Potential Effect of Apricot Kernel Powder on Hepatocarcinomic rats Induced by Potassium Bromate

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Abstract

Apricot kernels are rich in protein and fat, and many anti-cancer compounds. The current study was designed to examine the potential impact of apricot kernel powder (AKP) on rats with cancerous livers induced by potassium bromate. Thirty adult male albino rats, with an average weight of 150±10 g, were divided randomly into two main groups. Group 1 was given a standard diet and served as the negative control group (normal rats). Group 2 was administered a single intraperitoneal dose of potassium bromate at 125 mg/kg body weight to induce oxidative stress and follicular cells, then divided into 4 subgroups. Group 2 remained as the positive control group and received only the standard diet, while groups 3, 4, and 5 were given AKP at concentrations of 10%, 20%, and 30%, respectively. Throughout the 28-day experimental period, each rat's weight was monitored individually, and at the end of the study period, the rats were euthanized, and blood samples were collected. Biological and biochemical parameters were evaluated, and the potential cytotoxic activity against liver carcinoma cell line was measured. The outcomes demonstrated inhibition and repression at consume of AKP at some tumor parameter, as Interferons alpha (IFN-alpha), interleukin-6 (IL-6), tumor necrosis factor alpha (TNF-α), Protein carbonyl oxidation (PCO), Alpha-fetoprotein (AFP) and improving at oxidative

parameters and liver function and lipid profiles. The best results were for groups fed with 30% of AKP.

Key words: Apricot kernels - tumor - Potassium bromate - Hepatocarcinoma.

التأثير المحتمل لمسحوق نوي المشمش علي الفئران المصابه بسرطان الكبد المستحث بواسطه برومات البوتاسيوم

المستخلص :

نوي المشمش من المواد الغنية بالبروتين والدهون والمواد المضاده للسرطان . تم التخطيط لهذه الدراسة لمعرفة التأثير المحتمل لمسحوق نواة المشمش على سرطان الكبد المستحث بواسطه برومات البوتاسيوم. تم استخدام ثلاثين فأرا ألبينو بالغة (ذكور) بوزن (١٥٠ ± ١٠ جرام) وتم تقسيمها عشوائياً على مجموعتين رئيسيتين. المجموعة الأولى تغذت على النظام الغذائي الأساسي وتم تعيينها كمجموعة ضابطه سالبه (الفئران سليمه). وتم حقن المجموعة الثانية بجرعة واحدة من برومات البوتاسيوم داخل الصفاق بجرعة ١٢٥ ملجم/كجم من وزن الجسم لتحفيز الإجهاد التأكسدي وتسرطن الخلايا ثم أعيد تصنيفها إلى ٤ مجموعات. تركت المجموعة ٢ كمجموعة ضابطه موجبه وتم تغذيتها على النظام الغذائي الأساسي فقط بينما تلقت المجموعات الأخرى ٣، ٤، ٥(١٠-٢٠-٣٠%) من مسحوق نوي المشمش على التوالي. استمرت التجربة لمدة ٢٨ يوماً، وفي نهاية التجربة تم وزن كل فأر على حدة، ثم ذبح الفئران وجمع عينات الدم. تم عمل التحاليل البيولوجية و البيوكيميائية وقياس نشاط السمية الخلوية المحتملة ضد خلايا سرطان الكبد. أظهرت النتائج أن تناول مسحوق نوي المشمش يؤدي إلي انخفاض العديد من مؤشرات الورم والتسرطن، مثل إنترفيرون ألفا- إنترلوكين ٦ - عامل نخر الورم ألفا - أكسدة البروتين الكربونيل- ألفا فيتوبروتين وتحسين ملحوظ لعوامل الأكسدة ووظائف الكبد ومستوي الدهون بالدم . وكانت أفضل النتائج للمجموعات التي تم تغذيها علي ٣٠% من مسحوق نوي المشمش.

الكلمات المفتاحيه : نوي المشمش- التورم – برومات البوتاسيوم – سرطان الكبد .

1. Introduction:

Cancer is the second second-most common cause of death worldwide, according to global statistics **(Siegel *et al*., 2017)** reflecting a global public health concern with an increasing tendency, mostly as a result of population growth increase and rapid aging, especially in developed countries **(Bidram *et al*., 2019)**. Hepatocarcinoma is the fourth most frequent reason of mortality worldwide, accounting for over 800,000 mortality yearly **(Arnold *et al*., 2020)** and **(Chon *et al*., 2023)**. About 90% of initial Hepatocarcinomas are hepatocellular carcinoma, with intrahepatic cholangiocarcinoma and other primary liver malignancies following. Roughly 90% of cases of hepatocellular carcinoma have a recognized underlying etiology, which is most frequently non-alcoholic fatty liver disease, severe alcohol use, and chronic viral hepatitis **(Chon *et al*., 2021)**. Cancer therapy is defined by the World Health Organization (WHO) as a course of treatment intended to significantly extend the life expectancy of cancer patients and to guarantee a satisfactory standard of living for cancer survivors **(WHO, 2020)**. Practices with a biological foundation or natural goods such vitamins, botanicals, nutritional supplements, herbs, spices, diets, or specialty meals **(Guerra-Martín *et al*., 2021)**. Among these, the scientific community and the general public have paid particular attention to apricot kernels and their active ingredient, amygdalin **(Tvrdá *et al*., 2024).**

Potassium bromate (KBrO3) is one of the food additives which often used in bakeries as a dough conditioner and flour enhancer **(Elmahdy *et al*., 2015)**, water disinfection by-product, and known as a carcinogen. It causes exposure-related toxicities in living things that are dose-dependent **(Hassan *et al*., 2020)**. Studies have suggested that the posssible mechanism of KBrO3-induced carcinogenicity in experimental models includes mutation base modification (8-oxodeoxyguanosine), chromosomal aberrations, and alters gene expression, leading to cancer **(Manzoor *et al*., 2021; Jan *et al*., 2017).**

