 5 and 10 % . Liver damage was assessed by estimation of plasma concentration of enzymes activities of aspartate amino transferase (AST), alanine amino transferase (ALT), lipid fraction (total cholesterol and triglyceride), cholesterol fraction (HDL-c, LDL-c, VLDL-c), Uric acid, Urea nitrogen and glucose. Results showed an improvement in case of tested seeds at the level of 5% followed by the level of 10% for the above parameters. So, this study concluded that CCl_4 induced liver damage in rats can be ameliorated by administration of 5% chia seeds.

Key words: Liver damage – seeds- cholesterol fraction- glucose.

دراسات بيولوجية لبذور الشيا على الحالة الصحية للفئران المصابة بتليف الكبد

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الملخص العربي :

الهدف من البحث الحالي هو دراسة تأثير بذور شيا على رابع كلوريد الكربون (CCl4) والتي تتسبب فيها السموم الكبدية في الفئران. وتشتمل التجربة علي ٣٠ فأر وقسمت ذكور الفئران إلى (٥) مجموعات في كل مجموعة (٦) فئران. وكانت مجموعتين ضابطتين واحدة تتغذي علي النظام الغذائي فقط وهي المجموعة السالبة والاخري تتغذي علي النظام الغذائي بعد اضافة رابع كلوريد الكربون (CCl4) وهي المجموعة الموجبة . تم حقن المجاميع الاخري برابع كلوريد الكربون (CCl4) واضافة النظام الغذائي مضاف إلية بذور الشيا بتركيز ٢.٥% – ٥% – ١٠% .

تم تقييم تلف الكبد بتقدير تركيز البلازما لأنشطة الإنزيمات (AST)، (ALT)، الكوليسترول والدهون الثلاثية، (HDL-c، LDL-c، VLDL-c)، حمض اليوريك واليوريا النيتروجين والسكر. وأظهرت النتائج تحسنا في حالة استخدام بذور الشيا بتركيز ٥% تليها تركيز ١٠% للمجموعة المذكورة في التجربة .

بذلك، خلصت هذه الدراسة إلى أن رابع كلوريد الكربون CCl4 المتسبب في تلف خلايا الكبد بالفئران يمكن أن تحسن باستخدام بذور شيا ٥% .

الكلمات المفتاحية :

تلف الكبد – الكوليسترول – بذور الشيا – الجلوكوز.

Introduction

Liver diseases are among the most serious aliment. They may be classified as acute or chronic hepatitis (inflammatory liver diseases), hepatosis (non inflammatory diseases) and cirrhosis (degenerative disorder resulting in fibrosis of the liver) **(Kumar *et al.,* 2011)**.

Carbon tetrachloride (CCl_4) has been widely used in animal models to investigate chemical toxin-induced liver damage. The most remarkable pathological characteristics of CCl_4 induced hepatotoxicity are fatty liver, cirrhosis and necrosis **(Rencknagel *et al.,* 1989)**. CCl_4 is a well-known hepatotoxic agent **(Ilavarasan *et al.,* 2003)**. A single dose of CCl_4 (20 micro 1/kg) induced hepatotoxicity, manifested biochemically by significant elevation of serum enzymes activities, such as alanine trasaminase (ALT), aspartate aminotransferase (AST), and lactate dehydrogenase (LDH) **(Mansour, 2000)**.

