Ann. For. Res. 65(1): 2834-2844, 2022
ISSN: 18448135, 20652445

ANNALS OF FOREST RESEARCH
https://www.e-afr.org/

EFFECT OF COMMERCIAL AND NANO-CAPSAICIN SUBSTANCES ON THE REDUCTION OF FAT IN CHOLESTEROL-TREATED RATS

Neam allah Modher Taha[1] and A. Fatima F Juma Al Ani[2]
1-Baghdad Universit, Faculty of Education, Home Economics Department/ Baghdad, Iraq /www.nneaam507@gmail.com .
2- Baghdad Universit, Faculty of Education, Home Economics Department/ Baghdad, Iraq /mailto:fatima.faik@coeduw.uobaghdad.edu.iq .

Abstract :
This study was conducted to evaluate the effect of commercial and nanocapsaicin on the level of fat and liver and kidney function in rats. In this experiment, 40 female rats were used at the age of 4-5 months divided into 8 groups according to the following:

The control group was left untreated, and the second, third and fourth groups were dosed with cholesterol at a concentration of 20 mg/kg of body weight in addition to the nanocapsaicin in concentrations of 1,2.3 mg/kg respectively. The fifth, sixth and seventh group was dosed with cholesterol at a concentration of 20 mg/kg body weight, in addition to commercial capsaicin at a concentration of 8.4.2 mg/kg body weight respectively. Finally, the eighth group was dosed with cholesterol and a concentration of 20 mg/kg body weight. The results showed a significant decrease in the level of cholesterol, trigly fats, low-density protein fats, very low-density protein fats, and a high level of high-density fats, good when using commercial and nanocapsin. The effect of nanomaterial was more by the low level of fat images compared to commercial capsaicin. The results also showed that there are no negative effects of nanocapsaicin on liver function, which included measuring the effectiveness of the enzyme amine-conducting enzyme amine-conducting spartite, as well as kidney function, which included the level of blood urea and creatinine.
Keywords; Lipid profile, Rats, Blood urea, AST and ALT .

Introduction

Since the earliest times, medicinal herbs and plants have received great appreciation for their ability to relieve pain and heal. Today, we still rely on the therapeutic properties of plants in about 75% of our medicines(Gufran,2022). Societies of the world have over the years developed their own proverbial traditions to understand medicinal plants and their uses (Chevalier, 2010). The natural products of the plant can be used in their various forms whether as raw materials, pure ingredients or in the form of compounds which are used as medicines(Abu Dahi,1988). pesticides, flavorings, etc. Among the applications of nanotechnology in medicine that are currently being developed is the use of nanoparticles to deliver drugs, heat, light or other substances to certain types of cells (such as cancer cells). Nanoparticles are a general challenge for nanotechnology today and in the near future. Nanoparticles cover mostly all types of science (Hashim, 2012), and it was observed that it has a property dependent on the size of this small area such as resonance of surface Plasmon, high magnetism, materials used in biomedicine and others(Neean,2020). Nanoparticles have often unexpected properties as a result of the restriction of their electrons and the production of quantum effects. It is worth noting that the properties of the original materials that make up the particles change completely as they approach the nanoscale (Jeevanadam and Other, 2018). Recently, the system of converting molecules into nanoparticles is most likely appropriate, especially for molecules with little solubility in water as in medicinal plants and their conversion to nanoparticles, which gain them a high permeability and increase their resistance to metabolic processes (Amen, 2020). The tendency to deal with drugs extracted from natural sources and subject them to modern technologies such as nanotechnology gave hope to researchers in the medical sector, and currently the number of drugs based on nanotechnologies available is estimated at about 200 types.