Apricot seed contain sugars, polyphenols, fatty acids, sterol derivatives, carotenoids, cyanogenic glucosides, and volatile compounds are

abundant in the plant. There is growing research suggests that polyphenols, which are common micronutrients in the diet of humans, may help prevent degenerative diseases including cancer and heart disease **(Kumar *et al*., 2024)**. As a byproduct of apricot fruit, apricot kernel (*Prunus domestica, L*), vitamins, and carbohydrates. It has a higher concentration of natural antioxidants than the meaty section **(Soong and Barlow 2004)**. Additionally, it includes carotenoids, alkaloids, sterol derivatives, cyanogenic glucosides, and volatile compounds in addition to phenolic and flavonoid compounds (such as epigallocatechin, sinapic, benzoic acid, chlorogenic, caffeic acid, gallate, pcoumaric, syringic, quercetin and ferulic acid, pinocembrin, and galangin). vitamins, carbohydrates, polyphenols, mono- and polysaccharides, and fatty acids. It is a natural anticancer, antioxidant, fungicidal, bactericidal, and anti-parasitic substance **(Hamid *et al*., 2023)**. Furthermore, it can be used for medicinal purposes and to create culinary components. Furthermore, the kernel's numerous industrial uses in a wide range of disciplines of study and businesses, including thermal energy storage, cosmetics, pharmaceuticals, and food, have made it well-known **(Jaafar, 2021) & (Akhone *et al*., 2022)**. Apricot kernels contain amygdalin, despite of its importance as an antitumor and antioxidant, it breaks down into poisonous hydrogen cyanide, **(Fadl, 2023)**. Apricot kernels containing amygdalin (AMG), it is D-mandelonitrile-bi-glucoside or Vitamin B17. AMG as the major cyanogenic glycoside are potentially useful as a supplemental treatment for a number of conditions, such as cancer, asthma, the common cold, migraines, hypertension, constipation, chronic inflammation, improved nervous system function, and antinociceptive, antibacterial, and antioxidant properties **(Milazzo *et al*., 2006) & (Jasar *et al*., 2008) & (Badr *et al*., 2020)** & **(Tarek *et al*., 2023)& (Kumar *et al*., 2024)** and **(Tvrdá *et al*., 2024)**.

According to **(Ramadan *et al*., 2020)**, amygdalin increases the pancreatic enzymatic activity, which may prevent tumors. When amygdalin combines with cancer cells, beta-glucosidase breaks it down, producing a poisonous cyanide that can destroy tumor cells. Because rhodanase, another enzyme found in healthy cells, has the capacity to detoxify cyanide, the

entire process does not damage healthy cells. The fourth most common cause of mortality worldwide is Hepatocarcinoma. Amygdalin has anti-carcinogenic properties **(Ioannis *et al*., 2015)**. According to one theory, vitamin B-17 deficiencies are the cause of cancer. Between the glycoside and the benzene ring, a cyanide group found in amygdalin, which is released upon hydrolysis **(Cho *et al*., 2006)**. When amygdalin is hydrolyzed by an enzyme (beta-glucosidase in the human body), it releases benzaldehyde and HCN **(Milazzo *et al*., 2006)**. When taking amygdalin orally, it can cause toxicity via impeding the mitochondrial cytochrome oxidase, which is part of the electron transport chain **(Zhou *et al*., 2012)** & **(Jaswal *et al*., 2018)**. When administered intravenously, the maximum amygdalin dosage that a human body can withstand is roughly 0.07 g/kg **(Song and Xu 2014)**. If ingested in large quantities, amygdalin can be harmful to humans due to the emission of hydrocyanic acid (HCN) during enzymatic breakdown **(Blaheta *et al*., 2016)**. Apricot seeds have anticancer and hepatoprotective properties that support their traditional usage and potential for the treatment of liver illnesses such as hepatocellular carcinoma **(Ramadan *et al*., 2020)**.

Hence, this experiment was carried out to investigate the anti-carcinogenic properties of Apricot kernels on male albino rats induced by Potassium bromate (KBrO3).

2. Material and methods

2.1.Material:

2.1.1. Apricot kernels

The commercial dried and crushed apricot kernels (*Prunus domestica*, *L*) were sourced from food factories as secondary waste for jam industry, Egypt.

2.1.2.Chemicals: Casein, choline chloride powder, cellulose, and DL methionine powder were purchased from Morgan Co. in Cairo, Egypt. The chemical kits utilized in this research (TC, TG, HDL-c, ALT, AST, and ALP) and potassium bromate (KBrO3) in the shape of a white powder were purchased from the Al-Gomhoria Company for Drugs, Chemicals, and

Medical Instruments in Cairo, Egypt. Malondialdehyde kits were purchased from SIGMA Chemical Co. in Cairo, Egypt.

2.1.3. Rats: Thirty mature male albino rats of the Sprague Dawley strain, weighing an average of 150±10 g, were obtained from the Vaccine and Immunity Organization, Ministry of Health, Helwan Farm, Cairo, Egypt. This investigate was ethically accepted by the Institutional Animal Ethics committee of Menoufia University (Reg. No, MUFHE /F/NFS/25/24).

2.2. Methods :

2.2.1. **Preparations of apricot kernels**

To make the dried apricot kernel powder (flour), the kernels were properly washed under running tap water, dried, and crushed to a fine powder.

2.2.2. Detoxification of the apricot kernel.

Apricot kernel flour detoxification was conducted following the method of **Gupta and Sharma (2009).** One hundred grams of flour were submerged in 500 milliliters of a 25% sodium chloride solution for twelve hours.

The flour was then thoroughly rinsed with running water until the water ran clear. This salt treatment was repeated once more for another twelve hours, followed by a final rinse. The treated flour was subsequently dried in a hot air oven at 45 degrees Celsius for thirty-six hours.

2.2.3. **Experimental design**

All rats were fed on basal diet (casein diet) prepared according to **American Institute of Nutrition (AIN) (1993)** for 7 consecutive days for adaptation. Thirty adult male albino rats were divided randomly into two main groups. The first group was provided with a standard diet and served as a control group (normal rats). The second group was given a single intraperitoneal injection of potassium bromate at a dose of 125 mg/kg body weight to induce oxidative stress and follicular cell tumors, following the method outlined by **Khan and Sultana (2004)**. The second group was designated as the positive control group and maintained on the standard diet, while groups 3, 4, and 5 were given varying concentrations of apricot kernel powder (AKP) (10%, 20%, and 30%, respectively). The experiment lasted for 28 days, during which each rat's weight was monitored individually. At

the end of the experiment, the rats were euthanized, and blood samples were collected.

2.2.4. **Blood sampling.**

Blood samples were extracted from the hepatic portal vein at the conclusion of each trial. Two types of blood samples were procured and placed into dry, sterile centrifuge glass tubes. These samples were allowed to coagulate in a water bath set at 37 °C for half an hour, then centrifuged for 10 minutes at 3000 rpm to separate the serum. The serum was carefully drawn off and transferred into clean cuvette tubes, which were then stored in a deep freezer until further analysis.

