ABSTRACT

One of the most prevalent chronic liver illnesses, fatty liver is frequently accompanied by other metabolic disorders such as obesity, insulin resistance, hypertension, dyslipidemia, poor fat metabolism, and an elevated risk of cardiovascular disease. Sprouts are a great source of antioxidants, necessary amino acids, and a variety of healthy vitamins and minerals. For this study, 30 albino rats were employed. They were split into 6 groups; the first group served as a negative control group and was fed a standard diet, while the other groups were provided a high-fat diet to induce fatty liver. The remaining rats were divided into four groups and fed 5 and 10% of lentil and pea sprouts for 28 days. One of them was still suffering from fatty liver and was administered a base diet as a positive control group. The chemical build and total phenolic and flavonoid content of pea and lentil sprouts. Additionally, estimates were made for body weight gain (BWG), feed intake (FI), the feed efficiency ratio (FER), kidney and liver functions, blood sugar levels, insulin hormones, and the levels of lipid peroxidation (MDA), and antioxidant enzymes. The findings demonstrated that, in comparison to lentil sprouts, pea sprouts had a greater positive impact on the investigated parameters; the level of 10% was noticeably higher than the value of 5%. Therefore, sprouts of peas and lentils are the most widely prescribed and the most effective agents for improving fatty liver.

Keywords: Sprouts; liver; high-fat; liver enzymes; MDA
INTRODUCTION

Le et al., (2017) showed that the prevalent liver ailment globally is fatty liver disease (FLD). According to epidemiologic research, FLD affects an estimated 25% of the world's population at present, with Latin America and the Middle East having the greatest prevalence rates. Chronic liver disease mortality increased in 2019 and ranked as the 10th leading cause of death globally. It is characterized by an excessive buildup of fat that accounts for more than 5% of the liver's weight in the parenchymal hepatocytes of the liver. Elevated insulin levels are primarily responsible for the improper control of fatty acids and the ensuing steatosis, which can expose the liver to oxidative stress. A number of histological issues, including steatosis, discomfort, necrosis, cirrhosis, tissue damage, and ultimately liver cancer, can be brought on by FLD. High intakes of saturated fatty acids (SFA), trans fatty acids (TFA), simple carbohydrates (CHO), drinks with sugar, and fructose are among the nutritional risk factors for fatty liver. Therefore, changing the way you eat and adopting an active lifestyle are the main steps in weight loss and FLD prevention (Bedossa, 2013; Friedman et al., 2018; Asrani and colleagues, 2019; Huang and others, 2021). The focus is turning to exploring better ways to enhance the functionality of meals as people become more aware of the connection between nutrition and health. Edible seeds that have been sprouted recently have become more and more common in modern diets. There is a growing body of research about the therapeutic benefits of sprouted foods, and the consumption of legume seeds and sprouts is rising since they are regarded as "functional foods" because of their higher nutrient availability and bioactive substances. Sprouting seeds improve seed quality by lowering the amount of anti-nutritive substances while also enhancing resistant starch and digestibility. Sprouts addition-
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nally contain proteins, enzymes, vitamins, and minerals (Abdallah, 2008; Wieca et al., 2015). The bioavailability of substances including B vitamins and vitamin C is facilitated by sprouting, which also regulates phytic acid.

Lentils (Lens culinaris L.) have a benefit over other types of legumes and grains in that it has a very low amount of phytic acid and a high total amount of phenolic substances. In addition to having a large amount of protein, a relatively low-calorie value, and high levels of vital nutrients like fiber, vitamin C, and folate. So, according to Hoover et al. (2003); Thavarajah and others (2011); Magkos and colleagues (2019), this legume is a good source of nutrients, high-quality protein, and amino acids. Isoleucine and lysine are two of the essential amino acids found in lentils, but methionine and cysteine are typically under-represented. If lentils are sprouted before cooking, however, all of the essential amino acids including methionine and cysteine—are present. Sprouting helps break down some of the carbohydrates in lentils that cause intestinal gas in order to prevent gastrointestinal issues, reduce body weight and body fat, and improve antihypertensive function (Xu et al., 2010; Benincasa and work team, 2019).

Peas (Pisum sativum L.), a significant dietary legume, is mostly utilized globally for the production of grains. Peas seeds are a special dual-purpose crop that is rich in both energy and protein and includes a reasonable amount of nutritious protein and a high level of carbohydrate. Since ancient times, germination has been utilized to soften the structure of the kernel, enhancing its nutritional content, lowering anti-nutritional effects, and enhancing the functionality of seed protein. One of the greatest vegetable sources of protein, pea sprouts can deliver the same amount of protein as one-third of an egg. Peas sprouts are a great source of vitamin K, delivering...
66% of the daily value (DV) from a one-cup dose. Pea sprouts are high in antioxidants and carotene, supplying around 35% of the DV of vitamin C and 15% of the DV of provitamin A. It naturally aids diabetic people to maintain a close watch on their blood sugar level and helps the body battle against free radical damages that may induce cancer-related ailments (Cousin, 1997; Kaukovirta-Norja et al., 2004; Abdallah and Abo El-Naga, 2013; Ijarotimi and Keshinro, 2013).

The new study was done to investigate lentils and green pea properties towards fatty liver diseases.

**MATERIAL AND METHODS**

**Materials**

Green peas (*Pisum sativum* L.) and lentils (*Lens Culinaris* L.) were purchased from the community market in Shebin El-Kom City, Menoufia Governorate, Egypt, from Morgan Co. Cairo, Egypt, and received casein, cellulose, choline chloride, and DL-methionine powder.

