
***BIOLOGICAL STUDIES ON ANNONA FRUIT'S PULP (ANNONA CRASSIFLORA) AND ITS
PROTECTIVE EFFECT ON RATS WITH LIVER CANCER***

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Abstract:

The current investigation was carried out to examine the possible potential protective effects of ethanolic extract of the pulp of annona fruit against trichloroacetic acid (TCA) induced liver cancer. The biological experiment used twenty- four albino rats. After the adaptation period, the rats were divided into four groups (6 rats each). One of them was considered as a negative control and another positive control (Trichloroacetic acid group). The remaining groups were divided into two groups consisting of extracts from pulp at levels 100 and 150 mg / kg. Feed consumption was recorded daily, and the rats' body weights were assessed once a week. After the experiment period (47 days) had passed blood samples were collected to assays the levels of (WBC, RBC, HGB, PLT, HCT, MCV and MCHC) liver functions (ALT, AST, ALP, BIL, TP, ALB and GLB), some kidney functions (creatinine and urea), and oxidation stress (CAT, GPX and MDA). Liver tissues were collected for inflammation markers analyses (IL6, AFP, COX2 and PGE2).The study results were as the fallowing: all liver cancer protected groups by extracts of annona pulp at doses of 100 and 150 mg/kg of rat weight showed a significant improvement in rats weights, complete blood count, liver functions, some kidney functions, oxidation stress and inflammation markers, when compared them with the unprotected liver cancer group (+ve). Therefore, this study recommends that the insertion pulp of annona fruit in diets (Jelly - marmalade - jam - juices - pastries of all kinds) because its hepatoprotective, anti-cancer and antioxidants effects.

Keywords: Annona fruits- Pulp- Antioxidants- Cancer- Liver functions- Kidney- Trichloroacetic acid.

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Introduction

Annona pulp has widely potent antioxidants such as ascorbic, quinic, caffeic, and ferulic acids, xanthoxylin, rutin, caffeoyltartaric acid, caffeoyl glucose and [quercetin+hexose+pentose H] (Silva et al., 2013). There are many phenolic compounds in annona pulp including (derivatives of 4-hydroxybenzoic acid, p-coumaric acid, ferulic acid, gallic acid, sinapic acid, caffeic acid, (epi) catechin, quercetin, kaempferol, rutin, tangeretin, syringic acid, apigenin, and naringenin (Arruda et al., 2023). Cancer is a major reason of death both in developed and developing countries. Among the various types of cancers, liver cancer represents about 4% of all cancers around world. Liver cancer is a major health problem worldwide which described as a complex and heterogeneous malignancy from liver tissues (Severi et al., 2010; Abdelaal, 2019 and Sivakumari et al., 2022). The global burden of cancer is projected to raise from 13.3 to 21.4 million incident cases from 2010 to 2030 due to demographic changes alone, which dominated by a growing burden in middle- and low-income countries (Subha, 2019). Liver cancer is the fourth in Egypt and the sixth common cancer in worldwide (Rashed et al., 2020). Trichloroacetic acid (TCA) is a chemical carcinogen with the potential to cause experimental multistage hepatocarcinogenesis; it produces pre-neoplastic lesions after a short period in the form of dysplastic tissue changes, vascular congestion, hepatocyte ballooning, and liver cell foci with extensive vacuolation. (Abdel-Hamid and Morsy, 2010 and Alzergy et al., 2018).

Material and Methods

1) Material

Plant, chemicals, diet and microbiological environments:

- a) **Plant:** Annona fruit (*Annona crassiflora* Mart) was obtained from Local market, Mansoura, Egypt.
- b) **Chemicals:** Ethanol alcohol and trichloroacetic acid (TCA) were brought from El-Gomhouria for trading chemicals and medical appliance, Mansoura, Egypt.

- c) **Experimental rats:** Twenty- four healthy adult albino male rats (Sprague- Dawley strain.) were at the age of 2- 4 months. The weight of male rats was about 130 ± 10 g and were purchased from the Agricultural Research Center, Giza, Egypt.