2.2.5. **Biological evaluation:**

During the experimental period (30 day), the consumed feeding was recorded every day, body weight gain (BWG) and feed efficiency ratio (FER) were calculated according to **Chapman *et al*., (1959)** using the following equations:

$$\text{Body weight gain (BWGg)} = \frac{(\text{Finalweight} - \text{Initialweight})}{\text{Initial weight}}$$

$$\text{Feed efficiency ratio (FER)} = \frac{\text{Gain in body weight(g)}}{\text{Feed intake(g)/30}}$$

2.2.6. Biochemical analysis

Serum total cholesterol was determined according to the colorimetric method described by **Thomas (1992).** Serum triglycerides were determined by enzymatic method using kits according to the **Fossati and Principle, (1982).** HDL-c was measured using the technique published by **Grodon and Amer (1977)**. **Lee and Nieman (1996)** used the formula below to compute VLDL-c in mg/dl: VLDL-C (mg/dL) = Triglycerides / 5

Lee and Nieman (1996) used the following formula to compute LDL-c in mg/dl:

LDL-c (mg/dl) = total cholesterol minus HDL-c minus VLDL-c

The serum alanine aminotransferase (ALT), serum asparatate aminotransferase (AST), and serum alkaline phosphatase (ALP) levels were determined using the **Clinica Chimica Acta (1980), Hafkenscheid (1979), and Moss (1982)** methods, respectively. SOD was done according to the method of **Sun *et al*., (1988)**, catalase activity was performed following the method of **Diego (2011)**. Glutathione peroxidase (GPX), and malondialdehyde (MDA) were measured by method of **Zhao *et al*., (2001)** and **Ohkawa *et al*., (1979)**, respectively. Lipid peroxidation (LPO) was determined according to **(Buege and Aust 1978) ,** Protein carbonyl oxidation (PCO) content was determined according to **Levine *et al*., 1990**. Alpha-fetoprotein (AFP) was determined according to **Drugan et al., 1991.** Tumor necrosis factor -α (TNF– α),according to Acharya et al., (1996), Interleukin_ 6 (IL-6) levels in the serum was determined according to **Henry, (1964)**. Interferons alpha (IFN-alpha) was determined according to **(Pestka and Meager 1997)**. Determination of HB, WBC.s and RBC.s: Following the methods of **Dacie and Lewis (2006)**, **Koda-Kimble *et al.* (2001)**, and **Lubsandorzhiev (2006)**, respectively, hemoglobin, WBCs, and RBCs were measured. Determination of lymphocytes, neutrophils and PLT**:** **Boyum (1968)**, **Hoffbrand *et al.* (2016)**, and **Daly (2011)** methods were used, respectively, to determine serum lymphocytes, neutrophils, and platelet count. The sulphorhodamine (SRB) assay: Measurement of potential cytotoxicity activity against the liver carcinoma cell line (HEPG2) by SRB assay of the AKP was tested using the method of **Skehane *et al*., (1990)**.

2.2.7. **Statistical analysis**

Data was conducted by applying a fully randomized factorial design **(SAS, 1988)** after detecting a significant main effect. The means were differentiated using the Student-Newman-Keuls Test. Variances across treatments at a significance level of $P<0.05$ were deemed noteworthy with the application of the Costat Program. The biological outcomes were assessed using one-way ANOVA.

3. Results and discussion

3.1. Effect of Apricot Kernel Powder on Biological parameter (BWG – FI – FER) on Hepatocarcinomic rats Induced by potassium bromate

The data in Table (1) illustrate the influence of Apricot Kernel Powder on biological parameters (BWG, FI, and FER) in hepatocarcinoma rats. The obtained results indicated that control (-) group had the highest BWG at 44.00 g/28 days. The control (+) group showed a significant decrease in BWG at 17.00 g/28 days, indicating the adverse effect of potassium bromate. While, groups receiving 10%, 20%, and 30% apricot kernel powder showed a dose-dependent increase in BWG, with the 30% group nearly reaching the BWG of the Control(-) group.

About feed intake, the control (-) group had the highest FI at 13.43 g/day compared with control(+) group showed a significant decrease in FI at 9.37 g/day. Groups receiving 10%, 20%, and 30% apricot kernel powder showed significant increases in FI compared to the control(+) group, with the highest FI in the 30% group at 12.28 g/day.

Finally, The control(-) group had the highest FER at 0.118 g/rat/day compared with control(+) group showed a significant decrease in FER at 0.069 g/rat/day. Groups receiving 10%, 20%, and 30% apricot kernel powder showed significant improvements in FER compared to the control(+) group, with the highest FER in the 30% group at 0.119 g/rat/day.

The results of biological parameter's indicate that the inclusion of apricot kernel powder in the diet of hepatocarcinomic rats significantly improved all measured parameters (BWG, FI, FER) in a dose-dependent manner.

The significant reduction in BWG and FI in the control(+) group highlights the adverse impact of potassium bromate and indicative of the toxic effects of it, which likely led to reduced appetite and overall health. However, the groups receiving apricot kernel powder showed a marked improvement in BWG and FI, suggesting a protective or mitigating effect of the apricot kernel powder against potassium bromate-induced weight loss and helps to counteract these effects, potentially due to its nutritional benefits and possible anti-cancer properties. In the other hand the FER data

support the observations made for BWG and FI. The significantly lower FER in the control (+) group indicates a poor conversion of feed to body mass, likely due to the negative effects of potassium bromate on metabolic efficiency. The improved FER in the apricot kernel powder groups suggests better utilization of feed, likely due to the beneficial properties of apricot kernels.

These result agreed with some researches as **(Kalu *et al*., 2024)** who treated animals with KBrO3 alone exhibited a marked decrease in the body weight gain consequently indicating general toxicity and disturbance of metabolic functions in the exposed rats . The same behavior was reported by **(Radwan *et al*., 2022)** who revealed The final body weight a significant decrease in KBrO3 treated group comparing with control group . Positive control group (KBrO3) had the lowest estimation of final body weight, daily weight gain, and food and protein efficiency ratio compared to other groups. This might be due to toxic-induced by KBrO3 on metabolism disturbances in rats **(Abdrabou *et al*., 2024)**. Also these findings are consistent with previous research indicating that certain natural compounds, such as those found in apricot kernels, can offer protective effects against chemically induced carcinogenesis and may improve overall health and metabolic efficiency in affected organisms. A study by **Liu *et al*., 2013** investigated the effects of an apricot kernel extract on human lung cancer cells. The extract exhibited some anti-proliferative activity, The same behavior was reported by **Li *et al*., 2016** who examined the effects of various apricot kernel compounds on apoptosis, **Darwish *et al*.,(2023)** provides insights into the potential health benefits and cancer-fighting properties of natural food supplements as apricot kernel , **Krishnamoorthy, *et al*., (2024)** shedding light on the potential of natural antioxidants at apricot kernel powder in cancer therapy.

Table (1): Effect of Apricot Kernel Powder on Biological parameter (Body weight gain – feed intake – feed efficiency ratio) on Hepatocarcinomic rats Induced by potassium bromate

Parameters / Groups	BWG(g/28day)	FI(g/day)	FER(g/rat/day)
Control(-)	$44.00^{a} \pm 1.00$	$13.43^{a} \pm 0.40$	$0.118^{a} \pm 0.002$
Control(+)	$17^{d} \pm 1.00$	$9.37^{d} \pm 0.35$	$0.069^{c} \pm 0.005$
10% AKP	$31.33^{c} \pm 2.52$	$11.24^{c} \pm 0.26$	$0.099^{b} \pm 0.006$
20% AKP	$36.667^{b} \pm 2.08$	$11.6^{c} \pm 0.11$	$0.11^{a} \pm 0.007$
30% AKP	$41.00^{a} \pm 1.00$	$12.28^{b} \pm 0.19$	$0.119^{a} \pm 0.001$

The values indicate the mean ± SD of three replicates. Body Weight Gain (BWG), Feed Intake (FI), Feed Efficiency Ratio (FER) and Apricot Kernel Powder(AKP) .