30 adult normal male albino Sprague Dawley rats were acquired from the Vaccine and Immunity Organization, Ministry of Health, Helwan Farm, Cairo, Egypt, for a total weight of $160 \pm 5$ g. Al-Gomhoria Company for Chemical, Medical, and Instruments, Cairo, Egypt, provided the chemical, kits used for biochemical determination.

**Methods**

*The induction of experimental fatty liver*

A high-fat diet (HFD) containing 20% animal lipid (ghee) was fed to normal, healthy male albino rats for two weeks while also serving as a positive control group in order to induce fatty liver (Xu et al., 2010).

**Perpetration of lentil and green pea sprouts**

To prepare the seeds for sprouting, they were first well-cleaned under running water, dried in the shade, and then soaked for 8 to 12 hours in cool water (1 cup of seeds). Finally, they were thoroughly rinsed and
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drained. Every 8 to 12 hours, rinse and drain with cool water. On day 11, when the majority of the beans have short roots, Sporter was eventually harvested after being housed in a low-light environment. They were then processed into a fine powder using dried in an air oven at 50°C and milled (Shanmugam et al., 2015).

Estimation of the chemical compositions, total flavonoid, total phenols, and antioxidants activity of lentil and pea sprouts

According to A.O.A.C. (2012), moisture, protein, fat, ash, and crude fiber were measured. Total carbohydrates g% = 100-(moisture + protein + fat + ash).

According to Nzikou et al. (2009), the atomic absorption spectrophotometer was used to evaluate the mineral concentration. Using the colorimetric approach created by Klein and Perry (1982), vitamin C was determined. As estimated by the method of Klein and Perry (1982), pro-vitamin A. The aluminum chloride colorimetric method was used to quantify the total amount of flavonoid (Park et al., 1997). The Folin Ciocalteu reagent was used to calculate the total phenols in each of the sprouts under test using the Singleton and Rossi (1965) method. Blois (1958)'s method for measuring the 2,2-diphenyl-1-picrylhydrazyl (DPPH) compound's capacity to scavenge free radicals was used.

Experimental design

The study was carried out in compliance with the Guide for the Care and Use of Laboratory Animals, and approval for the study was granted by the Monofia University, Faculty of Medicine Research Committee (Protocol No: M11-2).

30 adult male white Sprague Dawley strain rats, weighing (160g), for seven days straight, were fed on a casein-based basal diet prepared in accordance with Reeves et al. (1993). Following this period of adaption, rats were split into six groups (5 rats/group), as follows: Rats fed a basic diet served as the negative control.
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group in Group (I). The remaining groups were fed 20% animal ghee for two weeks to induce fatty liver, and they were separated into the following categories: group 2 as a positive control. Rats with fatty livers in groups 3 and 4 were fed powdered lentil sprouts at a rate of 5 and 10% of their basal food weight, respectively. Rats in groups 5 and 6 were given powdered peas sprouts at a rate of 5 and 10% of their basal meal weight, respectively. After the starting period, there was a 28-day experiment period. Every day of the study period, the diet that was consumed was recorded, and every week, body weight was registered. According to Chapman et al. (1959), the BWG, FER, and the weights of several organs were calculated using the following equations:

\[ \text{BWG} = \text{Final weight (g)} - \text{Initial weight (g)} \]

\[ \text{FER} = \frac{\text{Body weight gain (g/day)}}{\text{Feed intake (g/day)}} \]

**Blood sampling**

Initially, blood was drawn from the retro-orbital vein to check for the presence of liver enzymes that could indicate the development of a fatty liver. Each rat was slaughtered at the conclusion of the experiment, and blood samples were taken from the hepatic portal vein after 12 hours of fasting. According to the procedure outlined by Schermer (1967), blood samples were collected into a dry, clean centrifuge glass tube, allowed to clot in a water bath (37°C) for 30 minutes, and then centrifuged for 10 minutes at 4000 rpm to separate the serum. The serum was then carefully aspirated, transferred into a clean Eppendorf tube, and stored frozen in a deep freezer (-20°C) until analysis. The brain and liver were separated, washed, and weighed.

**Biochemical analysis**

Total protein (Tp) (Serum total protein (g/dl) = Serum globulin + Serum albumin), Albumin (Alb), and globulin (Glb) were carried out as stated by Weichsel-Baum, (1964) and Domas and Biggs (1971). Aspartate amino-transaminase (AST), alanine
aminotransferase (ALT), and alkaline phosphatase (ALP) were measured as claimed by Henry (1974), Reitman and Frankel (1957); IFCC (1983) respectively. Urea, uric acid, and creatinine were determined on the report of Patton and Crouch (1977); Baraham and Trinder (1972); Henry (1974). Blood glucose was determined as maintained by Trinder (1969) while, insulin hormones were estimated by Matthews et al., (1985). Serum total cholesterol, triglyceride, and HDL-c were determined according to the method described by Thomas (1992), Young (1975), and Friedewaid (1972). LDL-c and VLDL-c were calculated in mg/dl according to Lee and Nieman (1996) using the following formula:

\[
\text{VLDL-c (mg/dl)} = \frac{\text{Triglycerides}}{5}
\]

\[
\text{LDL-c (mg/dl)} = \text{Total cholesterol} - \text{HDL-c} - \text{VLDL-c}.
\]

Butyrylcholinesterase was determined in serum according to the method of Ellman et al., (1961). Lactate dehydrogenase (LDH) was determined in serum using a test reagent kit according as maintained by Tietz, (1995). Glutathione peroxidase (GPX), superoxide dismutase (SOD), catalase (CAT), glutathione s-transferases (GSTs), and malondialdehyde (MDA) were measured by the method of Zhao (2001); Sun et al. (1988); Diego (2011); Koracevic (2001); Ohkawa and others (1979) respectively.