Pepper is one of the well-known medicinal plants that have been homogenized in many countries of the world after it was native to tropical regions, where it maintained its popularity, especially in areas where it was difficult for Western medicine to reach. Peppers, of all kinds, contain capsaicin, as peppers of both types, namely sweet and cayenne, are of medicinal plants that are used in many treatments. The compound capsaicin found in cayenne pepper is a natural substance and is responsible for the spicy taste and has received great interest in the scientific community. Thus, it is used in many treatments. The spicy taste of cayenne pepper varies according to the type of pepper extracted from it. It is found in many supplements and various pharmaceutical preparations to relieve back pain, muscles and joints and treat nerve pain (Gerisat et al., 2007). Pepper plants (hot variety) are characterized by containing capsaicin alkaloid (spicy substance) that is used as a spice, and is one of the important compounds in the manufacture of therapeutic substances and medicines(Al-muhareeb,2014). It was found that this substance is found in very small concentrations in various parts of the plant, while it is found in high concentrations inside the fruit of hot pepper (Yuzbeki and Al-Malah, 2005). Studying high cholesterol in the blood is important because it causes heart and brain clots and therefore capsaicin extracted from green cayenne pepper is used after it is turned into a nano-extract in different concentrations and compared to commercial capsaicin in different concentrations. Then, the treatment and reduction of blood cholesterol follow. Cholesterol is a health problem of a global effect where there is a tendency to treat it with herbs to improve its therapeutic properties instead of chemical treatments that have negative results. The motivation behind this study is the many cases with cholesterol so the Nano concentrations of capsaicin extracted from green cayenne pepper and concentrations of commercial capsaicin were used to lower blood cholesterol, in addition to the given the lack of studies on the use of capsaicin nanotechnology extracted from green cayenne pepper and the importance of medicinal plants in therapeutic uses, especially in lowering blood cholesterol.

Experimental design:

Methodology

In this experiment, 40 female white rats aged 4-5 months were purchased from the Biotechnology Research Center/Al-Nahrain University and left to adapt for one week. Then, they were divided into 8 groups (5 per group) as follows:

1- The first group was considered control animals and was given tap water and standard feed.

2- The second group was given capsaicin nanoparticles at a concentration of 1 mg/kg with cholesterol at a concentration of 20 mg/kg.

3- The third group was given capsaicin nanoparticles at a concentration of 2 mg/kg with cholesterol at a concentration of 20 mg/kg.

4- The fourth group was given capsaicin nanoparticles at a concentration of 3 mg/kg with cholesterol at a concentration of 20 mg/kg.

-5The fifth group was given commercial capsaicin at a concentration of 8 mg/kg with cholesterol at a concentration of 20 mg/kg.

6 -Group VI was given commercial capsaicin at a concentration of 4 mg/kg with cholesterol at a concentration of 20 mg/kg.

7 -Group VII was given commercial capsaicin at a concentration of 2 mg/kg with cholesterol at a concentration of 20 mg/kg.

8 -The eighth group was given cholesterol at a concentration of 20 mg/kg.

Dosage was given to the mice in the amount of 1 ml per concentration, for 30 days. At the end of the experiment, blood was drawn and the serum was separated for tests (kidney, liver, lipid profile, AST, ALT).

Blood was drawn from all animals after completing the duration of the experiment by cardiac acupuncture method, and placed in plastic tubes free of anticoagulant at room temperature until the completion of the clotting process. Then, the centrifugal process was performed, 3000 cycles/ minute, to obtain the serum. The serum was placed in Abendrov tubes and kept at a temperature of -20 degrees Celsius until chemical tests were performed, which included images of fat, liver and kidney function.

Results

The results confirmed, in Table1, that there is a significant increase at the level of $P \leq 0.05$ in the concentration of cholesterol in the treated groups at a concentration of 8, 4 and 2 mg/kg of commercial capsaicin (244.68 ±8.42, 246.72 ±5.03 , 246.98 ±7.72) mg/dL, as well as in the treated groups at a concentration of 2.1 mg/ml of capsaicin nanoparticles (236.03 ±1.04, 227.16 ±5.87) mg/dL compared to the control group (208.57 ±5.86) mg/dL. While the results did not show a significant difference between the group treated with capsaicin nanoparticles and at a concentration of 3 mg/kg). 208.11 ±1.60) mg/dL compared to the control group. All the above groups were dosed with cholesterol and at a concentration of 20 mg/kg of body weight, and the results also showed a high significant increase in the group that was dosed with cholesterol at a concentration of 20 mg/kg and did not undergo any treatment (positive control group) compared to the rest of the groups treated with commercial and nano-casein, where the concentration of cholesterol was (279.16 ±2.50) mg/dL.