3.2. Effect of Apricot kernel Powder on Lipid Profiles of Hepatocarcinomic Rats Induced by Potassium Bromate

The effect of Apricot kernel Powder on lipid profiles of Hepatocarcinomic rats are shown in Table (2). The obtained results indicated that the total Cholesterol of control (-) normal group had the lowest T.C levels of at 103.19 mg/dl compared with control(+) group showed a significant ($p \leq 0.05$) increase in T.C at 228.30 mg/dl, indicating the adverse effect of potassium bromate. While, Groups receiving 10%, 20%, and 30% apricot kernel powder showed a dose-dependent decrease in T.C, with the 30% group showing a significant ($p \leq 0.05$) reduction at 120.83 mg/dl. The best treatment of AKP recorded for 30% AKP.

On the other hand, the levels of Triglycerides of negative control group had the lowest T.G at 99.37 mg/dl compared with positive control group showed a significant ($p \leq 0.05$) increase in T.G at 175.37 mg/dl.

While groups receiving concentrations of apricot kernel powder (10,20 and 30%) showed significant ($p \leq 0.05$) decreases in T.G compared to the control(+) group, with the 30% group having the lowest T.G at 97.75 mg/dl.

On the contrary the control(-) group had the highest HDL at 52.32 mg/dl and the control(+) group showed a significant decrease in HDL at

32.15 mg/dl. And when receiving groups 10%, 20%, and 30% of apricot kernel powder showed significant increases in HDL compared to the control(+) group, with the 30% group having the highest HDL at 50.39 mg/dl.When estimating levels of LDL and VLDL The control(-) group had the lowest LDL and VLDL at 29.54 mg/dl and 19.87 mg/dl respectively. Compared to the control (+) group, there was a substantial rise in LDL and VLDL levels at 160.82 mg/dl and 35.31 mg/dl, respectively. Groups receiving 10%, 20%, and 30% apricot kernel powder showed significant decreases in LDL and VLDL compared to the cancerous group, with the 30% groups having the lowest significant LDL and VLDL at 50.29 mg/dl and 19.55 mg/dl respectively.

The significant increase in T.C, TG, LDL and VLDL and the significant reduction in HDL in the control(+) groups highlights the adverse impact of potassium bromate likely leading to dyslipidemia. **Kalu *et al*. (2024)** showed substantial increases in total cholesterol, TG, LDL, and VLDL, but significant reductions in HDL concentrations in the KBrO3 alone group compared to the control group. and **El-Dashlouty *et al*., 2020** Which confirmed the KBrO3 intoxication accompanied by the rise of TC, TG, VLDL, LDL, AI ratio. It is obvious KBrO3 intoxication lowered considerably the level of good cholesterol**.**

Also, These results agreed with **Mahdy *et al*., 2012 , Talha, *et al*., (2014)** which confirmed the improvement in T.G and HDL in the apricot kernel powder groups suggests that the supplementation helps to counteract these effects, potentially due to its lipid-lowering properties, and protective against cardiovascular diseases.

These findings are consistent with previous research indicating that certain natural compounds, such as those found in apricot kkernels **(Adewale *et al*., (2022)** can offer protective effects against chemically induced dyslipidemia and may improve overall lipid profiles in affected organisms **(Türkan, *et al*., 2009).** After the use of 1% apricot kernel oil (supplemented), there was a reduction in the maximum blood cholesterol level, LDL, VLDL, and triglyceride levels, while the HDL levels increased.

Apricot kernel oil demonstrates efficacy in lowering lipid profiles, particularly cholesterol **(Tabassum *et al*., 2023)**. Amygdalin (10 mg/kg) in AKP decreased lipid levels in mice with low-density lipoprotein receptor deficiency, including triglycerides, total cholesterol, and low-density lipoprotein **(Lv *et al*., 2017)**.

Table (2): Effect of Apricot kernel Powder on lipid profiles of Hepatocarcinomic rats Induced by potassium bromate

Parameters / Groups	T.C (mg/dl)	T.G (mg/dl)	HDL (mg/dl)	LDL (mg/dl)	VLDL (mg/dl)
Control(-)	103.19 ^{e}±1.71	99.37^{d} ±1.05	52.32^{a}±1.05	29.54^{e} ± 1.94	19.87^{d} ±0.21
Control(+)	228.30^{a} ±2.41	175.37^{a}±0.86	32.15^{d}±1.27	160.82^{a}±0.98	35.31^{a} ±0.30
10% AKP	173.40^{b} ±1.64	152.60^{b}±1.64	37.77^{c}±1.98	106.75^{b}±3.47	30.49^{b} ±0.28
20% AKP	147.17^{c} ±1.31	126.60^{c}±1.31	44.59^{b} ±0.71	77.27^{c} ± 1.41	25.44^{c}±0.106
30% AKP	120.83^{d} ±2.46	97.75^{d} ± 2.43	50.39^{a} ±1.02	50.29^{d} ± 3.49	19.55^{d} ±0.48

The values indicate the mean ± SD of three replicates. Total Cholesterol (T.C), Triglycerides (T.G), High-Density Lipoprotein (HDL), Low-Density Lipoprotein (LDL), Very Low-Density Lipoprotein (VLDL)and Apricot kernel Powder(AKP).

3.3. Effect of Apricot kernels Powder on Liver Functions of Hepatocarcinomic rats Induced by Potassium Bromate.

The results at Table (3) suggested that the liver enzymes of the control rats had the lowest AST, ALT and ALP at 91.15, 73.19 and 147.30 U/L respectively. But the liver enzyme of positive control rats showed a significant increase in AST, ALT and ALP at 184.17, 163.00 and 276.20 U/L respectively, indicating liver damage due to potassium bromate. These results agreed with **Abdrabou *et al*., (2024)** who reported that the liver enzymes (AST, ALT, and ALP) were increased, but total protein, albumin, globulin g/dl, and A/G ratio were lowered in the positive control group as compared to the negative control group and other groups were intoxicated by KBrO3. These findings could primarily be the consequence of these enzymes leaking into the blood stream from the liver cytosol. That gave rise to an increase in ALT and AST enzymes in the positive control rats. KBrO3

induced a significant increase ($p<0.05$) in the liver and kidney function indices when compared to the control after 10 and 15 days of administration. The increase in activity of the serum enzymes confirmed the property of KBrO3 as a membrane labializes **(Ataguba *et al*., 2024).** Finally, **Kalu *et al*., (2024)** said that the serum activities of ALT, AST, ALP and Bilirubin were significantly ($P \leq 0.05$) higher in KBrO3-only exposed rats.