Statistical analysis:
The mean values of the results are presented along with their standard deviation of the mean. One-way ANOVA and the Duncan post hoc test were used to analyze statistical differences between groups in SPSS version 11.0 for Windows (SPSS, Chicago, IL, USA). Snedecor and Cochran (1980) defined differences as significant when (p<0.05).

RESULTS AND DISCUSSION
Measurements in Table (1) described the nutrient content of powdered lentils and peas sprouts. It is clear to notice that
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Lentils had a higher content of protein, carbohydrates, energy value, potassium, and zinc than their contents in pea sprouts while, pea sprouts had high contents of moisture, fat, ash, fiber, calcium, iron, sodium, vitamin C and vitamin A when compared to the lentil sprouts. According to Ijarotimi and Keshinro (2013), the germination process has been utilized to soften the kernel structure, increase its nutritional value, lessen its anti-nutritional effects, and improve the functionality of seed protein. These findings are consistent with their findings. Due to the sprout's higher concentration of nutritious elements, such as vitamins, minerals, proteins, and enzymes, compared to traditional ones, and the lack of pesticide residues, sprout can be regarded as an organic food and has health benefits (Oates et al., 2014). The carbohydrate content yielded a similar effect, and these findings may be explained by the fact that during germination, seeds of legumes in particular use their stored carbohydrates as an energy source to initiate germination and other processes. Growing sprouts increased ash, low-fat, and carbohydrate levels, and the highest fiber content was noted. Pea sprouts can offer the body a variety of nutrients while being low in calories. On a dry weight basis, sprouts had the highest concentrations of phosphorus, potassium, calcium, magnesium, and iron. According to previous research by Anwar (2016), this resulted from the sprouts' exposure to light throughout the sprouting phase and their ability to absorb nutrients from an open field growing medium. In contrast to other ready-to-eat green leafy vegetables, pea shoots have a higher concentration of potassium and phosphorus, according to Santos et al.'s (2014) report. Several enzyme systems become active during sprouting (germination), which significantly alters the nutritional value of pulses. After sprouting, the level of vitamin C, which was essentially nonexistent in dried legume
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seeds, rose (Saha and Dunkwal, 2009). In contrast to other ready-to-eat green leafy vegetables, pea shoots have a higher amount of vitamins C, E, and A, according to Santos et al. (2014). In addition, Márton et al. (2010) found that the germination process results in a large decrease in Fe with a significant improvement in the availability of Fe. Xu et al. (2019) demonstrated that lentil has the greatest protein content and that total protein values rise after germination. On the other hand, calcium and zinc contents as well as their bioavailability were shown to rise following germination (Luo et al., 2014).

The dried lentil and pea sprouts' total phenol and flavonoid content was displayed in Table 2. In comparison to lentil sprouts, pea sprouts had significantly greater total phenol and total flavonoid concentrations. Pea sprouts had a greater increase in antioxidant activity than lentil sprouts due to their higher total phenol and flavonoid content. The most abundant phenols found in lentils are those with a flavone structure (i.e., monomers, oligomers, and gallate derivatives), with catechin glucoside being the predominant flavanol (Magkos et al., 2019). Lentil sprouts were found to be a good source of phenolic compounds, especially flavonoid derivatives. It is crucial to ascertain whether the benefits of the digesting process, such as antioxidant activity, are reflected in the bioactive chemicals' positive effects. The phenolic composition of food is significantly altered by gastrointestinal digestion, as is well-recognized (Xu and Chang (2010); Pineda-Vadillo et al., 2016). Due to the enrichment of the lentil sprouts with the probiotic, which significantly increased antioxidant activity against 2,2-diphenyl-1-picrylhydrazyl (DPPH), they demonstrated that the lentil sprouts appeared to be a good source of buffer-extractable and potentially bio-accessible antioxidants with multidirectional activity.
According to Santos-Silva et al. (2020), pea sprouts have a higher total phenol and flavonoid content than fruits like pineapple, banana, lychee, and papaya, as well as their by-products, demonstrating their potential as a source of bioactive substances. A higher concentration of simple phenols, such as gallic or syringic acids, which have a stronger ability to scavenge free radicals like the DPPH, found in pea extracts, according to the suggestion of Casas-Forero et al.'s (2020).

The details displayed in Table 3 showed the effects of feeding a high-fat diet to produce fatty liver for 28 days either alone or in combination with tested sprouts (5 and 10%) on BWG, FER, and FI. When compared to the results in the treated groups and the negative control group, feeding on a high-fat diet alone significantly (p 0.05) recorded the greatest value of BWG, FER, and FI.

Both of the tested sprouts showed substantial variations between levels 5 and 10%, and at the same time, pea sprout levels recorded higher values than those of lentil levels, although the differences were not statistically significant. The collected data are in line with the findings of Han et al. (2019), who discovered that the high-fat diet group's body weight was significantly higher than that of the normal control animals. According to Moraes et al. (2009), high-fat diets (HFD) can lead to a number of metabolic changes, including hyperphagia in humans, decreased lipolytic activity in fat tissue, particularly liver tissue, decreased leptin secretion and/or sensitivity, hypothalamic neuron apoptosis, impaired mitochondrial metabolism, insulin resistance, and obesity. Sprouts are a good source of dietary fiber and plant-based protein. They contribute to the daily protein requirement, which results in weight loss, and they aid to increase satiety. Pea sprouts are nutrient-rich sprouts that provide high supplies of a number of minerals, including potassium, magnesium, phosphorus, vitamin B, and an increase in protein (Martins,
According to Khazaei et al. (2019), lentils have a high protein content, a low-calorie value, and high quantities of vital nutrients like folate, vitamin C, fiber, and total phenols, which are associated with reduced body weight, body fat, and antihypertensive function.