Phytotherapy is the treatment and prevention of diseases using plants or plants part, such as leaves, flowers, roots, fruits, seeds, and rhizomes. Preparation made from them called medicinal plants, or herbs **(Weiss and Fintelmann, 2000)**. Today we are witnessing a great deal of interest in the use of herbal remedies. Some consumers have become dissatisfied with conventional medicine. They perceive it as impersonal and expensive, and conventional drug therapy often has undesirable side effects. For many Americans, the medicinal use of plant extracts seems to be a more natural, less expensive way, and involving therapies that are more gentle and largely without side effects. Plants have always played a significant role in maintaining the health and improving the quality of human life; many western drugs owe their origin to plant extracts. The American Indians also utilized a number of native herbs for medicinal purposes. Self-prescribed herbal preparations are commonly consumed today for a whole list of common ailments or conditions, while these herbs are generally consumed in small amounts, it is interesting to note that they contain similar health- promoting photochemical as do fruits and vegetables. There is clearly a botanical and chemical similarity between many of the herbal seasonings and conventional vegetables in human dietary. Chia (*Salvia hispanica* L.) is one of the oldest crops cultivated for centuries by the Aztec tribes in Mexico. Chia seeds are high in dietary fiber (34.6%), protein (24.6%), and oil contents (32.2%). The dietary fiber content of the seed is around 35%, which also has implications on its functional characteristics in food applications. Functional properties impacted by the dietary fiber include fat-binding and gel-forming. They found that the addition of dietary fiber into fish-based products improved their water binding, emulsion activity, and texture. It means that the addition of similar dietary fiber-based ingredients such as chia can improve the sensory perception of food products. At the same time, the major fatty acids of the chia oil are α-linolenic (ALA) (64% of total oil), linoleic (LA) (21% of total oil), oleic, stearic, and palmitic acids. Chia oil contains the highest α-linolenic acid content of any known vegetable source. The use of chia in food can help increase the availability of food products that contain omega-3 **(Ayerza, 2010 and Ixtaina, *etal.*, 2010)**.limiteapplications which are in drinks such as .

The effect of aqueous suspension of chia on carbon tetrachloride induced liver damage , CCl4 induced toxicity induced liver damage antagonize aqueous dose of 250-500 mg/kg suspension of chia seeds by raising the level of LDH (Lactate dehydrogenase) and lowering of chia seeds by raising the level of AST (aspartic transaminases) and ALT (L-alanine amino transfers) 5% seed given to albino mice to evaluate hepatro protective action against dimethyl lami-noaze-benzen induced liver carcinogenesis was studied and the results showed significant changes in the plasma level of alanine (AST) alkaline phosphate (ALP) , total protein and serum albumin which analyzed by malondialdehyde but there is no harmful effect of chia seeds on the liver moreover , it exerts hepatoprotective effect against hepatobiliary carcinogens because of their antioxidant property. So, the present study was carried out to investigate biological effects of different levels of chia seedss on serum parameters of liver intoxication in rats.

Material and Methods

Materials:

The tested seeds of chia were purchased from herbalist of Alexandria, Egypt.

Carbon tetra choloride (CCl_4) was used as an inducer for liver cirrhosis. It was purchased from El-Gomhorya Company, Cairo, Egypt as 10% liquid solution. Reagent kits were purchased from Diamond Diagnostics (Egypt).

Thirty white male albino rats weighing about 180 ± 5g were used as experimental animals in the present investigation. They were obtained from the animal house of Research Institute of Ophthalmology, El-Giza, Egypt. They were kept under observation for one week (as adapted period) before the onset of the experiment. The animals were housed in stainless steel cages at normal atmospheric temperature (25 ± 5°C) and had a 12 h light-dark cycle. Food and water were consumed *ad libitum*.

Methods:

Induction of liver intoxication in rats

Thirty rats were treated subcutaneous injection of carbon tetra chloride in paraffin oil 50% V/V (2ml/kg b.wt) twice a week for two weeks (**Jayashankar *et al.,* 1997**).

Preparation of seeds powder

These seeds were washed and dried in drying oven at ٥٠°C for 3 days, then crushed and milled as a dried powder.

Animals diet

The basal diet was prepared according to **AIN (1993)**. The vitamin mixture was prepared according to **Campbell (1963**), while salt mixture was prepared according to **Hegsted et al. (1941).**

Experimental design

Thirty male albino rats (180 ± 5g) were randomly divided into 5 equal groups (six rats each). All rats were fed on basal diet for one week before starting the experiment for acclimatization. After the adapted period, the initial weight was 205 ± 5g. Groups of rats were as the follows:

Group (1): Rats (n=6) were fed on basal diet only as control negative group.

Group (2) :Rats (n=6) were kept without any treatment as positive control group and fed on basal diet after injection with CCl٤.

Group (3): Rats (n=6) were injected by CCl٤ then fed on basal diet containing 2.5% chia seeds .

Group (4): Rats (n=6) were injected by CCl٤ then fed on basal diet containing 5% chia seeds.

Group (5): Rats (n=6) were injected by CCl٤ then fed on basal diet containing 10% chia seeds.