Groups receiving 10%, 20%, and 30% of apricot kernel powder showed significant decreases in AST, ALT and ALP compared to the control(+) group, with the 30% group showing the most significant reduction at 104.40 U/L, 87.00 U/L and 184.30 U/L respectively.These results agreed with **Ramadan, *et al*., (2020)** found that the apricot seeds possess hepatoprotective and anticancer activities that justify its traditional use, and its potential for the treatment of liver diseases including hepatocellular carcinoma. And **Wu, *et al*., (2022)** . The apricot kernel administration showed improvement of histological and chemicals analysis for four weeks at liver enzymes and oxidative stress in rats. AST, ALT, and ALP were significantly decreased but the levels of total protein and albumin were significantly increased in VB17-pre-treated mice when compared with the EAC group **(Tousson *et al*., 2020)**.

Table (3): Effect of Apricot Kernel Powder on Liver Functions of Hepatocarcinomic rats Induced by Potassium Bromate.

Parameters / Groups	AST(U/L)	ALT(U/L)	ALP(U/L)
Control(-)	$91.15^{e} \pm 1.18$	$73.19^{e} \pm 1.92$	$147.30^{e} \pm 1.35$
Control(+)	$184.17^{a} \pm 0.85$	$163.00^{a} \pm 2.11$	$276.20^{a} \pm 0.80$
10% AKP	$156.17^{b} \pm 0.96$	$128.77^{b} \pm 1.09$	$222.03^{b} \pm 1.84$
20% AKP	$143.77^{c} \pm 1.57$	$110.33^{c} \pm 0.65$	$210.20^{c} \pm 0.72$
30% AKP	$104.40^{d} \pm 1.25$	$87.00^{d} \pm 1.20$	$184.30^{d} \pm 0.89$

The values indicate the mean ± SD of three replicates. Aspartate Aminotransferase (AST), Alanine Aminotransferase (ALT), Alkaline Phosphatase (ALP) and Apricot Kernel Powder (AKP).

3.4. Effect of Apricot Kernel Powder on Protein Carbonyl Oxidation and Interferons Alpha of Hepatocarcinomic Rats Induced by Potassium Bromate

Data given in Table (4) show effect of apricot kernel powder on protein carbonyl oxidation and Interferons alpha of hepatocarcinomic rats. As a result of the obvious infection with potassium bromate, this led to the significant increased at cancerous positive groups in PCO and IFN-α at 8.57 ng/ml and 28.64 pg/ml. respectively, when compared with normal rats groups at 0.27 ng/ml and 0.48 pg/ml indicating oxidative stress due to potassium bromate. These results agreed with **Kaya & Topaktaş, (2007)** they reported genotoxic effect of KBrO3 in form of increased sister chromatid exchange frequency, chromosomal aberrations, and micronucleus formation. And **Elmahdy *et al.*, (2015)** supported them by reporting dysplastic foci in the liver of rats treated with KBrO3 high dose (600 ppm). **Elhadad *et al.*, (2022)** stated that Potassium bromate is a chemical oxidizing agent and it can attack cellular constituents through reactive oxygen species and destroy the cellular structures so it may lead to cancer as a result of administration of it for a long time. Finally, **Mahmoud *et al.*, (2024)** said that Potassium bromate is a proven carcinogen as it is a strong oxidizing agent that generates free radicals during xenobiotic metabolism.

Groups receiving 10%, 20%, and 30% apricot kernel powder showed significant decreases in PCO and IFN-α compared to the control(+) group, with the 30% group showing the most significant reduction at 0.71 ng/ml. and 1.92 pg/ml. respectively . The increase in PCO and IFN-α in the control(+) group indicates an inflammatory response to potassium bromate-induced carcinogenesis. The reduction in PCO and IFN-α levels in the apricot kernel powder groups suggests that supplementation helps to mitigate inflammation, which may contribute to its anti-cancer effects due to apricot kernel powder contains many antioxidants. This result agreed with Ali **Akhone *et al.* (2022)** that the antioxidant capabilities of apricot kernels can be beneficial in combating various chronic illnesses like cancer, stroke, and diabetes. Moreover, the presence of protein in apricot kernels enhances their antioxidant properties, which are essential in the realm of nutrition. Various studies have demonstrated that apricot kernels are rich in

antioxidants such as lutein, beta carotene, and zeaxanthin, which play a crucial role in neutralizing free radicals. **Kitic *et al*. (2022)** and **Sasane *et al*. (2021)** have highlighted the potential of bioactive compounds from AKP to possess significant pharmacological properties, particularly in the fight against cancer. Apricot seeds are a valuable source of oil containing bioactive elements like fatty acids, tocopherols, terpenoids, and phenolic compounds that exhibit potent antioxidant, anticancer, antimicrobial, and anti-inflammatory effects **(Siddiqui *et al*., 2023)**.

Table (4): Effect of Apricot Kernel Powder on tumor markers (protein carbonyl oxidation and Interferons alpha) of Hepatocarcinomic Rats Induced by Potassium Bromate

Parameters / Groups	PCO (ng-ml)	IFN- α (pg-ml)
Control(-)	$0.27^{d} \pm 0.035$	$0.48^{e} \pm 0.02$
Control(+)	$8.57^{a} \pm 0.62$	$28.64^{a} \pm 0.66$
10% AKP	$2.42^{b} \pm 0.37$	$8.29^{b} \pm 0.28$
20% AKP	$1.26^{c} \pm 0.12$	$4.22^{c} \pm 0.26$
30% AKP	$0.71^{cd} \pm 0.14$	$1.92^{d} \pm 0.53$

The values indicate the mean ± SD of three replicates. protein carbonyl oxidation (PCO) and interferons alpha (IFN-α), and Apricot Kernel Powder(AKP).

3.5. Effect of Apricot Kernel Powder on Tumor Markers (Tumor necrosis factor -α, Interleukin - 6 and Alpha-fetoprotein) of Hepatocarcinomic Rats Induced by Potassium Bromate

Data in Table 5 showed that administration with KBrO3can led to increase levels TNF-α , IL-6 and AFP in control positive group at 807.63 ± 1.18 pg/ml, 781.93 ± 1.10 pg/ml and 592.97 ± 2.05 pg/ml respectively, compared with negative control group at 59.27 ±0.66 pg/ml , 48.20 ± 0.72 pg/ml and 6.43 ± 0.55 pg/ml respectively, this indicating a high level of inflammation due to potassium bromate.