The effect of a given fatty diet alone or combined with different levels (5 and 10%) of tested sprouts (lentil and pea) on liver and brain weights is presented in Table (4). Given rats’ fatty diet alone significantly (p ≤ 0.05) increased both organ weights while significantly decreased organ weight when given fatty liver rats combined with tested sprouts. Moreover, no remarkable difference was noticed between the same level of different sprouts and it was significant between the different levels of the same sprouts. Both tested sprouts recorded significant changes with both of the control groups. According to research by Malnick and Knobler (2006), eating a high-fat diet leads to a detrimental deposit of fat in the liver, which can harden scar tissue and increase liver weight. They proposed that eating a high-fat diet is similarly linked to cognitive impairment. The effects of short- and long-term HFD feeding on biochemical and behavioral changes have been shown in a number of preclinical experiments. Sprouts have a high omega-3 fatty acid content, which supports brain function and lowers the risk of heart attack and stroke. Sprouts are rich in calcium and magnesium, which promote the health of the bones and muscles. Magnesium is crucial for the health of the brain and blood vessels. Additionally, sprouts provide higher levels of detoxifying enzymes and liver protection. Low-fat legumes are rich in fiber, vitamins (B and C), and protein, such as pea and lentil sprouts, are good for the health of the liver. Additionally, a subclass of vitamin B vitamins is essential for maintaining brain function (Martins, 2010; Khazaei et al., 2019).
Table 5 summarizes the average values for total protein, albumin, globulin, and albumin/globulin ratio (g/dl) in rats with fatty livers that consumed sprouts of lentils and peas at levels of 5 and 10%. It is evident that the negative control group's mean total protein (TP) (g/dl) level was higher than that of the other test groups. When globulin and the ratio of albumin to globulin were measured, the 10% of examined sprouts did not differ significantly from the negative control group. The mean values for pea sprouts were greater than those for lentil sprouts. Numerous illnesses and ailments, including fatty liver and inflammation or inflammatory disorders, are associated with high blood protein levels. The "A/G ratio," which compares the amounts of albumin and globulin, is used to calculate total serum protein, which represents all the proteins in the blood. Albumin predominates somewhat over globulin in healthy individuals. According to Jang et al. (2012), low levels of albumin and globulin could be an indication of liver issues. Consuming sprouts can increase overall protein levels, which will aid in liver detoxification. Low-fat legumes like pea and lentil sprouts are rich in protein and vitamins (B and C), vitamins, which help to maintain normal liver functions (Martins, 2010; Khazaei et al., 2019).

According to the data in Table (6), rats that were fed a fatty diet to cause fatty livers without receiving therapy had high levels of liver enzymes; however, this rise was not statistically different from the other groups. Additionally, it was shown that consuming the pea and lentil sprouts caused the liver enzymes to drop significantly in relation to the positive control sample. The pea sprout levels had a high effect as compared with the lentil sprouts but there is no significance between the same levels and is significant between different levels. The amount of 10% was the best treatment for liver enzyme values. With increased plasma activity of liver...
enzymes, evaluated high-fat / high-cholesterol diets caused increased liver weight, fat deposition, inflammation, and degeneration (Panchal et al., 2011). To increase the nutritional content of legumes, germination is used. Sprouts are beneficial for the liver because they contain antioxidants and phytochemicals that prevent hepatic steatosis and apoptosis. It improves protein digestibility and changes the dietary fiber fractions in lentils. Additionally, germination increases the concentration of bioactive antioxidant substances, such as melatonin. According to Daz and others (2019) and Khazaei et al. (2019), pea sprouts have a lot of fiber, B vitamins, protein, and low levels of fat, all of which are excellent for liver functions. In Table (7), the impact of sprouts tested at 5% and 10% on several renal function measures in rats with fatty livers is summarized. It was shown that rats with fatty livers suffered from reduced kidney function as well as higher urea, uric acid, and creatinine levels. The levels of these parameters significantly decreased after the addition of the pea and lentil sprouts. The impact of sprouts on the evaluated parameters considerably increased as their concentration increased. Long-term consumption of a high-fat diet (HFD) causes the kidneys to accumulate more lipids. The risk of kidney disease increases as a result of the kidneys having to work faster and filter impurities over the normal level (Panchal et al., 2011). Kidney disease manifests as an abnormality in the levels of urea, uric acid, and creatinine. Sprouts are on the alkaline side, reducing the acidity of the diet and relieving renal stress. Potassium-rich peas and lentil sprouts reduce calcium loss and prevent kidney stones from developing. Additionally, these foods have anti-oxidant properties that guard against kidney cancer (Daz et al., 2019; Khazaei and others 2019).

The information in Table (8) shows how rats with fatty livers were affected by pea and lentil sprouts at 5 and 10% in
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terms of their blood glucose levels (mg/dl) and insulin hormones. The positive control group was found to have significantly higher blood sugar levels and lower insulin levels. The mean value of glucose and insulin hormones improved when rats with fatty livers were fed sprouts, and the effect of 10% sprouts was substantially bigger than that of 5% sprouts. The negative control group and the 10% level of pea sprouts are not statistically different. A meal high in fat can slow down digestion and make it a challenge for insulin to work as it should. A high-fat diet increases fasting glucose levels, increasing hepatic glucose production and leading to the emergence of insulin resistance (Belfort et al., 2005). Sprouts contain a high antioxidant content, including vitamins C and K, are a rich source of dietary fiber, and can help lower blood sugar levels. Pea sprouts are a good substitute for those who have diabetes because they include fiber and protein, which can help to slow digestion and stabilize the body's blood sugar levels. Pea sprouts also have a low GI. In addition, lentil sprouts are rich in phytochemicals. Protein, fiber, B vitamins, iron, potassium, zinc, phosphorus, magnesium, manganese, copper, and phosphorus, these essential elements are also present in sprouted lentils. They help manage blood sugar and enhance the effects of insulin since they are low on the GI, with a GI value ranging from 18 to 52 (Benincasa et al., 2019).

