



## Fatty acid metabolism in colon cancer patients

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This study was conducted on patients with colon cancer. The study included 60 people with colon cancer (men and women) and 60 healthy people without any apparent disease. The patients were diagnosed by specialized doctors and the collection period was between September to December 2022. Blood serum was isolated from blood samples collected from both patients and healthy people (the latter being the control group) and then divided into several parts. Several biochemical variables were also measured in the blood serum in the second part, where the levels of total cholesterol (TC), triglycerides (TG), and high-density lipoprotein cholesterol (HDL-C) were measured via the enzymatic method and using a dry kit (Kit). Patients with colon cancer had higher levels of low-density lipoprotein cholesterol (LDL-C), very low-density lipoprotein cholesterol (VLDL-C) compared to the control. For the third part of the blood serum, the serum lipids were extracted using organic solvents and separated from each other using thin layer chromatography (TLC). The percentage of saturated and polyunsaturated fatty acids (mono and poly) was determined via gas chromatography (CGC) for the three fractions of blood serum (CE, TG, and PL) after fatty acid re-esterification. It was observed that there were differences between the percentages of fatty acids of various types in the patient and the control groups, and in the different parts of the blood serum lipids; this indicates the effect of fatty acids in the development of colon cancer, including risk factors for cardiovascular disease through the differences and imbalance that occurs in the percentage, especially for polyunsaturated fatty acids (PUFA).

**Keywords:** colon cancer; fatty acids; cholesterol; phospholipids; polyunsaturated fatty acids.

### Introduction

Colon cancer is one of the forms of cancer that begin in the colon (large intestine), which is the final part of the human digestive system. This type of cancer is common in the elderly, though with the possibility of infection in any age group. The first stage in the formation of colon cancer is the presence of small clusters of cells, which are considered at a specific stage to be benign, harmless tumors and are present inside the colon, then, after a period of time, these clusters develop to form small fleshy growths and can cause some minor symptoms. Therefore, a number of periodic examinations must be conducted for those who suffer from these symptoms in the colon. This helps prevent the development of colon cancer in patients by locating such polyps and removing them before they turn into malignant tumors (cancer). There are several methods of prevention and treatment, the most important of which are surgical methods, after pharmacological methods or the use of chemical radiotherapy, where chemotherapy and immunotherapy are the most important types of treatment. Colon cancer is sometimes called colorectal cancer. This type of cancer begins in the rectum and then spreads to other areas (Ferlay et al., 2008; Aoki & Narumiya, 2017).

The major causes of the occurrence of cancer are complex, but include two main types, one genetic and the other environmental; the available evidence indicates a significant association between lifestyle and the occurrence of certain cancerous tumors, especially with the increased intake of fats, especially polyunsaturated fatty acids (PUFA) (Adams et al., 2018). Studies also indicate that there is a direct relationship between an increased risk of colon cancer with an increased intake of fats, especially unsaturated fats, with the intake of arachidonic ( $n_6$ ) and linoleic ( $n_6$ ) acid; by contrast, fatty acids of the type ( $n_3$ ) reduce the risk of cancer (Qian et al., 2022), where studies have indicated a significant relationship between the nutritional role of polyunsaturated fatty acids and the active biological lipid receptors, namely the eicosonoid compounds, which include prostaglandins and thromboxin. Eicosonoids are also involved in metabolic, physiological, and pathological processes such as anti-inflammation and pain, and increased immunity, where the effects are identified by measuring the level of fatty acids in

the blood serum or platelets, red blood cells, adipose tissue, and a specific number of body parts. The process of analyzing fatty tissue helps to give an idea of fatty acid intake. Studies confirm a close correlation between the level of fatty acids in fatty tissues and the incidence of cancer, as high concentrations of unsaturated fatty acids ( $n_3$ ,  $n_6$ ) such as EPA 20:5 and DHA 22:6 are a good indicator of a low risk factor for colon cancer, as the main storage location for such is in the abdominal area and not under the skin (Wang et al., 2020). The symptoms of colon cancer are important signs of the disease, the most significant of which are the occurrence of continuous changes in bowel movements, if the individual begins to suffer from diarrhea or becomes constipated, as well as a change in the shape and consistency of the stool, or in some cases bleeding may occur in the rectum; gases are also considered one of the symptoms. Symptoms also include the occurrence of pain, as well as the feeling that the intestine does not completely empty, as well as unwarranted weight loss and the occurrence of fatigue and exhaustion. In some cases, it should be noted that the symptoms do not appear except in the late and advanced stages of the disease, and according to the location and size of the tumor inside the large intestine (Komprat et al., 2017).

