Chemical Composition, Nutritional Evaluation and Bioactive Compounds Content of Oat Flour (Avena sativa) and its Effects on Obesity in Rats

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Abstract:

The present study aims to determine the chemical composition, nutritional evaluation and bioactive compounds content of oat (*Avena sativa*) flour and its effects on obesity complications in rats. Oat flour had 10.33, 12.45, 6.63, 3.71, 2.06 and 64.82 percent moisture, total protein, crude fat, crude fibre, ash, and carbs, respectively. Additionally, total energy (Kcal/100g), adult man's daily requirements for protein (GDR/protein) and energy (GDR/energy), and percent satisfaction of adult man's daily requirements in protein (P.S./protein) and energy (P.S./energy) were 368.75, 506.02, 786.44, 15.81, and 10.17, respectively. Furthermore, bioactive compounds content of oat flour indicated that dietary fiber ($g.100g^{-1}$), *β*-glucans (soluble fiber) ($g.100g^{-1}$), phenolics (mg gallic acid equivalent. 100 g^{-1}), flavonoids (mg catechin equivalent. 100 g^{-1}) and carotenoids ($mg.100g^{-1}$) were 12.44, 4.46, 3.35, 2.36 and 4.97, respectively. The oat flour samples also recorded several very high biological activities which include antioxidant and radicals scavenging activities. The

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bioactive components content and biological effects of oat flour have played an essential role in obesity prevention and treatment efforts. As a result, the current study suggests that oat flour be included in our everyday meals and as a food supplement.

Keywords: oat, minerals, vitamins, antioxidant activity, radicals scavenging activity, body weight, serum lipid profile.

Introduction

Modern pharmacological therapy is expensive and comes with a slew of adverse effects, which leads to patient noncompliance. As a result, there is a need to investigate alternative therapies, particularly those derived from natural sources, which are less expensive and have less adverse effects. This focus is on Oats, or Avena sativa, are a type of cereal grain belonging to the Poaceae grass family. While oatmeal and rolled oats are good for human consumption, cattle feed is one of the most prevalent uses. Oats are commonly thought of as a secondary crop, as they evolved from a weed of the principal cereal domesticates, migrated westward into cooler, wetter locations appropriate for oats, and eventually domesticated in the Middle East and Europe (Zhou et al., 1999). Growing oats in a temperate environment is great. They require less heat in the summer and are more rain-tolerant than other cereals such as wheat, rye, or barley, making them particularly helpful in places with cool, wet summers, such as Northwest Europe and even Iceland. The term "grain" refers to the edible seeds of oat grass, which are what we eat for breakfast. Oats are recognised for their nutritional worth and health advantages, whether loved or despised for their mushy yet hearty texture when cooked. The Food and Drug Administration (FDA) has approved the use of a health claim on food labels linking -glucan soluble fibre from whole grain oats to a lower risk of coronary heart disease (FDA, 2017). Oatmeal's high water and soluble fibre content makes it a valuable asset for individuals seeking to lose weight and regulate hunger.

Obesity is defined as an abnormal buildup of bodily fat. The body mass index (BMI), which is defined as the weight in kilogrammes divided by the square of the height in metres (kg/m2), is a standard way to determine the prevalence of overweight and obesity. Overweight is defined as a BMI of over 25 kg/m2, and obesity is defined as a BMI of over 30 kg/m2. These markers provide common assessment standards, however illness risks in all populations can rise over time as BMI levels drop (Caterson, 2009 and Muñoz-Garach *et al.*, 2016). In 2016, the World Health Organization estimated that over 1.9 billion persons worldwide were overweight, with 650 million being obese. Between 1975 and 2016, the global prevalence of obesity tripled (https://obesity.procon.org/global-obesity-levels/). Obesity-related fatalities in Egypt were expected to be around 115 thousand per year (19.08 percent of total estimated deaths in 2020). Obesity-related DALYs may have reached 4 million by 2020. Obesity costs the Egyptian economy roughly 62 billion Egyptian pounds every year. This figure represents the expense of treating adult obesity-related disorders.

Obesity is linked to a variety of illnesses, including cardiovascular disease, diabetes mellitus type 2, obstructive sleep apnea, some forms of cancer, osteoarthritis, and asthma (Aronne and Segal, 2003; Caterson, 2009; Elhassaneen and Salem, 2014; Alexopoulos et al., 2016; Elmaadawy et al., 2016; Elhassaneen et al., 2019; and Shalaby and Elhassaneen, 2021). Obesity also raises the risk of a variety of physical and mental illnesses. The metabolic syndrome, a group of medical conditions that includes diabetes mellitus type 2, high blood pressure, high cholesterol, and high triglyceride levels, is the most common manifestation of these co-morbidities (Grundy, 2004). Obesity causes complications either directly or indirectly through mechanisms that share a common origin, such as a bad diet or a sedentary lifestyle (Bray, 2004).