The mean values of the lipid profile (total cholesterol, triglycerides, HDL-c, LDL-c, and VLDL-c (mg/dl) of rats with fatty livers fed on 5 and 10% pea and lentil sprouts are shown in Table (9) for comparison. Rats with fatty livers have higher lipid profile readings than normal rats. When fatty liver rats were fed on the tested amounts of pea and lentil sprouts, the collected data showed a much lower lipid profile and a significantly higher level of HDL-c. There were relationships between the lipid profile
measurements and the quantity of further tested sprouts. Lentil sprouts performed better on lipid fractions than pea sprouts, but there was little variation in amounts amongst the various tested sprout types. Low-density lipoproteins (LDL-c) and triglycerides are elevated in fatty liver, while high-density lipoproteins (HDL-c) are lowered, both of which increase the risk of developing cardiovascular disease (CVD). According to Papandreou et al., (2017), fatty liver disease increases the risk of having high cholesterol and may also be a sign of high triglyceride levels. During the germination process, lentils produce more protein and fiber so rats that received lentil sprouts had considerably higher levels of HDL-c, which helped to reduce their risk of cardiovascular disease (Benincasa et al., 2019). Treatments with peas showed a substantial fall in serum lipid profile with a greater dose; TC and LDL levels did drop, and the HDL level increased with plentiful phenolic compounds, particularly for a large number of polyphenols (Magalhaes et al.2017).

The data in Table (10) demonstrated the inhibition of butyrylcholinesterase and lactate dehydrogenase activity in the serum of rats when compared to the control value by a high-fat meal alone. With the continual increase in the concentration of the examined sprouts mixed with a high-fat meal, the inhabitation of enzyme activity is reduced. The other finding was seen in serum malondialdehyde content (MDA), which showed that levels of examined sprouts significantly reduced their concentration after being added to a high-fat meal alone. On the other the same direction, it was discovered that a high-fat diet paired with the studied sprouts had a beneficial effect on enzyme function. A high-fat diet has the ability to cause fatty liver, which affects the blood serum enzyme cholinesterase and the liver's ability to hydrolyze acetylcholine. In order to transport impulses from
the neuron to the muscle fiber, a substance called acetylcholine is synthesized at the nerve ends (Papandreou et al., 2017). According to research by Feillet et al., (2009), the consumption of pea sprouts suppressed MDA and prevented the activity of enzymes involved in the glucose metabolic pathway, such as hexokinase and LDH, from increasing.

As indicated in Table (11), fatty liver rats that received no therapy had lower serum levels of glutathione-S-transferase and glutathione peroxidase activity. Feeding a high-fat meal with lentil and pea sprouts at levels 5 and 10 was found to have a positive impact on serum glutathione-S-transferase and serum glutathione peroxidase, though the activity has remained lower than the control value. Lentil and pea sprouts can be added to the diet to protect the liver tissues, and a higher dosage of the tested sprouts can restore them to normal levels. Reactive oxygen species (ROS) may be produced as a result of a high-fat diet (Wang et al., 2015). In vivo, antioxidant enzyme defense mechanisms were used to control ROS. Sprouting can improve the lipid oxidation caused by HFD and can dramatically increase the activity of the key antioxidant enzymes in the serum of rats with fatty livers. These results mirrored those of Feillet et al. (2009). Rats with fatty livers have higher levels of oxidative stress, according to Patel et al. (2007). As indications of oxidative stress, the serum's GSHPx, CAT, and SOD activity were examined. The liver's antioxidant state can be improved by consuming lentil and pea sprouts on a daily basis, as demonstrated by the elevated levels of GSH-Px, CAT, and glutathione-S-transferase.

CONCLUSION

The buildup of fat in the liver is a frequent disorder known as "fatty liver," which can lead to liver damage. Sprouts supply great essential vitamins, minerals, fiber, and source antioxidants, they
improved the digestion of carbohydrates, proteins, and aid in gut health, and reduce intestinal gas. The study concluded that pea and lentil sprouts could improve the liver enzymes, renal functions, lipid profile, and oxidative stress indicators of fatty liver rats as compared to the positive control group.

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Xu ZJ; Fan JG; Ding XD; Qiao L and Wang GL (2010):

Young D (1975):

Zhao Y (2001):
Table (1): Nutrient contents per 100g of pea and lentil sprouts powder