The so-called essential fatty acids are divided into two groups: omega fatty acids, and cancer fatty acids. One of the functions of fatty acids is to manufacture prostaglandins, which are hormone-like substances that are produced and used by all cells. Once manufactured, these substances regulate the work of all body functions, including the functions of the immune system, the circulatory system, the reproductive system, and the nervous system. Essential fatty acids are also part of the structure of the cell membrane, and therefore protect cells from penetration by toxins, bacteria, viruses, and substances that can cause cancer. Thus, researchers have noted the link between an imbalance of essential fatty acids and the spread of chronic diseases in the body, such as cancer, heart and immune disorders, as well as allergic diseases and arthritis. We find fatty acids in fish such as tuna, sardines, mackerel, and salmon, as well as in eggs, bread, green vegetables, flax seeds, canola oil, sunflower oil, and walnuts. A recent study discussed the close relationship between eating omega-3 fatty acids and a reduced risk of de-

veloping colon cancer; this study, which was published in the British newspapers, indicated that people with colon cancer saw their chances of dying reduced by 70% with the introduction of omega-3 fatty acids into their diet. We find these acids, in particular, in sardines and mackerel. According to scientists, omega-3 fatty acids can suppress tumor growth and cut off the blood supply to cancer cells. They note that eating fatty fish once or twice a week can reduce the risk of dying from colon cancer, and can also be a healthy alternative to red and processed meat, which are associated with an increased incidence of cancer (Hardman, 2002; Bollu et al., 2015; D'Eliseo et al., 2016).

## Materials and methods

**Subjects and blood sampling.** The study dealt with two groups of people, the first group consisting of 60 men with colon cancer whose ages ranged between 40–60 years, and who had been hospitalized in the Oncology and Atomic Medicine Hospital in the city of Mosul, Nineveh Governorate, and were undergoing chemotherapy. Samples were taken after gaining the approval of the patients and the hospital administration. The second group included 60 healthy men who did not have any apparent disease as a control group, where blood was drawn from the vein area and the blood serum was separated by centrifuge. The serum was then divided into two parts: the first part was used to measure the different biochemical variables that have relationships with lipid metabolism of different types in blood serum, while the second part was preserved for analysis of fatty acids.

**Lipid analysis.** The blood serum parts were separated using thin layer chromatography through the use of a special vessel for the technique, in addition to a silica gel plate with dimensions of 20×20 cm, through the use of a mobile phase consisting of hexane: ether: formic acid (80:20:2 mix) on which the blood serum spot is placed. After separating the proteins using an ethanol: methanol mix from the starting line of the plate, and the process of passing the mobile phase inside the container for 45 minutes to the end line, the fat spots are then marked using a dye (2',7'-dichlorofluorescein) (Buckley et al., 2017). The spots are then scraped, and the re-esterification of the fatty acids in the blood serum parts is performed using the BF<sub>3</sub>/methanol method; the percentage of fatty acids in the separated parts is then measured using a capillary gas chromatography device (Shimadzu, type 2014) (Calviello et al., 2007; Bueno et al., 2019).

## Results

According to the findings of the present study, the patients with colon cancer had significantly higher serum levels of total cholesterol (TC), triglycerides (TG), LDL-c than those in the control group. However, it was shown that patients with colon cancer had similar levels of high-density lipoprotein cholesterol (HDL-C) to those in the control group.

**Table 1**  
Lipid profile for control and patients

Parameters	Control (n = 60)	Case (n = 60)	P
TC, mmol/L	3.38 ± 0.62	6.50 ± 0.32	0.001
TG, mmol/L	2.00 ± 0.12	3.32 ± 0.55	0.001
HDL-C, mmol/L	1.89 ± 0.14	1.86 ± 0.23	0.230
LDL-C, mmol/L	2.98 ± 0.21	4.87 ± 0.54	0.001

The studies also showed an increase in the level of monounsaturated fatty acids (MUFA) and a significant decrease in the level of polyunsaturated fatty acids (PUFA) in this part of the blood serum when comparing colon cancer patients with the control group (Table 2). In addition, the results in this study indicated that there was an increase in the percentage of SFA in the phospholipid part of the blood serum in colon cancer patients compared to the control group (Table 2). The results of this study also indicated a considerable decrease in the level of polyunsaturated fatty acids (PUFA) in this part of the blood serum when comparing the colon cancer patients with the control group (Table 2). The results of this study indicated a significant increase in the level of monounsaturated fatty acids (MUFA) in this part of the blood serum when comparing the hypothyroid group to the control group (Table 2).