On the other hand, the results in Table 1 showed no significant decreased in the concentration of triglycerides in the groups treated with capsaicin nanoparticles and concentrations 2 and 3 mg/kg (142.16 ±6.43, 132.58 ±1.61) mg/dL as well as the groups treated with commercial capsaicin concentration of 2,4 and 8 mg/ml (179.83 ±24.60) mg/dL compared to the control group (144.66 ±6.64) mg/dL. Whereas the results showed a significant increase in the concentration of triglycerides in the groups treated with commercial capsaicin and concentrations of 8 and 4 mg ml (200.09 ±11.83, 212.34 ±9.10) mg/dL the results showed significant increased l Positive Control Group (218.06 ±24.26) mg/dL compared to the Negative Control Group not treated by any substance (144.66 ±6.64) mg/dL.and groups treated with 2 and 3 mg\kg concentration of nano-capsaicin(142.16 ±6.43and132.58 ±1.61) mg/dL

As for high density lipo-protein (HDL), the results showed no significant of these fats in the groups treated with capsaicin nanoparticles concentrations 1, 2 and 3 mg/ml (46.33 ±0.88, 40.33 ±3.52, 40.00 ±2.88) mg/dL compared to the negative control group (44.33 ±2.02) mg/dL. While the results showed a significant decrease in the concentration of HDL in the groups treated with commercial capsaicin at a concentration of 8 and 4 (30.66 ±0.33), 28.00 ±2.31) mg/dL compared to the negative control range (44.33 ±2.02) mg/dL.

The results showed a significant increase in the concentration of low-density lipo- protein (LDL) in the groups treated with capsaicin nanoparticles and concentrations of 1 and 2 mg/ml (154.33 ±2.60, 158.33 ±7.31) mg/dL and a high significant difference in the groups treated with commercial capsaicin and concentrations of 8, 4 and 2 mg/ml(174.33 ±6.98, 176.00 ±5.19, 171.33 ±3.17) mg/dL and the cholesterol-only treatment group (positive control) (196.66 ±2.85) mg/dL compared to the negative control group (135.33 ±5.36) mg/dL.While the results revealed a significant decreased in LDL in groups treated with capsaicin nanoparticles and concentrations of 1 ,2 and 3 mg/ml(154.33 ±2.60, 158.33 ±7.31and 141.66 ±3.38)mg\dl

As for the very low density protein fats, the results showed no significant difference in the concentration of these fats in the groups treated with capsaicin nanoparticles and concentrations of 1, 2 and 3 mg/ml (35.00 ±4.35, 27.66 ±1.20, 26.00 ±0.57) mg/dL compared to the negative control group (28.93 ±1.32) mg/dl. While these groups showed a decrease in the concentration of these fats in the three groups treated above with the group treated with cholesterol only (44.66 ±3.48) mg/dL. The results also showed a significant increase in the concentration of very low density protein fats in the group treated with commercial capsaicin at a concentration of 8 and 4 mg/ml (39.33 ±2.33, 42.00 ±1.73) mg/dL compared to the negative control group (28.93 ±1.32) mg/dL. The results showed a significant increase in the concentration of these fats (44.66 ±3.48) mg/dL compared to the negative control group.

Comparison of different fats groups:

Group	Mean ± SE (mg/dl)				
	Cholesterol	Triglyceride	HDL	LDL	VLDL
Control	208.57 ±5.86 d	144.66 ±6.64 b	44.33 ±2.02 ab	135.33 ±5.36 f	28.93 ±1.32 cd
Nano 1	236.03 ±1.04 bc	176.25 ±22.62 ab	46.33 ±0.88 a	154.33 ±2.60 de	35.00 ±4.35 bc
Nano 2	227.16 ±5.87 c	142.16 ±6.43 b	40.33 ±3.52 ab	158.33 ±7.31 cd	27.66 ±1.20 cd
Nano 3	208.11 ±1.60 d	132.58 ±1.61 b	40.00 ±2.88 ab	141.66 ±3.38 ef	26.00 ±0.57 d
Concn.: 8	244.68 ±8.42 b	200.09 ±11.83 a	30.66 ±0.33 cd	174.33 ±6.98 b	39.33 ±2.33 ab
Concen.: 4	246.72 ±5.03 b	212.34 ±9.10 a	28.00 ±2.31 d	176.00 ±5.19 b	42.00 ±1.73 ab
Concen.:2	246.98 ±7.72 b	179.83 ±24.60 ab	39.33 ±3.28 ab	171.33 ±3.17 bc	35.66 ±4.84 bc
Cholesterol	279.16 ±2.50 a	218.06 ±24.26 a	37.33 ±3.38 bc	196.66 ±2.85 a	44.66 ±3.48 a
LSD value	16.24 **	47.60 **	7.74 **	14.78 **	8.64 **
P-value	0.0001	0.0007	0.0016	0.0001	0.0019
Means having with the different letters in same column differed significantly. ** ($P \leq 0.01$).					