<table>
<thead>
<tr>
<th>Constituents</th>
<th>Pea sprouts</th>
<th>Lentil sprouts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture (g)</td>
<td>10.09±2.34</td>
<td>9.34±0.34</td>
</tr>
<tr>
<td>Protein (g)</td>
<td>25.77±4.23</td>
<td>27.71±3.57</td>
</tr>
<tr>
<td>Fat (g)</td>
<td>3.91±0.26</td>
<td>0.64±0.02</td>
</tr>
<tr>
<td>Ash (g)</td>
<td>6.95±0.94</td>
<td>2.68±0.44</td>
</tr>
<tr>
<td>Fiber (g)</td>
<td>7.86±0.63</td>
<td>5.27±0.31</td>
</tr>
<tr>
<td>Carbohydrates (g)</td>
<td>45.42±3.96</td>
<td>54.64±7.92</td>
</tr>
<tr>
<td>Energy value (Kcal/100 g)</td>
<td>319.95±9.34</td>
<td>335.16±10.82</td>
</tr>
<tr>
<td>Calcium (Ca) (mg)</td>
<td>150.56±6.75</td>
<td>21.98±6.01</td>
</tr>
<tr>
<td>Iron (Fe) (mg)</td>
<td>3.76±0.54</td>
<td>2.34±0.34</td>
</tr>
<tr>
<td>Potassium (K) (mg)</td>
<td>234.56±10.43</td>
<td>244.76±11.05</td>
</tr>
<tr>
<td>Sodium (Na) (mg)</td>
<td>19.78±1.23</td>
<td>8.5±1.22</td>
</tr>
<tr>
<td>Zinc (Zn) (mg)</td>
<td>1.11±0.08</td>
<td>1.23±0.54</td>
</tr>
<tr>
<td>Vitamin C (mg)</td>
<td>30.85±3.42</td>
<td>23.54±1.44</td>
</tr>
<tr>
<td>Provitamin A (mcg)</td>
<td>178.54±9.76</td>
<td>19.78±2.41</td>
</tr>
</tbody>
</table>

Values are means ± SD (n = 3). Values bearing superscripts at the same row are significantly different at p ≤ 0.05.

Table (2): Total phenolic, flavonoid contents and antioxidant activity (DPPH) of pea and lentil sprouts powder

<table>
<thead>
<tr>
<th>Content</th>
<th>Lentil sprouts</th>
<th>Pea sprouts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total phenols (mg/kg)</td>
<td>107.5±13.05</td>
<td>646.88±14.16</td>
</tr>
<tr>
<td>Total flavonoid (mg/kg)</td>
<td>45.9±6.93</td>
<td>83.9±4.23</td>
</tr>
<tr>
<td>Antioxidant activity DPPH</td>
<td>38.92±8.45</td>
<td>74.58±5.99</td>
</tr>
</tbody>
</table>

Values are means ± SD (n = 3). Values bearing superscripts at the same row are significantly different at p ≤ 0.05.
Table (3): Body weight gain, feed efficiency ratio, and feed intake of fatty liver rats were affected by 5 and 10 % from lentil and pea sprouts (Mean ± SD).

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Negative control</th>
<th>Positive control</th>
<th>Fatty liver rats with 5% lentil sprouts</th>
<th>Fatty liver rats with 10% lentil sprouts</th>
<th>Fatty liver rats with 5% pea sprouts</th>
<th>Fatty liver rats with 10% pea sprouts</th>
<th>LSD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body weight gain (BWG) /28d</td>
<td>35.24±3.11</td>
<td>60.18±4.21</td>
<td>52.21±3.43</td>
<td>42.40±4.34</td>
<td>50.18±6.29</td>
<td>40.08±8.77</td>
<td>7.34</td>
</tr>
<tr>
<td>Feed intake/day</td>
<td>13.22±2.33</td>
<td>19.12±3.21</td>
<td>18.15±2.39</td>
<td>15.90±4.16</td>
<td>17.80±2.74</td>
<td>15.01±2.98</td>
<td>0.96</td>
</tr>
<tr>
<td>Feed efficiency ratio (FER)</td>
<td>0.095±0.00</td>
<td>0.112±0.04</td>
<td>0.103±0.01</td>
<td>0.095±0.03</td>
<td>0.101±0.02</td>
<td>0.095±0.06</td>
<td>0.002</td>
</tr>
</tbody>
</table>

Values are means ± SD (n = 6). Values bearing superscripts at the same row are significantly different at p ≤ 0.05.

Table (4): Liver and brain weights of fatty liver rats were affected by 5 and 10 % from lentil and pea sprouts (Mean ± SD).

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Negative control</th>
<th>Positive control</th>
<th>Fatty liver rats with 5% lentil sprouts</th>
<th>Fatty liver rats with 10% lentil sprouts</th>
<th>Fatty liver rats with 5% pea sprouts</th>
<th>Fatty liver rats with 10% pea sprouts</th>
<th>LSD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brain (g)</td>
<td>0.73±0.00</td>
<td>1.09±0.17</td>
<td>0.99±0.048</td>
<td>0.89±0.02</td>
<td>0.95±0.08</td>
<td>0.83±0.07</td>
<td>0.07</td>
</tr>
<tr>
<td>Liver(g)</td>
<td>4.96±0.71</td>
<td>6.87±0.58</td>
<td>6.12±0.42</td>
<td>5.44±0.52</td>
<td>6.07±0.32</td>
<td>5.11±0.72</td>
<td>0.62</td>
</tr>
</tbody>
</table>

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Table (5): Total protein, albumin, globulin, and albumin/globulin ratio of fatty liver rats were affected by 5 and 10 % from lentil and pea sprouts (Mean ± SD).