KBrO3 -alone treated elicited significantly ($p < 0.05$) higher IL-b, IL-6 and TNF-α levels in serum of rats **(Kalu *et al*., 2024)**. KBrO3 produced DNA damage spots in a comet assay, which were related with elevated inflammatory indicators (IL-6), decreased anti-apoptotic Bcl-2, and increased apoptotic markers (Bax and caspase-3). (**Osman *et al*., 2023).** KBrO3-induced carcinogenicity in experimental models includes mutation base modification (8-oxodeoxyguanosine), chromosomal aberrations, and alters gene expression, leading to cancer **(Manzoor *et al*., 2021).**

The results indicated that treatment with 10%, 20%, and 30% apricot kernel powder can decrease significant in TNF-α , IL-6 and AFP compared to the control(+) group. The best treatment recorded for 30% concentrate of AKP.

Similar findings were reported by **Qiao *et al*. (2020)**, indicating that Apricot kernel exhibits a wide range of applications in medicine, such as anti-cancer, skin diseases, cardiovascular diseases, hemostasis, pain relief, and anti-inflammatory properties. The key anti-inflammatory compounds include Acetylcholinesterase, Lipoxygenase, Cycloxygenase, Interleukin 6, Prostaglandin, Toll-like receptors, and Tumor necrosis factor alpha. **Fogarasi *et al.* (2022)** highlighted the significant role of apricot seeds and kernels as anti-inflammatory agents, attributing their effectiveness to various compounds that reduce inflammation in both animal and human tissues. Additionally, **Dávila-Vega *et al*. (2023)** discovered that Amygdalin, a naturally occurring anti-cancer substance classified as a β-cyanogenic glycoside, is abundant in members of the Rosaceae family like almonds, apricots, apples, and peaches. The anticancer properties of amygdalin are primarily attributed to its active metabolite, hydrocyanic acid.

Table (5): Effect of Apricot Kernel Powder on Tumor Markers (Tumor necrosis factor -α, Interleukin - 6 and Alpha-fetoprotein) of Hepatocarcinomic Rats Induced by Potassium Bromate

Parameters / Groups	TNF-α (pg-ml)	IL-6 (pg-ml)	AFP(pg-ml)
Control(-)	59.27^{e} ±0.66	48.20^{e} ± 0.72	6.43^{e} ± 0.55
Control(+)	807.63^{a} ± 1.18	781.93^{a} ± 1.10	592.97^{a} ± 2.05
10% AKP	415.67^{b} ± 1.53	342.90^{b} ± 1.15	303.37^{b} ± 2.41
20% AKP	347.83^{c} ± 0.76	204.27^{c} ± 0.93	110.60^{c} ± 1.22
30% AKP	109.10^{d} ± 1.15	156.03^{d} ± 1.25	58.07^{d} ± 1.70

The values indicate the mean ± SD of three replicates.Tumor Necrosis Factor-alpha (TNF-α), Interleukin-6 (IL-6), Alpha-fetoprotein (AFP), and Apricot Kernel Powder (AKP).

3.6. Effect of Apricot Kernel Powder on Oxidative Parameters of Hepatocarcinomic Rats Induced by Potassium Bromate

Data in Table 6 shows effect of Apricot Kernel Powder on SOD, CAT, GPX, MDA and LPO level of of hepatocarcinomic rats induced by potassium bromate. The control(-) group had the highest SOD,CAT and GPX levels at 238.93 U/ml, 10.65 U/ml and 214.60 U/ml respectively, and the significant decreased in MDA and LPO levels at 1.86 nmol-ml and 1.16 nmol-ml, respectively these may be indicating normal oxidative balance and indicating low lipid peroxidation. On other hand, the control(+) group showed a significant decrease in SOD,CAT and GPX levels to 31.23 U/ml, 0.49 U/ml and 15.08 U/ml respectively , and a significant increase in MDA and LPO levels at 11.09 nmol-ml and 22.97 nmol-ml respectively , reflecting oxidative stress induced by potassium bromate. These results agreed with **Starek and Starek-Świechowicz, (2016)** who found that oxidative stress induction by KBrO3 is also widely thought to play a role in the carcinogenicity and mutagenicity of KBrO3. **Adewale *et al*., (2022)** observed that administration of KBrO3 lead to a significant decrease in the levels of glutathione, superoxide dismutase, glutathione peroxidase, and

catalase group when compared to control. Potassium bromate significantly decreased plasma, hepatic, renal, and cardiac catalase, superoxide dismutase (SOD), and glutathione peroxidase (GPx) activity, lowered glutathione (GSH) concentrations, and raised MDA levels **(Ugwu *et al*., 2022)**.

Treatment of 10%, 20%, and 30% apricot kernel powder showed dose-dependent increases in SOD, CAT and GPX levels, with the 30% group showing the most significant improvement in a dose dependent manner when compared to positive control rats. Conversely, malondialdehyde (MDA) and lipid peroxidation (LPO) levels were reduced in all apricot kernel powder-treated groups compared to the control. The best treatment recorded for 30% AKP. These results are in agreement with **Singh, *et al*., (2017)** show the antioxidant properties of apricot kernels, supporting their potential to combat oxidative stress. **Khan *et al*. (2020)** demonstrated that apricot kernel extract enhanced liver and kidney functions, as determined by the levels of AST, ALT, urea, creatinine, MDA, and the activities of SOD and CAT. Additionally, **Ataguba *et al*., (2024)** found that incorporating an apricot fruit diet provided significant protection against oxidative stress induced by radiotherapy and DMBA in the liver of rats. Apricot kernel oil, at 2 ml/kg, 4 ml/kg, and gabapentin resulted in significant decreases in the MDA **(Akaberi *et al*., 2024)**.

Table (6): Effect of Apricot Kernel Powder on Oxidative Parameters of Hepatocarcinomic Rats Induced by Potassium Bromate

Parameters / Groups	SOD (U-ml)	CAT (ng-ml)	GPX (U-ml)	MDA (nmol-ml)	LPO (nmol-ml)
Control(-)	238.93^{a} ±1.10	10.65^{a}±0.56	214.60^{a} ±1.22	1.86^{e} ± 0.05	1.16^{e} ± 0.42
Control(+)	31.23^{e} ± 0.75	0.49^{e} ± 0.08	15.08^{e} ± 1.33	11.09^{a} ± 0.24	22.97^{a} ± 0.91
10% AKP	91.85^{d} ± 1.62	3.06^{d} ± 0.31	105.27^{d}±1.10	9.09^{b} ± 0.08	10.98^{b} ± 0.07
20% AKP	163.53^{c}±1.50	5.60^{c} ± 0.53	117.57^{c} ± 1.9	6.58^{c} ± 0.39	7.24^{c} ± 0.50
30% AKP	202.07^{b} ±1.35	7.05^{b} ± 0.24	177.67^{b}±3.79	3.87^{d} ± 0.91	3.91^{d} ± 0.64

The values indicate the mean ± SD of three replicates., Superoxide Dismutase (SOD), catalase (CAT) , Glutathione peroxidase (GPX), malondialdehyde (MDA), Lipid peroxidation (LPO) and Apricot Kernel Powder (AKP).