It can be determined from the results in the table above that the three coefficients (1,2,3) Nano capsaicin are better than the coefficients (2,4,8). The best results were in the treatment of Nano3 and this indicates the possibility of using capsaicin and the best treatment is 3HDL, LDL and VLDL nanoparticles in lowering cholesterol and triglycerides. This indicates the possibility of using concentrations higher than 3mg nanoscale to reach better results in future research and studies.

Blood urea and Creatinine

The results in Table 3 showed no clear significant differences in the groups treated with capsaicin nanoparticles and concentrations of 3,2,1 (28.66 ±1.20, 33.33 ±1.76, 37.66 ±2.96) mg/dL as well as the groups treated with commercial capsaicin and concentrations of 2,4,8 (42.66 ±3.28, 36.66 ±4.25, 39.00 ±1.00) mg/dL compared to the negative control group (38.33 ±3.38) and the cholesterol-only group (43.00 ±4.93) mg/dL. On the other hand, the results did not show significant differences between the groups treated with Nano capsaicin with concentrations of 3,2,1 (1.140 ±0.08, 1.233 ±0.29, 1.60 ±0.25) mg/dL as well as the groups treated with commercial capsaicin with concentrations of 2,4,8 (1.366 ±0.12, 1.866 ±0.07, 1.700 ±0.28) mg/dL

Table 3: Comparison of different urea and Creatinine groups:

Group	Mean ± SE	
	B. Urea (mg\dl)	Creatinine (mg\dl)
Control	38.33 ±3.38 ab	1.366 ±0.03 abc
Nano 1	28.66 ±1.20 c	1.140 ±0.08 c
Nano 2	33.33 ±1.76 bc	1.233 ±0.29 bc
Nano 3	37.66 ±2.96 abc	1.60 ±0.25 abc
Concen 8	42.66 ±3.28 ab	1.366 ±0.12 abc
Concen 4	36.66 ±4.25 abc	1.866 ±0.07 a
Concen 2	39.00 ±1.00 ab	1.700 ±0.28 ab
Cholesterol	43.00 ±4.93 a	1.566 ±0.08 abc
LSD value	9.421 *	0.546 *
P-value	0.0443	0.0494
Means having with the different letters in same column differed significantly. * ($P \leq 0.05$).		

Comparison of different Alanine and Aspartate transaminase enzymes:

The results of the analysis of the current study showed no significant difference in the concentration of the alanine enzyme transporter of amine between the groups treated with capsaicin nanoparticles with concentrations of 3,2,1(22.82 ±0.26, 27.45 ±1.13, 24.25 ±0.94) international unit/liter as well as the groups treated with commercial capsaicin with concentrations of 2,4,8(19.72 ±4.23, 27.20 ±3.55, 19.64 ±1.46) international units/liter compared to the negative line group (21.94 ±1.44) international units/liter and the cholesterol treatment group only (21.31 ±1.35) international units / liter. On the other hand, the results showed that there was no significant difference in the enzyme aspartite transporting the amine in the groups treated with capsaicin nanomaterial with concentrations of 3,2,1(27.61 ±1.55, 32.83 ±2.13, 24.72 ±1.47) IU/L as well as the groups treated with commercial capsaicin with concentrations of 2.4 (28.85 ±2.85, 26.63 ±1.39) IU/L compared to the negative line group (23.09 ±1.82) IU/L and the cholesterol treatment group only (24.42 ±1.74) IU/.

Comparison of different Alanine and Aspartate transaminase enzymes:

Group	Mean ± SE	
	ALT (IU/L)	AST (IU/L)
Control	21.94 ±1.44 ab	23.09 ±1.82 cd
Nano 1	22.82 ±0.26 ab	27.61 ±1.55 abc
Nano2	27.45 ±1.13 a	32.83 ±2.13 a

Nano 3	24.25 ±0.94 ab	24.72 ±1.47 bc
Concen 8	19.72 ±4.23 b	17.54 ±1.41 d
Concen 4	27.20 ±3.55 a	28.85 ±2.85 ab
Concen 2	19.64 ±1.46 b	26.63 ±1.39 bc
Cholesterol	21.31 ±1.35 ab	24.42 ±1.74 bc
LSD value	6.612 *	5.564 **
P-value	0.0482	0.0017
Means having with the different letters in same column differed significantly. * (P≤0.05), ** (P≤0.01).		