By the end of the experimental periods (28 days), rats were scarified using diethyl ether anesthesia at fasting state . Part of the blood was taken to determine the level of serum glucose and other portion of blood samples was collected and allowed to coagulate at room temperature; other portion of blood was added to it, EDTA (ethylene diamine tetracetic acid) and centrifuged at 3000 r.p.m for 15 minutes. Serum was carefully aspirated and transferred into clean covet tubes and stored frozen at -20°C until the time of analysis.

Biochemical analysis:

Serum Alkaline phosphatase (ALP) was determined according to the procedure of **(IFCC methods., 1983).** Aspartate aminotransferase (AST) or (GOT) glutamic -oxaloacetic transaminase and glutamic pyruvic transaminase (GPT) or Alanine aminotransferase (ALT) were carried out according to the method of **Henry (1974)** and **Yound (1975)**. Serum uric acid was determined according to the method described by **Fossati et al. (1980)**. Serum urea in plasma was determined according to the enzymatic method of **Patton and Crouch (1977).** Glucose was determined by enzymatic test according to **Tietz (1976) and Yound (1975).** Enzymatic colorimetric determination of triglycerides was carried out according to **Fassati and Prencipe (1982).** Total Cholesterol was determined by colorimetric method according to **Allain (1974)**.The determination of HDL was carried out according to the method **of Fnedewaid (1972)** and **Gordon and Amer (1977**). The determination of VLDL (very low density lipoproteins) and LDL (low density lipoproteins) was carried out according to the method of **Lee and Nieman (1996)** .

Statistical analysis:

Statistical analysis were done using the Statistical Package for the Social Sciences (SPSS for WINDOWS, version 11.0; SPSS Inc, Chicago). Comparative analyses were conducted using the general linear models procedure (SPSS Inc). Values of $P<0.05$ were considered statistically significant.

RESULTS

1-Effect of feeding different levels of chia seeds on ALP, AST and ALT levels of CCl٤-intoxicated rats.

The results in table (1) indicated that mean value of ALP enzyme, rats injected with CCl٤ (C +ve group) was 231.7±٣.٤٧U\L while in normal rats (C -ve) was 98.3±1.32U\L. These results denote that there was a significant increase in the mean value of ALP enzyme of rats poisoned by CCl٤ as compared to normal rats. The mean values of (ALP) of diets from groups 3, 4 and 5 were significantly higher than control negative group. Also, it could be noticed that there is no significant differences between the values of ALP enzyme of groups 2 and 3. Meanwhile, rats given CCl٤ then fed on diet of group 4 (rats fed on basal diet with 5% chia seeds) showed the lowest mean value in ALP enzyme level in the serum which was 198± 13.11U\L and recorded the best result of all treatment. It could be observed that due to

intoxicated rats the serum levels of AST in table (1) showed a significant increase in control positive group as compared to normal rats represents 98.25±5.82 and 32.06±1.07 U/L, respectively. There is no significant differences between groups 3 and 5. Meanwhile, group 4 (rats fed on basal diet with 5% mixture) showed the lowest level in serum AST and recorded the best results as compared to all treatments. For ALT ,in rats given CCl٤ then fed on all treatments groups 3, 4, and 5 were showing a significant differences when compared to control negative group .There is no significant difference between groups 2 and 3. The obtained results showed that serum levels of ALT in group 4 as compared to positive group and treatment groups recorded the highest effect.

Table (1): Effect of feeding different levels of chia seeds on ALP, AST and ALT levels of CCl٤-intoxicated rats.

Animal Groups	Liver function		
	ALP Mean SD	**AST Mean SD**	**ALT Mean SD**
Group (1) Control – ve	٩٨.٣ ±١.٣٣^{d}	3٢.٠ ±٦١.٠٧^{d}	3٩.٥ ±١٠.٩٥^{d}
Group (2) Control + ve	٢٣١.٧ ±٣.٤٧^{a}	9٥.٨٢±٨.٢٥^{a}	8 ١.١١±٧.١٠^{a}
Group (3)	٢٢٨.٣ ±٥.٠٦^{a}	90.٦. ±١.٧٦^{b}	8٣.٢٩ ±٠.٢٧^{a}
Group (4)	198.١. ±٣.١٥^{c}	70.١٢. ±٠.٥٢^{c}	6٥.٨٠ ±8٤٩.^{c}
Group (5)	٢٢٠.٧ ±٢.٠٨^{b}	8٦.١٠ ±٤.٩٣^{b}	78.٤٣. ١.٢٢^{b}

Non significant differences between the values had the same letter. Significant at $p \leq 0.05$.