2) Methods:

a- Preparation of annona fruits:

Ripe fruits were selected free from scratches and microbial infections or any color changes in preparation for making the ethanolic extract. Annona fruit was washed with tap water to remove surface dirt. The pulp was cut into thin slices (Arruda *et al.*, 2016).

c- Extraction method:

Annona pulp was oven-dried at 45 °C. The dried pulp was ground into powder by domestic electrical mill and stored at 4 °C until further use (Shehata *et al.*, 2021). The powder of pulp was weighed and soaked them in a containers with 95% ethanol was added at ratio (1:2 v/v) (Abd-Elrazek *et al.*, 2021). The soaking was done for three days with 95% ethanol (4 L) at room temperature (25 °C). This process was repeated 3 times. After filtration, ethanol was removed by using a rotary evaporator in a water bath at 40 °C (Justino *et al.*, 2019).

Induction of liver cancer:

TCA was neutralized with NaOH to a final pH of 6.5 (Herren-Freund *et al.*, 1987). TCA had been given as a carcinogen after 28 day from experimental period at dose 500mg/kg orally once a day for 5 days consecutive according to Tao L. *et al.*, (2000).

Experimental rats design:

The animals were housed in polypropylene cages under the standard laboratory condition (25 ± 2 °C, humidity 60–70%, 12-h light/dark cycles). They were fed with standard commercial rat pellet diet and water was provided ad libitum. The rats were acclimatized to laboratory conditions for 7 days prior to the commencement of the experiment. After acclimatization period, the animals were divided into four groups (6 rats/ group). One of

them healthy control group and three liver cancer groups (including one without protected and two groups protected with annona pulp extracts). The experiment continued for 47 days. The protected liver cancer groups received annona extracts for 28 days. Then, TCA was given for 5 consecutive days at dose 500mg/kg orally (**Tao L. et al., 2000**). After that, the extracts were given for 14 day. It was arranged as follows:

- **Group 1:** The animals fed on based diet as normal control group during the experiment period.
- **Group 2:** liver cancer group which the animals were subjected to chemo-induction of liver cancer through administration of TCA.
- **Group 3:** liver cancer group protected by annona pulp extract (APE) at level 100mg/kg B.W. by oral stomach tube once daily.
- **Group 4:** liver cancer group protected by annona pulp extract (APEX) at level 150mg/kg by oral stomach tube once daily.

Determination of food efficiency ratio (FER):

Feed consumption was recorded daily, and the rats' body weights were assessed once a week. At the end of the experimental, feed intake and total body weight gain were calculated, and the feed efficiency ratio was calculated according to **Chapman et al., (1959)**.

Biochemical analysis:

At the end of the experiment period, rats were anesthetized di-by using ethyl ether. Blood samples were collected from the inner canthus of the rats eye using heparinized capillary tubes for CBC analysis including RBC, WBC, HGB, HCT, PLT, MCV and MCHC according to the method published by **Schalm et al., (1975)**; **Brown, (1976)**; **Schallenberg et al., (1987)** and **Feldman and Zink, (2002)**, respectively. Then the serum were obtained after centrifugation at 3000 rpm for 10 minutes **Bull et al., (1993)** and **Vidya et al., (2021)**. The serum samples were preserved in a deep freezer at -20 °C until be used for liver functions (ALT, AST, ALP, BIL, TP, ALB and GLU) were determined accordance to the method of **Hafkenschied and Dijt, (1979)**; **Tietz et al., (1983)**; **Doumas et al., (1985)**; **Schneditz et al., (1989)**; **Doumas et al., (1972)** and **Fernandez et**

al., (1966), respectively. Kidney functions (creatinine and urea) according to **Houot (1985) and (Patton and Crouch, 1977)**, respectively. Oxidation stress analyzes (MDA, CAT, and GPX) according to **Stocks and Donnandy, (1971); Aebi, (1984) and Tappel, (1978)**, respectively. On the other hand, liver tissues were collected for inflammation markers analyses (AFP, COX2, IL6 and PGE2) according to **(Abelev, 1974; Uotila et al., (1981); Chan and Miao, (1986); Mohamed et al., (2016); Kulmacz and Lands, (1983); Lemay et al., (1990) and Kelly et al., (1986)**, respectively. All experimental animals in this study were managed according to the guidelines for the Care and Use of Laboratory Animals in Neuroscience and Behavioral Research and were approved by the Research Ethics Committee, Home Economics Department, nutrition and food science, Mansoura University, Egypt, under animal protocol code No (R/35).

Statistical analysis:

The gained data were statistically analyzed by SPSS computer software according to **Artimage and Berry, (1987)**. The calculation accrued by analysis of variance ANOVA & follow up LSD (SPSS) Computer program variation.