Discussion

Capsaicin is one of the active compounds in cayenne pepper, and many studies have confirmed the many medicinal uses of this substance. It is also considered an anti-obesity compound through its function to reduce appetite and inhibit the process of fat formation. The data revealed that the consumption of foods containing capsaicin was associated with a lower prevalence rate of obesity in a randomized experiment of two control groups. It indicated that the treatment of overweight in obese people with 6 mg/day of capsaicin-packed capsules for 12 weeks was associated with abdominal fat loss measured by X-ray absorption measurement of absorptiometry, where body weight decreased by 0.5- 0.9 kg in the two treatment groups respectively. Moreover, none of the patients had any adverse events. (Martel, J., 2017).

In another study that aimed to determine whether capsaicin helps maintain weight by reducing weight recovery after weight loss by 5% to 10%. The results showed that capsaicin therapy causes fat to be oxidized continuously while maintaining weight compared to placebo by increasing energy and oxygen consumption. The study also showed that increasing fat oxidation and increasing energy consumption are beneficial for controlling weight loss (Whiting, S., 2012).

Red pepper containing capsaicin added to food can reduce body weight by regulating appetite and satiety. One study aimed to investigate the effects of capsaicin on nutrition behavior and energy consumption, noting that the addition of capsaicin-containing red pepper to breakfast significantly reduced the intake of protein and fat at lunchtime. Also, the addition of red pepper to appetizers significantly reduced the accumulation of energy and carbohydrates. These effects are associated with an increase in the sympathetic nervous system that plays an important role in maintaining heat generation and is expected to be a therapeutic target for obesity and related metabolic disorders in humans. The study has shown that chili peppers affect energy consumption by operating the best mechanisms available in the same way in the event of low temperatures leading to increased energy consumption. The potential mechanisms underlying the anti-obesity effects of capsaicin include the following:

(1) Prevents the formation of fats; (2) Activate the best available techniques and induce heat generation; (3) suppresses appetite and increases satiety regulated by neural circuits in the hypothalamus; (4) Modulate the function of the digestive system and microbiology. One study indicated the importance of capsaicin in inhibiting the hormone lipidine, which is responsible for the sensation of hunger and increases the activity of the hormone adiponectin, which is responsible for lipolysis that acts as an anti-obesity as obese people often suffer from a deficiency of this hormone. Capsaicin also increases cell death, especially fat cells, which are responsible for storing fat and thus inhibiting lipid formation (Hsu, C.L and Yen, G.C., 2007).

The largest study ever – involving 147 million people – suggests that most people whose cholesterol levels are not receiving the treatment they need to reduce their risk of cardiovascular disease, such as heart attack and stroke. Cardiovascular diseases are at the forefront of deadly diseases in the world, claiming the lives of more than 17 million people. Every year, however, figures in our Arab world clearly indicate high rates of high cholesterol and weight gain among the population and at the local level. In Iraq, the percentage of people, who have a BMI of 25 or more, are aged 20 years or older (Nairat & Hamrasha, 201).

In one experiment, it was shown that mice treated with 10 mg/kg of body weight of commercial capsaicin, can significantly inhibit the accumulation of body fat and enhance energy metabolism. Hence, these studies have supported that capsaicin can reduce lipid generation and regulate the function of genes associated with fat metabolism and metabolism, and then can have the ability to make people lose weight.

It has been shown that commercial capsaicin can resist the harmful effects of a high-fat diet, including glucose intolerance, high cholesterol, and suppressed activity in the best available techniques. These effects were mainly by increasing the metabolic expression of heat when adding capsaicin to foods after following a high-fat diet, promoting weight loss and enhancing respiratory exchange. All these data suggest that capsaicin may be an ingredient to counter obesity caused by diet by boosting metabolism and energy consumption (Baskaran, 2016).