2- Effect of feeding different levels of chia seeds on total cholesterol and triglyceride levels (mg/dl) of CCl٤ intoxicated rats.

Data in table (2)revealed that Injection of CCl٤ led to significantly ($P \leq 0.05$) increased serum total cholesterol level in hepatotoxic rats. The mean value ± SD of serum cholesterol in hepatotoxic group control (+ve) was 193.55±12.38 mg/dl compared to 89.78 ± 5.25 mg/dl in the negative control (- ve) group.

The mean values of total cholesterol in rats given CCl٤ then fed on all diets of groups 3 , 4 and 5 were significantly lower than positive control group .There is no significant differences in total cholesterol between groups 3 and 5. Concerning triglycerides, (Table 2) data revealed that rats injected with CCl٤ (control positive group) had higher value ($P \leq 0.05$) of serum levels triglycerides compared to normal rats control negative group. There were significant differences among groups 3,4 ,5 and both control groups. Meanwhile, group 4 (rats fed on diet contained 5% seeds) showed the lowest level in the mean value of serum triglycerides which showed 100.10 ± 0.92 mg/dl as compared to all treatment and recorded the best result.

Table (2): Effect of feeding different levels of chia seeds on total cholesterol and triglyceride levels (mg/dl) of CCl٤ intoxicated rats.

Animal Groups	Lipid Fraction	
	Total cholesterol Mean SD	Triglyceride Mean SD
Group (1) Control – ve	٨٩.٧٨ ±٥.٢٥^{d}	7٠.٤٠ ±6.٩٦.^{e}
Group (2) Control + ve	١9٣.٥٥ ±١٢.٣٨^{a}	١5١.٧٠ ±٣.١١^{a}
Group (3)	١7٢.٢٩ ±٦.٩٢^{b}	13٢.٣٠ ±١0.٤٤.^{b}
Group (4)	١٣٨.٠٨ ±١0.٠٤.^{c}	10٠.١٠ ±٠.٩٢^{d}
Group (5)	١6٥.٣١ ±٦.١٥^{b}	11٧.٠٠ ±٢.٨٥^{c}

Non significant differences between the values had the same letter. Significant at $p \leq 0.05$.

3- Effect of feeding different levels of chia seeds on HDL-c, LDL-c, VLDL-c and the ratio between LDL-c/ HDL-c levels (mg/dl) of CCl_4-intoxicated rats.

It is obvious that in rats injected with CCl٤ (control+ ve) the mean value of serum levels HDL-c was 29.38±٥.٣3 mg/dl. In normal rats (control-ve) the mean value of serum levels the HDL-c was 59.00±٣.٦٢ mg/dl in table (3). These finding denote that there was a significant decrease in HDL-c in the serum of rats poisoned by CCl٤ as compared to normal rats in table ٣. There were non significant differences between

rats given CCl٤ then fed on diet of groups 3, and 5 . Finally group ٤(rats fed on diet contained 5% seeds) showed the highest increase in serum level of HDL-c and recorded the best treatments. It could be noticed that the data in table 3 evidence that, LDL-c levels was significantly elevated in control positive group to 105.03±8.07 from 21.86±2.74 mg/dl in control negative group. All rats intoxicated with $CCl_٤$ then fed on all tested seed materials showed significant decrease in LDL-c as compared to control positive group. Group 4 showed the lowest value of serum LDL-c and recorded the best results as compared to all treatments. Data presented in table ٣ indicated the effect of feeding $CCl_٤$ intoxicated rats with different levels of seeds on the serum levels of VLDL-c. There were nonsignificant differences between group 3 and group 5. Group 4 showed the lowest decrease in serum level of VLDL-c and recorded the best results as compared to all groups in table 3. As regards to rats injected with $CCl_٤$ without treatment (control positive), the serum LDL-c/HDL-c increase dramatically from 0.37 ± 0.04 for control negative group to 3.57±1.03 for control positive group in table (3). Rats fed on based diet contained 5% seeds showed the lowest level in the serum LDL-c/HDL-c and recorded the best results as compared to all treatments.