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Negative control</th>
<th>Positive control</th>
<th>Fatty liver rats with 5% lentil sprouts</th>
<th>Fatty liver rats with 10% lentil sprouts</th>
<th>Fatty liver rats with 5% pea sprouts</th>
<th>Fatty liver rats with 10% pea sprouts</th>
<th>LSD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total protein (g/dl)</td>
<td>8.50 ±0.06</td>
<td>5.27 ±0.06</td>
<td>6.32 ±0.04</td>
<td>7.47 ±0.05</td>
<td>7.07 ±0.06</td>
<td>8.02 ±0.06</td>
<td>0.40</td>
</tr>
<tr>
<td>Albumin (g/dl)</td>
<td>5.29 ±0.43</td>
<td>3.70 ±0.16</td>
<td>4.11 ±0.26</td>
<td>4.60 ±0.15</td>
<td>4.45 ±0.26</td>
<td>4.93 ±0.15</td>
<td>0.28</td>
</tr>
<tr>
<td>Globulin (g/dl)</td>
<td>3.21 ±0.55</td>
<td>1.57 ±0.12</td>
<td>2.21 ±0.31</td>
<td>2.87 ±0.05</td>
<td>2.62 ±0.66</td>
<td>3.09 ±0.49</td>
<td>0.45</td>
</tr>
<tr>
<td>Albumin/globulin</td>
<td>1.65 ±0.12</td>
<td>2.36 ±0.12</td>
<td>1.86 ±0.12</td>
<td>1.60 ±0.12</td>
<td>1.70 ±0.12</td>
<td>1.60 ±0.12</td>
<td>0.17</td>
</tr>
</tbody>
</table>

Values are means ± SD (n = 6). Values bearing superscripts at the same row are significantly different at p ≤ 0.05.

Table (6): Liver enzymes of fatty liver rats were affected by 5 and 10 % from lentil and pea sprouts (Mean ± SD).

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Negative control</th>
<th>Positive control</th>
<th>Fatty liver rats with 5% lentil sprouts</th>
<th>Fatty liver rats with 10% lentil sprouts</th>
<th>Fatty liver rats with 5% pea sprouts</th>
<th>Fatty liver rats with 10% pea sprouts</th>
<th>LSD</th>
</tr>
</thead>
<tbody>
<tr>
<td>AST (U/L)</td>
<td>37.76 ±2.23</td>
<td>77.32 ±4.97</td>
<td>67.76 ±3.33</td>
<td>56.31 ±2.84</td>
<td>62.19 ±4.31</td>
<td>53.89 ±4.17</td>
<td>5.99</td>
</tr>
<tr>
<td>ALT (U/L)</td>
<td>35.89 ±4.12</td>
<td>64.10 ±5.49</td>
<td>58.90 ±1.5</td>
<td>49.05 ±1.78</td>
<td>54.95 ±2.03</td>
<td>48.04 ±3.04</td>
<td>6.21</td>
</tr>
<tr>
<td>AST/ALT</td>
<td>1.05 ±0.01</td>
<td>1.21 ±0.01</td>
<td>1.15 ±0.01</td>
<td>1.14 ±0.01</td>
<td>1.13 ±0.01</td>
<td>1.12 ±0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>ALP (U/L)</td>
<td>184.11 ±4.12</td>
<td>226.77 ±3.09</td>
<td>219.43 ±3.45</td>
<td>206.06 ±4.20</td>
<td>214.39 ±2.37</td>
<td>199.19 ±4.80</td>
<td>6.54</td>
</tr>
</tbody>
</table>

Values are means ± SD (n = 6). Values bearing superscripts at the same row are significantly different at p ≤ 0.05.
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Table (7): Renal functions of fatty liver rats were affected by 5 and 10 % from lentil and pea sprouts (Mean ± SD).

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Negative control</th>
<th>Positive control</th>
<th>Fatty liver rats with 5% lentil sprouts</th>
<th>Fatty liver rats with 10% lentil sprouts</th>
<th>Fatty liver rats with 5% pea sprouts</th>
<th>Fatty liver rats with 10% pea sprouts</th>
<th>LSD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uric acid (mg/dl)</td>
<td>3.69±0.12</td>
<td>5.50±0.58</td>
<td>4.90±0.74</td>
<td>4.19±0.03</td>
<td>4.74±0.34</td>
<td>4.03±0.78</td>
<td>0.34</td>
</tr>
<tr>
<td>Urea (mg/dl)</td>
<td>25.61±2.43</td>
<td>44.23±2.42</td>
<td>38.42±2.12</td>
<td>32.04±1.00</td>
<td>38.01±2.05</td>
<td>31.01±1.07</td>
<td>3.22</td>
</tr>
<tr>
<td>Creatinine (mg/dl)</td>
<td>0.64±0.02</td>
<td>1.30±0.13</td>
<td>1.19±0.14</td>
<td>0.98±0.05</td>
<td>1.11±0.04</td>
<td>0.91±0.25</td>
<td>0.09</td>
</tr>
</tbody>
</table>

Values are means ± SD (n = 6). Values bearing superscripts at the same row are significantly different at p ≤ 0.05.

Table (8): Blood glucose and insulin hormone of fatty liver rats were affected by 5 and 10 % from lentil and pea sprouts (Mean ± SD).

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Negative control</th>
<th>Positive control</th>
<th>Fatty liver rats with 5% lentil sprouts</th>
<th>Fatty liver rats with 10% lentil sprouts</th>
<th>Fatty liver rats with 5% pea sprouts</th>
<th>Fatty liver rats with 10% pea sprouts</th>
<th>LSD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blood glucose (mg/dl)</td>
<td>80.00±2.00</td>
<td>137.00±2.00</td>
<td>115.00±2.00</td>
<td>89.20±2.00</td>
<td>107.00±2.00</td>
<td>82.01±2.00</td>
<td>6.63</td>
</tr>
<tr>
<td>Insulin hormones (IU/ml)</td>
<td>19.03±2.00</td>
<td>7.11±2.00</td>
<td>13.22±2.00</td>
<td>17.27±2.00</td>
<td>14.21±2.00</td>
<td>18.53±2.00</td>
<td>1.01</td>
</tr>
</tbody>
</table>

Values are means ± SD (n = 6). Values bearing superscripts at the same row are significantly different at p ≤ 0.05.
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Table (9): The serum lipid profile of fatty liver rats was affected by 5 and 10 % from lentil and pea sprouts (Mean ± SD).