3.7. Effect of Apricot Kernel Powder on A complete blood count of Hepatocarcinomic Rats Induced by Potassium Bromate

Data in Table 7 (a) illustrate the effect of Apricot Kernel Powder on the complete blood count of hepatocarcinoma rats. The results showed that the control(-) group had the highest HB levels at 13.28 g/dl, indicating normal red blood cell function. The control(+) group showed a significant decrease in HB levels to 8.45 g/dl, reflecting the adverse effects of potassium bromate on red blood cells. Treatment with KBrO3 revealed a significantly decrease in the mean of the body weight, red blood corpuscles (RBCs), white blood cells (WBCs), blood platelets (PLTs), hemoglobin (HB), hematocrit value (HCT) comparing to the control group **(Radwan *et al*., 2022).**

Treatment of 10%, 20%, and 30% apricot kernel powder showed dose-dependent increases in HB levels, with the 30% group showing a significant improvement at 11.96 g/dl, suggesting a restorative effect of apricot kernel powder on hemoglobin levels. The control(-) group had the highest RBC count at 4.58 million/cmm, indicating normal erythropoiesis. The control(+) group exhibited a significant reduction in RBC count to 2.80 million/cmm. Apricot kernel powder groups (10%, 20%, and 30%) showed increases in RBC counts, with the 30% group showing a notable improvement to 3.84 million/cmm, indicating partial recovery. The control(-) group had the highest WBC count at 15.06 thousand/cmm. The control(+) group showed a significant decrease in WBC count to 6.05 thousand/cmm, reflecting immunosuppression. The 10%, 20%, and 30% apricot kernel powder groups showed significant increases in WBC counts, with the 10% group showing the most significant improvement to 10.23 thousand/cmm. The control(-) group had the highest platelet count at 536.67 thousand/cm3. The control(+) group showed a significant decrease in platelet count to 111.67 thousand/cmm, indicating impaired thrombopoiesis. Apricot kernel powder groups (10%, 20%, and 30%) showed dose-dependent increases in platelet counts, with the 30% group showing a significant recovery to 520.33 thousand/cmm. The control(-) group had the highest HCT levels at 37.66 %.

The control(+) group showed a significant decrease in HCT levels to 26.03 %, indicating anemia. Apricot kernel powder groups (10%, 20%, and 30%) showed increases in HCT levels, with the 30% group showing a notable improvement to 36.54 %. All these changes, both increases and decreases in treatments with apricot kernel powder, may be due to works to inhibit lymphocytes, a subset of WBCs essential to the immune system and also, decrease the other hematological parameters this may be owing to the action of antioxidants in AKP on hemostasis, since flavonoids have been linked to platelet aggregation inhibition**. Aydın et al. (2019)** came to a similar conclusion as ours, stating that apricots kernel has several medicinal advantages, including antioxidants, anti-inflammatory, antidiabetic, hepatoprotective, antibacterial, and antiviral characteristics that could benefit the medical field. **Tareen *et al.* (2021)** revealed that apricot kernels possess significant antioxidant properties, which can help in protecting the liver from oxidative damage and improving overall liver function. **Kumar& Singh (2021)** demonstrated that the rats treated with apricot kernel significantly decreased WBC, LYM and PLT when compared with CCl4 treated rats. Apricot kernel oil was found to considerably activate the immune system of cyclophosphamide-treated rats **(Zhang *et al*. 2022)**. Apricot kernels particularly rich in lipid and protein, they are potentially useful in human nutrition and causes the simultaneous, permanent division and differentiation of cells from stem cells, which results in an increase in red blood cells **Xue & Qin, (2023).**

Table 7 (a&b): Effect of Apricot Kernel Powder on A complete blood count of Hepatocarcinomic Rats Induced by Potassium Bromate

Table 7(A):

Parameters / Groups	HB (g/dl)	RBC (Millions/cmm)	WBC (Thousands/cmm)	Platelets (Thousands/cmm)	HCT (%)
Control(-)	$13.28^{a}\pm0.70$	$4.58^{a}\pm0.49$	$15.06^{a}\pm0.27$	$536.67^{a}\pm1.53$	$37.66^{a}\pm0.70$
Control(+)	$8.45^{d}\pm0.58$	$2.80^{c}\pm0.27$	$6.05^{e}\pm0.76$	$111.67^{e}\pm1.53$	$26.03^{d}\pm1.03$
10% AKP	$9.78^{c}\pm 0.75$	$3.52^{b}\pm0.27$	$10.23^{b}\pm0.68$	$288.33^{b}\pm1.53$	$29.14^{c}\pm1.73$
20% AKP	$10.64^{c}\pm0.58$	$3.72^{b}\pm0.12$	$8.44^{c}\pm 0.60$	$472.67^{c}\pm2.52$	$32.59^{b}\pm1.19$
30% AKP	$11.96^{b}\pm0.77$	$3.84^{b}\pm0.16$	$7.11^{d}\pm 0.26$	$520.33^{d}\pm1.53$	$36.54^{a}\pm0.54$

The values indicate the mean ± SD of three replicates. WBCs: White Blood Cells, RBCs: Red Blood Cells, Hb: Hemoglobin, hematocrit value (HCT) and Apricot Kernel Powder (AKP).

Statistical Analysis of Table 7 (b): Effect of apricot kernel powder on complete blood count of hepatocarcinomic rats induced by potassium bromate. The results showed that normal group had the highest basophil percentage at 0.26 %, indicating normal basophil count. Cancerous group showed a significant decrease in basophil percentage to 0.12 %, reflecting immunosuppression caused by potassium bromate. Groups receiving 10%, 20%, and 30% apricot kernel powder showed dose-dependent increases in basophil percentage, with the 30% group showing a significant improvement at 0.23 %.

And also, the control (-) group had an eosinophil percentage of 0.26 %, indicating a normal level. But the control (+) group showed a slight decrease to 0.18 %, indicating a reduction in eosinophils due to potassium bromate. The 10%, 20%, and 30% apricot kernel powder groups showed slight increases, with the 30% group reaching 0.25 %, indicating a partial recovery.

In the same table the negative group had a lymphocyte percentage of 83.79 %.The positive group exhibited a significant increase in lymphocyte

percentage to 89.29 %, reflecting an altered immune response. Apricot kernel powder groups (10%, 20%, and 30%) showed decreases in lymphocyte percentage, with the 30% group achieving a significant reduction to 82.92 %, indicating a normalization of lymphocyte levels.

On the other hand, the control(-) group had the highest monocyte percentage at 14.30 %. The control(+) group showed a significant decrease in monocyte percentage to 6.27 %.The 10%, 20%, and 30% apricot kernel powder groups showed dose-dependent increases in monocyte percentage, with the 30% group showing a significant recovery to 13.63 %.