The results of this study also indicated that there was a significant increase in the percentage of saturated fatty acids (SFA) in the triglyceride fraction of the blood serum in colon cancer patients compared to the control group (Table 2). The results also indicated a decrease in the proportion of monounsaturated fatty acids (MUFA) and polyunsaturated fatty acids (PUFA) in this part in the blood serum when comparing colon cancer patients with the control group (Table 2). The results indicated a significant increase in the percentage of saturated fatty acids (SFA) in the ester cholesterol fraction of serum in colon cancer patients compared to the control group (Table 2).

**Table 2**  
Percentage of fatty acid in the TG part for the control and patients

Fatty acid	Control (n = 20)	Case (n = 20)	P
C11:0	7.65 ± 13.94	0.25 ± 19.98	0.164
C16:0	2.29 ± 4.84	1.11 ± 4.00	0.531
C17:0	1.50 ± 3.11	0.35 ± 3.67	0.499
C18:0	1.55 ± 5.04	2.19 ± 11.46	0.001
C23:0	1.81 ± 3.69	2.12 ± 7.24	0.030
Total	14.83 ± 30.59	6.04 ± 36.41	1.225
C18:1 Trans	0.31 ± 1.33	0.02 ± 1.33	0.710
C18:1 cis	0.85 ± 3.05	1.39 ± 6.15	0.004
C20:1	2.33 ± 5.07	0.23 ± 8.50	0.023
Total	3.42 ± 9.42	1.64 ± 10.58	1.015
C18:3	0.67 ± 2.47	0.53 ± 3.96	0.009
C18:2	0.80 ± 2.26	0.11 ± 3.10	0.226
Total	3.13 ± 4.73	0.34 ± 7.06	0.235

**Table 3**  
Percentage of fatty acid in the CE part for the control and patients

Fatty acid	Control (n = 20)	Case (n = 20)	P
C11:0	1.8 ± 7.4	5.5 ± 21.4	0.003
C16:0	2.4 ± 5.1	0.2 ± 7.4	0.868
C17:0	0.3 ± 3.6	0.2 ± 4.9	0.001
C18:0	3.0 ± 8.0	1.1 ± 9.4	0.408
C23:0	1.1 ± 3.1	1.3 ± 6.3	0.013
Total	8.6 ± 27.2	8.3 ± 49.4	1.294
C18:1 Trans	0.4 ± 1.6	0.1 ± 1.6	0.943
C18:1 cis	0.2 ± 2.6	1.8 ± 7.9	0.001
C20:1	1.7 ± 5.1	0.1 ± 7.19	0.058
Total	2.3 ± 9.3	2.0 ± 16.7	1.002
C18:2	0.7 ± 2.6	0.4 ± 4.4	0.006
C18:3	0.2 ± 3.7	1.1 ± 6.3	0.004
Total	0.9 ± 6.3	1.5 ± 10.7	0.010

## Discussion

The findings of the present study confirmed that the patients with colon cancer had significantly higher serum levels of TC than those in the control group. This may be attributed to the low concentrations of thyroid hormones, reducing the manufacture of thyroid function. Cholesterol at the same time it is destroyed, but the rate of its demolition is slower than the rate of its manufacture, which leads to its accumulation and increase in its levels in the blood serum (Rizos et al., 2022), accompanied by a lack of cholesterol oxidation due to the lack of formation and secretion of bile acids in patients with colon cancer (Carracedo et al., 2012). Recent studies have addressed a relationship between cholesterol concentration and intestinal absorption (Alobeady & Jasim, 2021) as the actual amount absorbed in the intestine is normal but may sometime increase due to lack of bowel movement, which provides more time for the absorption process and thus leads to an increase in cholesterol concentrations in the blood serum (Chapkin et al., 2007). These results are in agreement with previous studies (Chen & Tseng, 2005; Chapkin et al., 2007; Chen et al., 2018).

According to the study's findings, patients with colon cancer had significantly higher levels of triglycerides (TG) than those in the control group (Table 1).