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Negative control</th>
<th>Positive control</th>
<th>Fatty liver rats with 5% lentil sprouts</th>
<th>Fatty liver rats with 10% lentil sprouts</th>
<th>Fatty liver rats with 5% pea sprouts</th>
<th>Fatty liver rats with 10% pea sprouts</th>
<th>LSD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total cholesterol (mg/dl)</td>
<td>118.56±2.54</td>
<td>214.33±1.09</td>
<td>204.45±1.17</td>
<td>195.87±2.59</td>
<td>200.12±1.38</td>
<td>189.54±2.11</td>
<td>7.88</td>
</tr>
<tr>
<td>Triglycerides (mg/dl)</td>
<td>115.23±2.58</td>
<td>177.54±1.05</td>
<td>170.09±2.83</td>
<td>161.67±3.06</td>
<td>167.43±4.61</td>
<td>158.54±4.29</td>
<td>5.34</td>
</tr>
<tr>
<td>HDL-c (mg/dl)</td>
<td>55.11±2.00</td>
<td>40.61±1.00</td>
<td>45.69±1.00</td>
<td>50.06±2.00</td>
<td>48.03±1.00</td>
<td>53.44±2.00</td>
<td>2.21</td>
</tr>
<tr>
<td>VLDL-c (mg/dl)</td>
<td>23.05±0.46</td>
<td>35.51±0.28</td>
<td>34.02±0.86</td>
<td>32.33±0.43</td>
<td>33.49±2.04</td>
<td>31.71±1.92</td>
<td>1.86</td>
</tr>
<tr>
<td>LDL-c (mg/dl)</td>
<td>40.40±0.49</td>
<td>138.21±5.99</td>
<td>124.74±2.45</td>
<td>113.48±3.31</td>
<td>118.6±4.38</td>
<td>104.39±3.56</td>
<td>9.32</td>
</tr>
</tbody>
</table>

Values are means ± SD (n = 6). Values bearing superscripts at the same row are significantly different at p ≤ 0.05.

Table (10): Butyrylcholinesterase; lactate dehydrogenase activity and malondialdehyde of fatty liver rats were affected by 5 and 10 % from lentil and pea sprouts (Mean ± SD).

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Negative control</th>
<th>Positive control</th>
<th>Fatty liver rats with 5% lentil sprouts</th>
<th>Fatty liver rats with 10% lentil sprouts</th>
<th>Fatty liver rats with 5% pea sprouts</th>
<th>Fatty liver rats with 10% pea sprouts</th>
<th>LSD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Butyryl Cholinesterase U/mL</td>
<td>18.45±1.09</td>
<td>8.93±0.43</td>
<td>11.73±1.54</td>
<td>14.53±3.43</td>
<td>12.53±2.69</td>
<td>16.32±1.09</td>
<td>1.34</td>
</tr>
<tr>
<td>Lactate dehydrogenase (IU/L)</td>
<td>107.54±5.76</td>
<td>197.43±5.85</td>
<td>177.08±7.07</td>
<td>152.43±7.57</td>
<td>165.54±8.44</td>
<td>139.43±5.85</td>
<td>8.67</td>
</tr>
<tr>
<td>Malondialdehyde (µmol)</td>
<td>0.93±1.170</td>
<td>9.33±1.170</td>
<td>7.34±0.93</td>
<td>5.16±0.08</td>
<td>6.26±0.08</td>
<td>4.05±1.170</td>
<td>1.07</td>
</tr>
</tbody>
</table>

Values are means ± SD (n = 6). Values bearing superscripts at the same row are significantly different at p ≤ 0.05.
Table (11): Serum glutathione-S-transferase, glutathione peroxidase, superoxide dismutase, and catalase of fatty liver rats were affected by 5 and 10% from lentil and pea sprouts (Mean ± SD).

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Negative control</th>
<th>Positive control</th>
<th>Fatty liver rats with 5% lentil sprouts</th>
<th>Fatty liver rats with 10% lentil sprouts</th>
<th>Fatty liver rats with 5% pea sprouts</th>
<th>Fatty liver rats with 10% pea sprouts</th>
<th>LSD</th>
</tr>
</thead>
<tbody>
<tr>
<td>glutathion-S-transferase (U/L)</td>
<td>112.67 ±3.88</td>
<td>60.36 ±3.49</td>
<td>73.38±7.26</td>
<td>84.68 ±8.31</td>
<td>81.81±4.93</td>
<td>94.81±4.93</td>
<td>6.47</td>
</tr>
<tr>
<td>Glutathion peroxysdase (U/ml)</td>
<td>1.19 ±0.65</td>
<td>0.77±0.07</td>
<td>0.82±0.01</td>
<td>0.97±0.11</td>
<td>0.90±0.33</td>
<td>1.01±0.14</td>
<td>0.08</td>
</tr>
<tr>
<td>Superoxide dismutase (U/ml)</td>
<td>109.50 ±1.33</td>
<td>81.65±2.13</td>
<td>89.65±5.72</td>
<td>97.67±3.98</td>
<td>94.65±5.05</td>
<td>104.65±5.05</td>
<td>6.98</td>
</tr>
<tr>
<td>Catalase (U/ml)</td>
<td>157.87 ±6.82</td>
<td>101.93±7.58</td>
<td>110.62±8.66</td>
<td>120.05±6.94</td>
<td>115.85±9.36</td>
<td>128.85±9.36</td>
<td>7.82</td>
</tr>
</tbody>
</table>

Values are means ± SD (n = 6). Values bearing superscripts at the same row are significantly different at p ≤ 0.05.
Biological and Biochemical Effect of Green Peas and Lentils Sprouts on Rats with Fatty Liver

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