Table (3): Effect of feeding different levels of chia seeds on HDL-c, LDL-c, VLDL-c and the ratio between LDL-c/ HDL-c levels (mg/dl) of CCl_4-intoxicated rats.

Animal Groups	Lipid fraction			
	HDL-C Mean± SD	LDL-C Mean± SD	VLDL-C Mean± SD	LDL-C/HDL-C Mean± SD
Group (1) Control – ve	٥٩.٠٠ ±٣.٦٢A	٢١.٨٦ ±٢.٧٤e	٨.٩٢ ±٠.١٩E	٠.٣7 ±٠.٠٤e
Group (2) Control + ve	٢٩.٣٨ ±٥.٣٣d	١٠٥.٠٣ ±٨.٠٧A	59.14 ±٠.٦٤A	٣.5٧ ±١.٠٣A
Group (3)	3١.٠٥ ±٤.٠٨c	٩٣.٩٧ ±٨.٤٨b	٤٦.٤٢ ±٠.٩٤b	3.0٢٦. ±٠.٢٢b
Group (4)	٣9.٤٦. ±١.٠٤b	٥٩.54 ±٠.٦١d	٣٩.٠٨ ±٠.٣٨d	1.51± ٠.١٢d
Group (5)	3٣.٠٣ ±٤.١٦c	8٨.٨٨ ±٨.٥٨c	43.4 ±٠.٢٨b	2.69± ٠.٢٦b

Non significant differences between the values had the same letter.
Significant at $p \leq 0.05$.

4- Effect of feeding different levels of chia seeds on glucose levels (mg/dl) of CCl-$_{٤}$intoxicated rats.

It could be observed that, the mean value ±SD of glucose in table (4) of control positive group significantly increase, as compared to normal rats, it was being 141.14±0.02 and 81.05±2.11 mg/dl, respectively. In rats given $CCl_{٤}$ then fed on all treatments, there were significant increases in the glucose levels as compared to normal group which were 126.79±0.72, 118.14±0.59, and 131.12±0.85 mg/ dl for groups 3, 4, and 5 respectively. There is no significant difference between groups 3and 5. Finally, group 4 showed the lowest increase in glucose level which were 118.14±0.59 and recorded the best treatment.

Table (4): Effect of feeding different levels of chia seeds on glucose levels (mg/dl) of CCl-$_{٤}$intoxicated rats.

Animal Groups	Glucose Mean ±SD
Group (1) Control – ve	٨1. ٢١±٥^{D}
Group (2) Control + ve	١٤١.١٤ ±3.٠٢.^{A}
Group (3)	١٢٦.٧2 ±٩.٧٢^{B}
Group (4)	١١٨.١7± ٤.٥٩^{C}
Group (5)	١٣١.١5 ±١٠.٢٠^{B}

**Non significant differences between the values had the same letter. Significant at p≤0.05

5- Effect of feeding different levels of chia seeds on Uric acid and Urea nitrogen levels (mg/dl) of $CCl_{٤}$ intoxicated rats.

Results revealed that, treated rats with $CCl_{٤}$ -intoxicated diet control positive group led to a significant increase (P≤0.05) in serum uric acid when compared with control negative group. The mean values of uric acid of groups 4, and 5 were significantly lower than positive control group (Table 5). Nonsignificant differences were observed between groups 3 and control positive group. Meanwhile, group 4 showed the lowest level in serum uric acid among all treatment and recorded the best results compared to normal group .

For urea nitrogen, there is no significant difference between group 3 and control positive group. Group 4 showed lower (P≤0.05) in urea nitrogen than both control groups. Finally, group 4 showed the lowest level of urea nitrogen among all treatment groups.

Table (5): Effect of feeding different levels chia seeds on Uric acid and Urea nitrogen levels (mg/dl) of $CCl_{٤}$ intoxicated rats.