The study's findings support the findings of other researchers (Comerford et al., 2014; Choi et al., 2019). However, it was shown that patients with colon cancer had similar levels of high-density lipoprotein cholesterol (HDL-C) to those in the control group, as reported in Table 1, which may be due to the decreased activity of the lipoprotein

lipase enzyme (Cox et al., 2002). In addition to the above, it was found that the concentrations of high-density lipoprotein cholesterol are variable in hypothyroid patients, results which are supported by the current literature (Cruz et al., 2020; Patel et al., 2022). Regarding the level of low-density lipoprotein cholesterol (LDL-C) for patients with colon cancer compared with the control group (Table 1), the reason for this may be attributed to its low rate of clearance. The mechanism responsible for this could be due to the lack or absence of Apo B receptors –100, which indicates a decreased intake of LDL-cholesterol by the liver and consequently an increase in its concentration in the blood (Currie et al., 2013). It was also observed that an increase in LDL-cholesterol was associated with an increase in very low-density lipoprotein cholesterol (VLDL-C) (Das, 2006; D’Eliseo & Velotti, 2016), which is consistent with the results obtained in the current study, where an increase in the concentrations of both very low density lipoprotein cholesterol and VLDL-C was observed. The results in this study also indicated a significant increase in the level of VLDL-C for patients with colon cancer compared to the control group.

This may be attributed to the rise in the levels of triglycerides resulting from the weak activity of the lipoprotein lipase enzyme. These results are consistent with the literature (Diakos et al., 2014; Davis et al., 2017), as are the results of the current study in general (Dinu et al., 2014; Drew et al., 2016).

The percentage of fatty acids was measured using capillary gas chromatography (CGC) by comparing the results with a sample consisting of 18 standard fatty acids. The results indicated a significant increase in the percentage of saturated fatty acids (SFA) in the ester cholesterol fraction of serum in colon cancer patients compared to the control group, as shown in Table 2. This may be due to colon cancer (Didenko et al., 2022).

An imbalance and deficiency in cholesterol metabolism leads to an increase in the level of total cholesterol in the blood serum, because thyroid hormones are an integral part of the lipid balance processes in the liver, which is the main site for the metabolism of cholesterol and other fats (Alsawaf et al., 2021). This imbalance is reflected in the high percentage of saturated fatty acids within this fraction as present in the blood serum (Drury et al., 2022). This may also be due to the fact that a lack of thyroid hormones leads to a significant imbalance in the number of enzymes, especially liver lipase (LPL), which in turn leads to an increase in the formation of LDL and thus an increase in the level of saturated fatty acids in this part of the blood serum (because it is related to the level of cholesterol and LDL). This is reflected in an increase in risk factors for cardiovascular disease in patients with colon cancer because it significantly affects cholesterol absorption and its reverse transport (Dueck et al., 1996). The results also indicated a decrease in the proportion of monounsaturated fatty acids (MUFA) and polyunsaturated fatty acids (PUFA) in this part in the blood serum when comparing colon cancer patients with the control group, as shown in Table 2. This may be due to both TH and TRS, which are considered effective elements in controlling a large number of genes related to the metabolism of fats and carbohydrates, and which significantly affect the synthesis of monounsaturated and polyunsaturated fatty acids in the liver, especially in patients with colon cancer, which leads to a decrease in the percentage of this type of fatty acid in this fraction in the blood serum (Ehehalt et al., 2006). This may also be due to the role of the DNL *de novo* lipogenesis pathway, which plays a major role in the level of fatty acids within the normal level; any defect in this pathway can lead to a decrease in the level of unsaturated fatty acids in patients with colon cancer (Fazolini et al., 2015). This may also be due to the role and function of a number of enzymes that work to convert saturated fatty acids into blood (Ferlay et al., 2012). The results of this study also indicated that there was a significant increase in the percentage of saturated fatty acids (SFA) in the triglyceride fraction of the blood serum in colon cancer patients compared to the control group, as shown in Table 2. This may be due to a decrease in thyroid hormones  $T_4$  and  $T_3$ , which greatly affect lysophosphatidylcholine (LPC), which leads to a high percentage of saturated fatty acids in this part of the blood serum and which is a risk factor for the development of colon cancer (Fernandes et al., 2020), or otherwise due to the role of the ALT enzyme, whose level decreases in patients with colon cancer and which greatly affects the