Results and Discussion

Data presented in **Table (1)** showed the mean values of initial weight, final weight, weight gain (g), food intake, and Food efficiency ratio (FER) of normal control and liver cancer groups. The initial weight of all groups had similar values to that of the control group. The non-protected group of rats with liver cancer showed a significant lower in final weight, weight gain, food intake, and food efficiency ratio, compared with the normal control (-ve). Liver cancer group protected by APEX showed a significant higher in final weight, weight gain (g), food intake, and Food efficiency ratio, compared to the positive group followed by APE. Our results agreed with the results of **Kumar et al. (2017)** who noted that rat body weight is an important predictor for estimating the pathological status of liver tissue. Accordingly, lower body weight is associated with liver cancer as a result of decreasing food intake and increasing water intake

(**Esparza-Baquer et al., 2021**). On the other hand, our results agree with **Elumalai et al., (2017)** who reported that groups treated with extract of annona fruit at doses of 200, 250, and 300 mg/kg b.w. / day had increased in body weight compared to the group with cancer.

Data presented in **Table (2)** showed the mean values of white blood cells (WBC), red blood cells (RBC), hemoglobin (HGB), hematocrit (HCT), platelet (PLT), mean corpuscular volume (MCV) and mean corpuscular hemoglobin concentration (MCHC) of normal control and liver cancer groups. The obtained results showed that, non-protected group of rats with liver cancer showed a significant higher in WBC, but correspondingly a significant fall in RBC, HGB, HCT, PLT, MCV and MCHC, compared with the normal control (-ve). Liver cancer group protected by APEX showed a significant lower in WBC, but on the other hand showed a significant higher in RBC, HGB, HCT, PLT, MCV and MCHC levels, compared to the positive group Followed by APE. Our results agreed with the results of **Christy et al., (2022)** who indicated that red blood cells and hemoglobin decreased in rats with cancer as a result of receiving TCA dissolved in distilled water for a period of 28 days. **While, Price, (1958) and Marklund et al., (1982)** who noticed that anemia is one of the common problems in cancer. Using annona extracts contributed to improving the level of hemoglobin, and therefore it could have a protective effect against anemia. As well as the annona fruit is used in anemia treated and enriches blood (**Vyas et al., 2012**). Add to that, **Morimoto et al., (2014)** who showed that platelet counts were higher in liver cancer patients with extrahepatic metastases compared to those without metastases, indicating a possible role for platelets in liver cancer metastasis

Data presented in **Table (3)** showed the mean values of alanine transaminase (ALT), aspartate transaminase (AST), alkaline phosphatase (ALP), bilirubin (BiL), globulin (GLU), total protein (TP), and albumin (AIB) of normal control and liver cancer groups. The obtained results showed that, non-protected group of rats with liver cancer showed a significant raise in ALT, AST, ALP and BiL, but correspondingly a significant fall in TP, AIB and GLU compared with the normal control (-

ve). Liver cancer group protected by APEX showed a significant lower in ALT, AST, ALP and BiL, but on the other hand showed a significant higher in TP, GLU and Alb levels, compared to the positive group followed by APE. Our results agreed with the results of **Abdel-Hamid et al., (2011)** who indicated that taking TCA at level 500 mg/kg of body weight for 5 consecutive days due to rise in ALT, AST, ALP, and BiL levels. While, consuming the pulp extract helped improve liver function, which achieves hepatoprotective effect.

Data presented in **Table (4)** showed the mean values of in creatinine and urea of normal control and liver cancer groups. The non-protected group of rats with liver cancer (+ve) showed a significant higher of creatinine and urea, compared to the normal control (-ve). Liver cancer groups protected by APEX showed a significant lower in creatinine and urea levels, compared to the positive control followed by APE. Our results are consistent with **El Arem et al., (2014)** who confirmed that creatinine in the serum increased significantly when mice were given TCA at a dose of 500 g/L in drinking water, compared to normal rats. While, **Saha, (2011)** stated that resulted of oral administration of annona aqueous extract to diabetic rats for 30 days a major reduced urea and creatinine that near to control levels.