Janssens (2014) indicated that energy balance requires the brain's ability to detect the state of energy stores and align energy consumption with the amount need to be consumed. Energy balance is mainly controlled by neural circuits in the hypothalamus. The stress of the endoplasmic network occurs in obese individuals and is believed to stimulate low levels of leptin receptors, and these signals play a key role in the development of resistance to leptin derived from adipose tissue works through its receptors in the brain to regulate energy balance. The function of the neuroendocrine glands means there is no deficiency in appetite in response to leptin. The addition of dietary capsaicin increases the feeling of satiety and indicates that capsaicin increases the feeling of satiety in the energy balance, and the decrease in the desire to eat after dinner in the negative energy balance. Although studies on capsaicin and its role in appetite are limited, it has been shown that neural circuits in the hypothalamus region respond to it and may be a central target of capsaicin.

In some studies, the effect of capsaicin to increase the energy consumption and thermogenesis caused by the diet has been shown most likely due to the stimulation of adrenergic and a decrease in the respiratory quotient, which means a shift in the oxidation of carbohydrates to the oxidation of fats. The decrease in the oxidation of lipoprotein and the decrease in the oxidation of fat supports weight loss. This was confirmed by a reduced rate of oxidation of lipoprotein in the blood observed when adding chili peppers to the diet which decreased fat concentration due to the increased oxidation process (Shook RP, 2015).

Adipocytes play a key role in maintaining energy balance and fat bala by releasing free fatty acids and storing triglycerides in response to changes in energy. Natural products specifically targeted at inhibiting lipid formation have promising potential in the treatment of obesity. For example: polyunsaturated fatty acids act as signal conversion molecules in adipocyte differentiation, 2007), and play a central role in suppressing lipid formation and regulating Lipids cell differentiation (Deepa, N., and Others), by suppressing late-stage differentiation of adipocytes. There are many products that have effects that cause apoptosis on the maturation of fat cells, such as capsaicin.

One study in the Netherlands reported that capsaicin increases satiety and fullness, preventing overeating and also preventing the negative effect of energy balance on the desire to eat.

The investigation on the effect of capsaicin in a dietary supplement for 10 weeks in obese mice fed a high-fat diet reported that it could prevent insulin resistance and fat accumulation in liver cells. It also reported that capsaicin reduces the level of fasting glucose, insulin, triglycerides, leptin. Capsaicin also works to reduce fat in fat cells and reduces intracellular fat by increasing gene expression for some enzymes, such as the enzyme Lebise, which works to analyze and undermine (2011, Lee ms and Others).

One application of capsaicin on male mice that feed on a high-fat diet reported significantly reduced weight gain, reduced fat accumulation in mesenteric adipose tissue. Capsaicin could also reduce glucose, cholesterol and triglyceride levels, and also caused the expression of adiponectin whose deficiency leads to obesity and burns fat and regulate the level of GR, blood glucose. (2013, Lee).

One study of obese rats in China reported that capsaicin decreases body weight, body fat, and serum fats (e.g., triglycerides and low-density lipoprotein, also generating fat and fat metabolism (2016, Xioa).

Conclusion:

It can be concluded, from this research, that capsaicin nanoparticles extracted from cayenne pepper led to lower cholesterol and triglycerides and increased high-density protein fats more than commercial non-Nano-capsaicin substance, and there were no negative effects on the liver and kidneys.

Refrences :

ابو ضاحي ، يوسف محمد ومؤيد احمد اليونس (1988) . دليل تغذية النبات ، مديرية دار الكتب للطباعة والنشر . جامعة بغداد .

المحارب، محمد زيدان خلف (2014) . تأثير مستويات الري و المادة العضوية في النمو و الحاصل و نوعيتة للفلفل الحريف تحت نظام الزراعة العضوية ، اطروحة دكتوراه ، كلي الزراعة ، جامعة بغداد .

اليوزبكي ، غاده شرف الدين و الملاح ، مزاحم قاسم (2005) . انتاج قلويد الكابسيسين من نبات الفلفل الحار و من الكالس المستحدث منها ، مجلة التربيه و العلم ، المجلد(17) ، العدد(2) .

امين ، منال محمد (2020) . النباتات الطبية ، معهد بحوث الصحه الحيوانيه ، مركز البحوث الزراعيه _ مصر .