normal fat metabolism, leading to an increase in the level of saturated fatty acids in the blood serum. Studies have shown low levels of this enzyme, in addition to the AST enzyme, in colon cancer patients (Altner et al., 2023). The results of this study indicated a significant increase in the level of monounsaturated fatty acids (MUFA) in this part of the blood serum when comparing the hypothyroid group to the control group, as can be seen in Table 2. This may be due to the role of food, whose effect is evident in this part of the blood serum, as the imbalance that occurs in thyroid hormones greatly affects the metabolism of fats and carbohydrates in terms of their role in the very important energy production process in many metabolic pathways (Fingar & Bennis, 2004). The results of this study also indicated a considerable decrease in the level of polyunsaturated fatty acids (PUFA) in this part of the blood serum when comparing the colon cancer patients with the control group, as can be seen in Table 2. This may be due to a lack of thyroid hormones due to a significant defect in the genes in the liver related to the triglyceride metabolism process and this gene (PPAR $\alpha$ ), which controls the process of lipid metabolism, especially for unsaturated fatty acids. A significant increase in the level of the PPAR $\alpha$  gene has been observed in colon cancer patients in previous studies which is inversely proportional to the level of polyunsaturated fatty acids, which in turn is considered a risk factor in the development of colon cancer in terms of cardiovascular disease (Fuentes et al., 2018). The reason for the low level of polyunsaturated fatty acids may also be due to the role of hepatic lipase, whose activity increases as  $\beta$ -oxidation processes increase, which leads to a decrease in the level of polyunsaturated fatty acids, especially EPA and DHA, and thus the level of polyunsaturated fatty acids decreases in this part of the blood serum (Sedlak et al., 2023). In addition, the results in this study indicated that there was an increase in the percentage of SFA in the phospholipid part of the blood serum in colon cancer patients compared to the control group, as shown in Table 2. This may be due to the role of thyroid hormones, which affect the specific activities of a number of enzymes such as malic ME, Na-K-ATPase, and glycoposphate dehydrogenase (GPDH), which are responsible for the formation of fatty acids within the phospholipid part of the liver. Studies have shown that there is a defect in these enzymes in patients with colon cancer, the presence of which is reflected in the level of these saturated fatty acids (Gabrielson et al., 2001; Furuhashi & Hotamisligil, 2008). The research also showed an increase in the level of monounsaturated fatty acids (MUFA) and a significant decrease in the level of polyunsaturated fatty acids (PUFA) in this part of the blood serum when comparing colon cancer patients with the control group, as can be seen in Table 2. This may be due to the fact that colon cancer generally leads to a decrease in the level of phospholipids within the structure of the inner membrane, and fatty acids are generally low due to the effect on the kinetics of protein leakage within the mitochondrial membrane (Gilligan et al., 2017). This results in a decrease in the level of polyunsaturated fatty acids and an increase in monounsaturated fatty acids by reducing the activity of elongation enzymes ( $6\Delta$ ) and increasing the activity of desaturating enzymes ( $5\Delta$ ), which leads to an increase in the percentage of monounsaturated fatty acids and a decrease in the percentage of polyunsaturated fatty acids. Research has shown that this occurs in patients with colon cancer (Hoxha et al., 2022), potentially due to a decrease in the rigidity of the inner mitochondrial membrane (carboline). This affects the permeability properties of the membranes, which increases with the increase of polyunsaturated fatty acids with the increase in the elasticity of the membrane (Granchi, 2018). There are other factors that can lead to fluctuation in the level of fatty acids, including the role of FASN, an enzyme involved in the biosynthesis of fatty acids in mammals. The defect that occurs in the protein constituting this enzyme leads to a marked decrease in the formation of the majority of unsaturated fatty acids in general, but especially in patients with colon cancer (Green et al., 2010). This fluctuation is also due to the role of thyroid hormones (THs), which play a major role in the metabolism of fatty acids in both catabolic and building processes by affecting the process of  $\beta$ -oxidation of fatty acids in mitochondria (Hanahan & Weinberg, 2011). As colon cancer causes a significant imbalance in this pathway, this leads to a defect in the synthesis of unsaturated fatty acids (Aziz et al., 2024) through its effects on the genes that regulate the gene expression of a large number of enzymes, especially ACC and FAS

enzymes, by controlling the binding site with the SREBP1 transcription factor and the consequent imbalance in the process of formation and metabolism of fatty acids in general (Hatzivassiliou et al., 2005; Hatanaka et al., 2010; Harris & Thorne, 2012).