Data presented in **Table (5)** showed the mean values of malondialdehyde (MDA) free radical, glutathione peroxidase (GPX) and catalase (CAT) antioxidant enzymes of normal control and liver cancer groups. The obtained results showed that, non-protected group of rats with liver cancer showed a significant raise in MDA, but correspondingly a significant fall in GPX and CAT compared with the normal control (-ve). Liver cancer group protected by APEX showed a significant lower in MDA but on the other hand showed a significant higher in GPX and CAT levels, compared to the positive group followed by APE. Our results agreed with **Fouad et al., (2013)** who indicated that oral administration of TCA led to hepatocellular tumors in rats due to the carcinogenic effect of this chemical as a result of increased oxidative stress, lipid peroxidation and cellular proliferation. While, **Dragano et al., (2010)** who observed that MDA level decreased when annona pulp was administered 1%, 10%, and 20% of the

meal for 15 days in cyclophosphamide use-induced oxidative stress rats. While, **Roesler, (2011)** reported that annona fruit extracts contains many compounds such as ascorbic acid, caffeic acid, quinic acid, xanthoxylin, caffeoyltartaric acid, and caffeoyl glucose, [hexose + pentose-H], which widely reported as potent antioxidants.

Data presented in **Table (6)** showed the mean values of alfa fetoprotein (AFP), cyclooxygenase-2 (COX2), interleukin 6, and prostaglandin (PGE2) of normal control and liver cancer groups. The non-protected liver cancer group showed significant higher in AFP, COX2, IL6 and PGE2, compared with normal control. Liver cancer group protected by APEX showed a significant lower in AFP, COX2, IL6 and PGE2 levels, compared to the positive group followed by APE. Our results agreed with **Fouad et al., (2013)** who indicated that giving TCA for 5 days orally at a dose of 500 mg / kg led to an increase in the level of alpha-fetoprotein as a result of liver cancer. While, **Jagan et al., (2008)** who stated that high levels AFP are believed to be strongly suggestive of liver cancer because greater than 70% of liver cancer patients have high serum concentration of AFP because of the tumor secretion. However, Gallic acid from annona fruit treatment significantly reduced the levels of AFP which revealed the anti-tumor effect of the compound against liver cancer. Add to that, micronutrients including vitamins C, and B9 from annona extracts are necessary dietary constituents for cancer prevention. This micronutrient contain a public functions like anti-oxidant and anti-inflammatory agents; however, they also contain specific functions such as regulating genes associated with carcinogen metabolism and carcinogenesis (**Fagbohun et al., 2023**).

Table (1): Effect of ethanolic extracts (at levels 100 & 150 mg/ kg) of annona pulp on body weight gain, feed intake and feed efficiency ratio (FER) in experimental rats:

Variable / Groups		Initial weight (g)	Final weight (g)	Weight gain (g)	Weight gain (%)	Feed intake (g)	FER%
Non-protected Groups	Normal control	a 130.50 ±4.65	a 187.75 ±5.56	a 57.25 ±6.65	a 43.99 ±6.17	a 17.07 ±0.51	a 0.071 ±0.007
	Positive (+ve)	a 131.75 ±2.99	d 170.25 ±2.08	d 38.75 ±3.77	d 29.46 ±3.45	d 15.50 ±0.19	c 0.053 ±0.005
Liver cancer groups protected with	APE	a 129.75 ±5.12	c 171.75 ±2.99	b 42.00 ±4.55	b 32.49 ±4.48	b 15.61 ±0.27	b 0.057 ±0.006
	APEX	a 128.75 ±5.25	b 173.50 ±1.73	b 44.75 ±6.18	b 34.94 ±6.11	b 15.77 ±0.16	b 0.060 ±0.008

Values (mean± SD, n= 4). Means in within the same column sharing the different superscript are significantly different (P> 0.05).

FER: feed efficiency ratio, APE: Pulp extract at level 100 mg/ kg and APEX: Pulp extract at level 150 mg/ kg.

Table (2): Effect of ethanolic extracts (at levels 100 &150 mg/ kg) of annona pulp on complete blood count in experimental rats:

Variable Groups		WBC	RBC	HGB	HCT	PLT	MC V	MCH C
		(UL)	(UL)	(g/dl)	(%)	(UL)	(FL)	(g/dL)
Non-protected Groups	Normal control	e 10.75 ±0.90	a 8.43 ±0.93	a 14.55 ±0.85	a 43.28 ±0.88	a 622.50 ±20.27	a 61.30 ±0.82	a 34.00 ±0.37
	Positive (+ve)	a 17.63 ±0.99	c 5.33 ±0.32	d 10.58 ±0.82	d 31.35 ±0.19	d 515.50 ±8.50	c 51.80 ±2.74	d 28.65 ±0.31
Liver cancer groups protected with	APE	b 15.90 ±0.91	b 6.45 ±0.29	C 11.38 ±0.34	c 35.03 ±0.33	c 520.00 ±15.90	b 55.40 ±1.82	c 31.18 ±0.26
	APEX	c 14.50 ±0.91	b 6.46 ±0.12	b 12.15 ±0.21	b 39.20 ±0.22	b 547.00 ±6.68	a 61.20 ±0.96	b 32.38 ±0.63

Values (mean± SD, n= 4). Means in within the same column sharing the different superscript are significantly different (P> 0.05). WBC: white blood cells, RBC: Red blood cells, HGB: Hemoglobin, HCT: hematocrit, PLT: Platelet, MCV: Mean Corpuscular Volume, MCHC: Mean corpuscular hemoglobin concentration, APE: Pulp extract at level 100 mg/ kg and APEX: Pulp extract at level 150 mg/ kg.

Table (3): Effect of ethanolic extracts (at levels 100 &150 mg/ kg) of annona pulp on liver function in experimental rats:

Variable Groups		ALT	AST	ALP	BiL	TP	ALB	GLU
		(U/L)	(U/L)	(U/L)	(mg/dl)	(g/dl)	(g/dl)	(g/dl)
Non-protected Groups	Normal control	d 24.75 ±2.50	d 68.25 ±3.40	d 192.75 ±4.50	d 0.21 ±0.02	a 7.53 ±0.06	a 4.49 ±0.02	a 2.37 ±0.04
	Positive (+ve)	a 55.00 ±2.94	a 244.75 ±10.21	a 367.75 ±10.21	a 0.66 ±0.06	d 5.83 ±0.09	d 2.94 ±0.08	d 0.84 ±0.09
Liver cancer groups protected with	APE	b 46.75 ±1.26	b 196.25 ±10.28	b 321.25 ±4.50	b 0.46 ±0.05	c 6.17 ±0.11	c 3.23 ±0.10	c 1.14 ±0.09
	APEX	c 41.25 ±1.26	c 144.75 ±8.96	c 263.25 ±9.39	c 0.31 ±0.02	b 6.58 ±0.09	b 3.76 ±0.08	b 1.54 ±0.09

Values (mean± SD, n= 4). Means in within the same column sharing the different superscript are significantly different (P> 0.05). ALT: Alanine transaminase, AST: Aspartate transaminase, ALP: Alkaline phosphatase, BiL: Bilirubin, GLU: Globulin, TP: Total protein, Alb: Albumin, APE: Pulp extract at level 100 mg/ kg and APEX: Pulp extract at level 150 mg/ kg.

Table (4): Effect of ethanolic extracts (at levels 100 & 150 mg/ kg) of annona pulp on kidney function in experimental rats:

Variable		Creatinine (mg/dl)	Urea (mg/dl)
Groups			
Non-protected Groups	Normal control	d 0.42±0.03	d 20.63±0.79
	Positive (+ve)	a 1.19±0.02	a 49.23±3.04
Liver cancer groups protected with	APE	b 0.92±0.02	b 43.18±4.45
	APEX	c 0.75±0.03	c 29.53±2.17

Values (mean± SD, n= 4). Means in within the same column sharing the different superscript are significantly different (P> 0.05). APE: Pulp extract at level 100 mg/ kg and APEX: Pulp extract at level 150 mg/ kg.

Table (5): Effect of ethanolic extracts (at levels 100 & 150 mg/ kg) of annona pulp on oxidation in experimental rats:

Variable		MDA (nmol/ml)	GPX (mU/ml)	CAT (U/L)
Groups				
Non-protected Groups	Normal control	d 7.73±0.49	a 127.23±2.82	a 2.83±0.05
	Positive (+ve)	a 34.10±1.31	d 52.20±4.53	d 0.91±0.07
Liver cancer groups protected with	APE	b 26.88±1.27	c 67.70±2.79	c 1.24±0.05
	APEX	c 16.38±1.27	b 87.18±3.89	b 1.73±0.14

Values (mean± SD, n= 4). Means in within the same column sharing the different superscript are significantly different (P> 0.05). MDA: malondialdehyde, GPX: glutathione peroxidase, CAT: catalase, APE: Pulp extract at level 100 mg/ kg and APEX: Pulp extract at level 150 mg/ kg.