Animal Groups	Kidney functions	
	Uric acid Mean ± SD	Urea Nitrogen Mean± SD
Group (1) Control – ve	١.٠٥ ±٠.١١[b]	١٤.٧ ±٠.٩[B]
Group (2) Control + ve	١.١٤ ±٠.١٢[a]	١٥.٦ ± ٢.٢[A]
Group (3)	١.١٣ ±٠.١١[a]	١٥.٦ ±١.٤[A]
Group (4)	٠.٧٩ ±٠.٧٢[c]	١٠.١ ±١.٢[E]
Group (5)	١.١١ ±٠.١٠[a]	١٣.٨ ±٠.٩[b]

Non significant differences between the values had the same letter.Significant at $p \leq 0.05$

Discussion:

The reactive electrons species from CCl_4 induces rat liver cirrhosis that resembles the human disease, and it can serve as a suitable animal model for studying human liver cirrhosis **(An *et al.*, 2006)**.

Toxicity experienced by the liver during CCl_4 poisoning results from the production of a metabolite, CCl_4 which is a direct hepatotoxin responsible for change in cell permeability and it inhibits mitochondrial activity followed by cell death **(Ambrose *et al.*, 2009)**. It has also been reported that chronic CCl_4 exposure produced cirrhosis in rats **(Chieli and Malvadi, 2008)**.

An obvious sign of hepatic injury is the leakage of cellular enzyme into plasma **(Schmidt *et al.*, 1975)**. When the liver cell plasma membrane is damaged, a variety of enzymes normally located in the cytosol are released into blood stream. Their estimation in the serum is a useful quantitative marker for the extent and type of hepatocellular damage **(Ansari *et al.*, 1991)**. ALT and AST are the most often used and most specific indicators of hepatic injury and represent markers of hepatocellular necrosis. These liver enzymes catalyze transfer of alpha-amino group aspartate and alanine to the alpha-ketoglutaric acid. Whereas ALT is primarily localized to the liver, AST is present in a wide variety of tissue, including heart, skeletal, kidney, brain, and liver. AST is present in both the mitochondria and cytosol of hepatocytes, but ALT is found only in the cytosol. In an asymptomatic person with isolated elevation of AST or ALT level, diagnostic clues can be garnered from the degree of elevation **(Rosen and Keeffe, 1998)**.

Results of the current study revealed that administration of CCl٤ caused significant increases in the levels of aspartate aminotransferase, alanine aminotransferase, glucose levels, lipid profile and kidney enzymes and these are in agreement with **Túnez *et al.* (2005)**. On the other hand, the current study demonstrated that the treatment with chia seeds caused marked ameliorations of transaminase enzymes activity (ALT and AST). The results are in accordance with **Tapiero *et al.* (٢٠٠٢)**who showed the effect of chia extracts on carbon tetrachloride–induced hepatotoxicity in rats.

The mechanism by which the chia seeds induces its hepatoprotective activity is not certain. However, it is possible that β-sitosterol, a constituent of chia, which is at least partly responsible for the protective activity against CCl٤ hepatotoxicity **(Tesoriere *et al.*, 2004)**. An additional and important factor in the hepatoprotective activity of any drug is the ability of its constituents to inhibit the aromatase activity of cytochrome P-450, thereby favoring liver regeneration. On that basis, it is suggested that flavonoids in cactus pear could be a factor contributing to its hepatoprotective ability through inhibition of cytochrome P-450 aromatase (**Kowalska *et al.,* 1990)**. In addition, the recorded content of vitamin C in the chia (35 -38 mg per 100 g) may also play a role in hepatoprotection. Previous in vivo studies indicate that hepatic microsomal drug metabolism decreases in ascorbic acid deficiency and is augmented when high supplements of the vitamin are given to guinea pigs **(Burtis and Ashwood, 2001)**.

Blood glucose concentration is known to depend on the ability of the liver to absorb or produce glucose. The liver performs its glucostatic function owing to its ability to synthesize or degrade glycogen according to the needs of the organism, as well as via gluconeogenesis **(Ahmed *et al.*, 2006)**. The blood sugar level after overnight fasting in cirrhotic patients is believed to decrease only in severe hepatic failure **(Kruszynska and McIntyre, 1991)**. This is confirmed by our data that indicate that glucose levels in cirrhosis decreased.

Conclusions :

The study clearly demonstrates that 5% of tested seeds have potential for treatment and prevention of CCl4٤ -induced hepatic cytotoxicity. This study, along with other research, targets seeds as a potentially safe and effective plant seeds that has important medicinal values and benefits.

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