It was noted in this study that there was a significant difference in the level of fatty acids in the PL fraction in the blood serum of colon cancer patients compared to healthy individuals. Position No.  $S_{n-2}$ , while in the case of monounsaturated fatty acids the esterification takes place at the  $S_{n-1}$  site, and through this the integrity of the structure of the bilayer membrane is preserved and absolute liquidity is prevented (Horiguchi et al., 2008). The level of lipids in the membranes of cancer cells differs from that of normal cells as a result of a number of enzymes changing due to colon cancer via metabolism. Because of their high saturation levels, cells are less vulnerable to oxidative stress brought on by chemical treatment and are more resistant to oxidation and reduction (Pizzino et al., 2006). Additionally, the presence of high levels of saturated fatty acids and cholesterol makes the cell membrane stiffer, which hinders cell growth and triggers aberrant cell growth and uncontrolled division (Husted et al., 2017).

Gene expression also plays an important role by increasing the expression of associated protein (CRC), and works to increase the expression of oncogenes through  $\beta$ -catenin signals, where high levels of CRC were found in the nucleus of cancer cells (Igarashi & Guarente, 2016). This may also be due to the role of oxidative phosphorylation in mitochondria and glycolysis to generate energy (ATP) in normal cells, as cancer cells mostly obtain ATP from the breakdown of ATP (Ikonen, 2001). The majority of therapeutic methods depend on the energy metabolism of cancer cells and the control of such, through which the ATP required for phosphorylation and replication reactions (rRNA) are controlled and then the programmed death of cancer cells (Imray et al., 1992).

This is greatly affected by the toxic accumulation of long-chain fatty acids, which is highly associated with the formation of reactive oxygen species (ROS) and the occurrence of damage to mitochondria (Jahn et al., 2011). This may also be due to the fact that the conversion of citrate and acetyl-CoA is effected by ATP via the ACLY enzyme (Yuskiv et al., 2020), which is linked to the metabolism of fats and glucose, where low fatty acid levels and high glucose levels stimulate (*de novo*) fatty acid production in cancer cells. Additionally, this is followed by the breakdown of glucose, which turns into pyruvate. Inhibitors (ACLY) can act as anticancer agents because hyper-ACLY works to increase the acetyl-CoA necessary for the synthesis of fats. It has been found that the increase of this enzyme in breast and hepatocellular carcinoma patients, and that its inhibition, leads to changes in the metabolism of cancer cells (Jaishy & Abel, 2016). Also, the enzyme stearoyl-CoA (SCD) plays an important role in controlling the formation of fats, as it plays a major role in the production of monounsaturated fatty acids (MUFA) from saturated fatty acids (SFA) (Shevchenko et al., 2020), where a high rate of gene expression for the enzyme has been found in the liver, colon, kidneys (Janakiram et al., 2011). The fact that arachidonic acid is converted into prostaglandin and thromboxin (A<sub>2</sub>) by a number of cyclooxygenase enzymes may also be the cause, as it has been noted that the COX-2 form is excessively secreted in a number of human cancers, including those of the breast, ovary, brain, colon, and stomach. Additionally, non-steroidal anti-inflammatory medications (NSAIDs) and COXIBs contribute to a delay in the development or recurrence of tumors (Jay & Hamilton, 2018).

Some studies have also found the presence of the main metabolite of COX2, namely PGE<sub>2</sub>, in the colon, whose levels increase with the progression of the disease and the size of the tumor (Jin et al., 2019). Energy levels must be controlled through the diet to control the energy supply, as polyunsaturated fatty acids form 7–10% of daily energy intake in various types of cancer, as the  $\beta$ -oxidation process is the preferred pathway for the formation of ATP (Kanarek et al., 2020). In some types of cancer, the  $\beta$ -oxidation process is activated under the pressure of metabolic processes (Karpishev et al., 2019). It has been noted that a diet rich in fat (HFD), especially palmitic acid and saturated fatty acids, as well as cholesterol, alters a form of intestinal stem cells and thus increases the likelihood of bowel cancer (Khawairakpam et al., 2015). Therefore, a specific diet must be followed because the source of

energy, metabolic activity, and nutritional requirements are different for different types of cancers, and many studies have shown that there is considerable variation between individuals in terms of the metabolism of fatty acids (present in the diet). Therefore, the results reported above were conflicting when completing the treatment of the disease with fatty acids as an aid (Kimura et al., 2019).

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