Table (6): Effect of ethanolic extracts (at levels 100 & 150 mg/ kg) of annona pulp on inflammation markers in experimental rats:

Groups		Variable	AFP (ng/mg Protein)	COX2 (ng/mg protein)	IL-6 (Pg/mg protein)	PGE2 (Pg/ml)
Non-protected Groups	Normal control	d	1.93±0.09	1.27±0.03	26.27±0.74	44.35±1.59
	Positive (+ve)	a	4.42±0.120	3.61±0.03	49.97±1.07	91.50±3.60
Liver cancer groups protected with	APE	b	3.07±0.10	2.39±0.06	43.87±1.14	83.08±1.96
	APEX	c	2.71±0.04	1.87±0.07	36.00±1.02	71.25±3.34

Values (mean± SD, n= 4). Means in within the same column sharing the different superscript are significantly different (P> 0.05).

AFP: Alphafeto protein, COX2: Cyclooxygenase, IL6: Interlochen-6, PEG2: Prostaglandin, APE: Pulp extract at level 100 mg/ kg and APEX: Pulp extract at level 150 mg/ kg.

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دراسات بيولوجية على لب فاكهة القشطة وتأثيرها الوقائي على الفئران المصابة بسرطان الكبد

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الملخص العربي:

تم إجراء البحث الحالي لفحص التأثيرات الوقائية المحتملة للمستخلص الإيثانولي لب فاكهة القشطة ضد سرطان الكبد الناجم عن حمض ثلاثي كلورو أسيتيك. استخدمت التجربة البيولوجية أربعة وعشرين فأراً ألبينو. بعد فترة التكيف، تم تقسيم الفئران إلى أربعة مجموعات (٦ فئران لكل مجموعة). تم اعتبار إحداهما سيطرة سلبية وأخرى إيجابية (مجموعة حمض ثلاثي كلورو أسيتيك). تم تقسيم المجموعات المتبقية إلى مجموعتين مكونة تلقت مستخلصات اللب بمستويات ١٠٠ و ١٥٠ ملغم/كغم من وزن الفأر. تم تسجيل استهلاك العلف يومياً، وتم تقييم أوزان الفئران مرة واحدة في الأسبوع. بعد مرور مدة التجربة (٤٧ يوم)، تم جمع عينات الدم لفحص مستويات كرات الدم البيضاء و كرات الدم الحمراء و الهيموجلوبين و الصفائح الدموية و الهيماتوكريت و متوسط حجم كريات الدم الحمراء و كمية الهيموجلوبين الموجودة في خلايا الدم الحمراء وظائف الكبد بما في ذلك انزيم ناقل أمين الألانين ناقل أمين الأسبارتات و إنزيم الفوسفاتيز القلوي و البيليروبين و البروتين الكلي و بروتين الألبومين و بروتين الجلوبيولين ، وبعض وظائف الكلى مثل الكرياتينين واليوريا. وإجهاد الأكسدة بما في ذلك الكتاليز و المانولدهيد و الجلوتاثيون بيروكسيديز. كما تم جمع أنسجة الكبد لتحليل علامات الالتهاب مثل البروستاجلاندين و الكوكس ٢ و الألفا٢توبروتين و الأنتروكين ٦ . وكانت نتائج الدراسة على النحو التالي: سجلت جميع المجموعات المحمية من سرطان الكبد باستخدام المستخلص الكحولي لب فاكهة القشطة بجرعات ١٠٠ و ١٥٠ ملجم / كجم من وزن الفئران تحسناً ملحوظاً في أوزان الفئران و صورة الدم الكاملة و وظائف الكبد، وبعض وظائف الكلى، وإجهاد الأكسدة، علامات الالتهابات، عند مقارنتها. مع مجموعة سرطان الكبد غير المحمية. لذلك توصي هذه الدراسة بإدخال لب فاكهة القشطة في الوجبات الغذائية (الجيلي - المرملاذ - المربي - العصائر - المعجنات بكافة أنواعها) لما له من تأثيرات وقائية للكبد ومضادة لسرطان ومضادة للأكسدة.

الكلمات المفتاحية: فاكهة القشطة - اللب - مضادات الأكسدة - السرطان - وظائف الكبد - الكلى - حمض ثلاثي كلورو أسيتيك.

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