جريسات ، لؤي و اللوزي ، مجد و شنطاوي ، طارق و دامر ، سونيا و الداؤودة ، بشار و زيادين ، هنادي (2007) . الدليل الفني لمحصول الفلفل الحار ، دار النفاس .

شوفالييه ، أندرو (2010) . الطب البديل : التداوي بالاعشاب والنباتات الطبيه ، لبنان – بيروت .

نعيرات ، قيس و حمارشه ، عبد السلام (2011) . مؤشر كتلة الجسم لدى طلبة جامعتي النجاح الوطنية والقدس ابو ديس ، مجلة جامعة النجاح الوطنيه للأبحاث (العلوم الأنسانية) مجلد 25 (2).

Baskaran, P., Krishnan, V., Ren, J. and Thyagarajan, B. (2016) . Capsaicin induces browning of white adipose tissue and counters obesity by activating TRPV1 channel-dependent mechanisms. Br. J. Pharmacol. 173, 2369–2389 .

Deepa, N.; Kaur, C.; George, B.; Singh, B.; Kapoor, H.C.(2007). Antioxidant constituents in some sweet pepper (Capsicum annuum L.) genotypes during maturity. LWT-Food Sci. Technol, 40, 121–129 .

Hashim, A. A. (2012) . The Dilivery of Nanoparicales . INTECHOPEN. Com, 540 pp.

Hsu, C.L. and Yen, G.C. (2007). Effects of capsaicin on induction of apoptosis and inhibition of adipogenesis in 3T3-L1 cells. J. Agric. Food Chem. 55, 1730–1736 .

Janssens, P.L., Hursel, R. and Westerterp-Plantenga, M.S. (2014). Capsaicin increases sensation of fullness in energy balance, and decreases desire to eat after dinner in negative energy balance. Appetite 77, 44–49 .

Jeevanandam, J.؛ Barhoum, A.؛ Chan, Y .S.؛ Dufresne, A. and Danquah, M. k., (2018) . Review on nanoparticales and nanostrured materials : history, sources, toxicity and regulations. Bwilstin J. Nanotechnol., 9,1050-10774.

Lee GR, Shin MK, Yoon DJ, Kim AR, Yu R, Park NH, et al. (2013). Topical application of capsaicin reduces visceral adipose fat by affecting adipokine levels in high-fat diet-induced obese mice., [1] Department of Medical Science , School of Medicine, University of Ulsan, Korea . Jan; 21(1):115-22 .

Lee MS, Kim CT, Kim IH, Kim Y. (2011) . Effects of capsaicin on lipid catabolism in 3T3-L1 adipocytes. Phytother Res;25:935-9 .

Martel, J., Ojcius, D.M., Chang, C.J., Lin, C.S., Lu, C.C., Ko, Y.F. et al. (2017) . Anti-obesogenic and antidiabetic effects of plants and mushrooms. Nat. Rev. Endocrinol. 13, 149–160 .

Shook RP, Hand GA, Paluch AE, Wang X, Moran R, H ebert JR, Jakicic JM, Blair SN. (2015). High respiratory quotient is associated with increases in body weight and fat mass in young adults. Eur J Clin Nutr. 70:1197–1202.

Whiting, S., Derbyshire, E. and Tiwari, B.K. (2012). Capsaicinoids and capsinoids. A potential role for weight management? A systematic review of the evidence. Appetite 59, 341–348 .

Xiao-minZHANG , Zheng-haiZHANG , Xiao-zhenGU , Sheng-liMAO and Other (2016) . Genetic diversity of pepper (Capsicum spp.) germplasm resources in China reflects , doi.org/10.1016/S2095-3119(16)61364 .

Gufran Mahmood Mohammed and Sumaiya Naeema Hawar (2022). Green Biosynthesis of Silver Nanoparticles from Moringa oleifera Leaves and Its Antimicrobial and Cytotoxicity Activities , Biology Department, College of Education for Pure Sciences/Ibn Al-Haitham, University of Baghdad, Iraq , International Journal of Biomaterials , Volume 2022, Article ID 4136641, 10 pages, https://doi.org/10.1155/2022/4136641.

Neean F Majeed and Other (2020) . Synthesis of Nano curcumin Via Sol-Gel / Ultrasonic Processors Route and Improving their properties by Microwaves-Induced Plasma, November 2020Journal of Physics Conference Series 1660(1):012042, DOI:10.1088/1742-6596/1660/1/012042 .