Finally, The control(-) group had a neutrophil percentage of 0.26 %. The control(+) group showed a decrease to 0.18 %.The 10%, 20%, and 30% apricot kernel powder groups showed increases in neutrophil percentage, with the 30% group showing a significant recovery to 0.25 %.

The results suggest that the administration of apricot kernel powder has a significant impact on the hematological parameters of hepatocarcinoma rats. The observed increase in basophils, eosinophils, and neutrophils in the treated groups, compared to the control positive group, indicates a potential immunomodulatory effect of apricot kernel powder. This aligns with previous studies suggesting the therapeutic potential of apricot kernels due to their bioactive compounds like amygdalin, which has shown anti-cancer and anti-inflammatory properties. **Ramadan *et al.* (202**0) studied the pharmacological effects of apricot seed extracts and amygdalin in experimentally induced liver damage and hepatocellular carcinoma. **Lu& Wei, (2023)** whose study focuses on how apricot kernel extract influences hematological parameters, showing significant improvements in blood profiles of treated rats, and also **Kim & Lee (2022)** reported that the immune-modulating and hematological effects of apricot kernel powder.

The reduction in lymphocyte levels in the treated groups compared to the control positive group may indicate a normalization of immune function, which could be beneficial in the context of cancer, where lymphocyte levels are often elevated. Additionally, the significant increase in monocyte levels in the 30% apricot kernel group suggests enhanced immune surveillance, which is critical in fighting cancer. The research of **Gao & Zhang (2021)**

highlights the beneficial impact of apricot kernel supplementation on blood parameters and inflammation in cancer models.

These findings are supported by the literature, where apricot kernels have been shown to possess bioactive compounds with potential anticancer properties. For instance, **Singh and Gupta (2017)** highlighted the antioxidant properties of apricot kernels, which can help combat oxidative stress and improve immune function. Furthermore, **Khan and Aslam (2020)** discussed the therapeutic benefits of apricot kernels, emphasizing their bioactive components and mechanisms of action in treating cancer and other diseases.

Table 7 (a&b): Effect of Apricot Kernel Powder on A complete blood count of Hepatocarcinomic Rats Induced by Potassium Bromate

Table 7(B):

Parameters / Groups	Basophils (%)	Esophils (%)	Lymph (%)	Monocyts (%)	T.Nutrophils (%)
Control(-)	$0.26^{a} \pm 0.02$	$0.26^{a} \pm 0.01$	$83.79^{c} \pm 0.26$	$14.300^{a} \pm 0.61$	$0.26^{a} \pm 0.10$
Control(+)	$0.12^{e} \pm 0.007$	$0.18^{b} \pm 0.01$	$89.29^{a} \pm 0.77$	$6.27^{d} \pm 0.64$	$0.18^{d} \pm 0.10$
10% AKP	$0.15^{d} \pm 0.01$	$0.24^{a} \pm 0.05$	$86.27^{b} \pm 0.95$	$8.27^{c} \pm 0.64$	$0.21^{c} \pm 0.015$
20% AKP	$0.19^{c} \pm 0.01$	$0.23^{a} \pm 0.01$	$84.14^{c} \pm 0.96$	$12.30^{b} \pm 1.2$	$0.23^{bc} \pm 0.01$
30% AKP	$0.23^{b} \pm 0.10$	$0.25^{a} \pm 0.01$	$82.92^{c} \pm 0.38$	$13.63^{ab} \pm 0.55$	$0.25^{ab} \pm 0.01$

The values indicate the mean ± SD of three replicates. Apricot Kernel Powder (AKP).

3.8. Effect of apricot kernel powder on human Hepatocarcinoma cells:

Table (8). and Fig. (1). depict the effects of apricot kernel powder. The data presented in the table shows that apricot kernel powder induces apoptosis in human cancer liver cells. Apoptosis is a natural process crucial for tissue homeostasis, regulating cell populations during growth and aging. The findings highlight the significant apoptotic impact of apricot kernel powder on cancer cells. The outcomes of this study align with previous research by **Ramadan *et al*. (2020)**, who reported the hepatoprotective and

anticancer properties of apricot kernel, supporting its traditional use and potential for treating liver conditions such as hepatocarcinoma. Additionally, **Sasane *et al*. (2021)** demonstrated the anti-proliferative and pro-apoptotic effects of apricot kernel extract on human cancer cell lines, indicating its promise as a supplementary cancer treatment. Furthermore, **Siddiqui *et al*. (2023)** found that apricot seeds contain bioactive components like fatty acids, tocopherols, and phenolic compounds with potent antioxidant, anti-cancer, antimicrobial, and anti-inflammatory properties. Studies have shown that compounds extracted from apricot and apricot kernel possess anti-tumor activity against human pancreatic, colon, and liver Cancer cells in laboratory experiments **(Akaberi *et al*., 2024**).

Table (8): LC50 Average lethal concentration for apricot kernel powder that kills half of human liver cancer cells (surviving cells).

Concentration (ug/ml)	Survival fraction of cancer cell HEPG2
0.000	1.000
62.5	0.751
125.00	0.622
250.00	0.474
500.00	0.443
IC50(ug/ml)	**224**

HEPG2 cells are cancer cells from a liver, IC50 is a measure of how much of a drug is needed to kill 50% of these cancer cells.

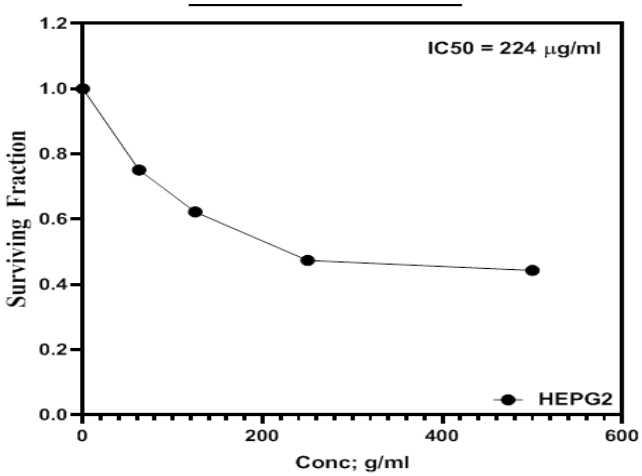

Fig. (1): LC50 Average lethal concentration apricot kernel powder that kills half of human Hepatocarcinoma cells (surviving cells).

4. Conclusion

Recently, many cancer causes have increased, most notably potassium bromate, which is used in the field of the bakery industry as a substance that works to strengthen dough and improve its consistency, which has caused a defect in many vital indicators in laboratory rats. Using apricot kernel powder after processing it, it led to a noticeable improvement, a decrease in cancerous signs and indicators, an improvement in the level of liver enzymes and lipid profiles, and an increase in the immunity of the rats. This proves the maximization of the benefit from fruit and vegetable waste after processing it and using it in safe doses.

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