Oats include a number of nutrients that have been linked to improved health. Beta-glucan is the most common form of soluble fibre found in oats, and it has been shown to aid digestion, improve fullness, and reduce hunger. In the colon, beta-glucan can bond with cholesterol-rich bile acids and transport them through the digestive tract and out of the body. Whole oats also include plant substances known as phenolic compounds and phytoestrogens, which work as antioxidants to minimise the harmful effects of chronic inflammation, which is linked to diseases such as cardiovascular disease and diabetes (2013). Oats are linked to heart health advantages, however studies reveal varying levels of benefit. A systematic evaluation of nine randomised controlled trials found insufficient evidence that whole grain diets containing oats lowered the risk of cardiovascular disease or decreased blood cholesterol or blood pressure (Kelly et al., 2017). β- Because -glucan fibre is broken down and fermented by intestinal bacteria, it may assist to reduce abrupt elevations in serum glucose and insulin levels after eating a meal. It may also promote gut health (Hou et al., 2015; Li et al., 2016 and He et al., 2016). Oat fibre (both soluble and insoluble) helps to maintain intestinal regularity and prevent constipation. It has the ability to make stools heavier and more watery, making them easier to pass (Slavin et al., 2013). Cereal fibres, such as wheat and oat bran, are thought to be more effective than fruit and vegetable fibre. The breakdown and fermentation of -glucan oat fibre has also been shown to boost gut microbial diversity (Rebello et al., 2015). This could help with digestive problems such diarrhoea, constipation, and irritable bowel syndrome. More research is needed, however, to determine the impact of diverse bacteria on digestive problems. Beta-glucan fibre draws water and increases the viscosity (thickness) of digested food, resulting in more food in the stomach. This slows digestion and enhances fullness by slowing digestion and food absorption. Short-chain fatty acids produced by bacteria that ferment beta-glucan fibres may also boost satiety by triggering a cascade of events that control hunger hormones (Rebello et al., 2015). Although multiple randomised controlled trials have indicated that consuming -glucan oat fibre increases satiety, other research have not consistently demonstrated that consuming oats results in considerable weight loss (Hou et al., 2015; Rebello et al., 2015; and Li et al., 2016). Despite numerous research on the link between consuming oats and fat, many parts of the subject remain unknown. As a result, the current research will focus on oat flour's chemical and nutritional properties. This research will also look into the link between oat flour consumption and obesity, as well as the interpretation of some of the mechanisms that contribute to this problem.

Materials and Methods

Materials

Wheat and Oat grains

Variety Giza 155 wheat (*Triticum vulgare*) grains were obtained from Benha markets, Al Qalyubia Governorate, Egypt during the 2020 harvesting period. Variety Giza 155 oat (*Avena sativa*) grains were obtained from from ElMisryia Company for Trading Herbs and Medical Plants (Haraz), Bab ElKhalk, Cairo, Egypt. The obtained samples were taken to the laboratory and immediately placed in the refrigerator at -40C until they were used to make flour. The grains samples were confirmed by staff from Minoufiya University in Shebin El-Kom, Egypt's Faculty of Agriculture.

Chemicals

Sigma Chemical Co. in St. Louis, Missouri, USA, provided the standards and fine compounds (unless otherwise noted). Morgan Chemical Co., Cairo, Egypt, provided casein. All chemicals, including minerals and vitamin mixes for rat meals, reagents, buffers, and solvents in analytical grade, were acquired from El-Ghomhorya Company for Trading Drugs, Chemicals, and Medical Instruments, and Morgan Chemical Co., Cairo, Egypt (unless where otherwise noted). Biodiagnostic Co. Dokki, Giza, Egypt, provided kits for the assessment of serum lipid profile.

Methods

Preparation of wheat and oat flour

Wheat and oat grains were manually cleaned and sorted before being dried in a hot air oven (Horizontal Forced Air Drier, Proctor and Schwartz Inc., Philadelphia, PA) at 55 0C until the moisture content in the final product reached roughly 10%. In a miller, the dry grains were ground into flour (Moulinex Egypt, ElAraby Co., Benha, Egypt). The flour samples were sieved in standard sieves to prepare flour sample with 85% extraction rate.

Preparation of control and composite wheat flour extracts

For their aqueous extracts, control and composite wheat flour samples were used as follows: A 20 g wheat sample plus 180 ml water was homogenised and transferred to a beaker, where it was swirled at 200 rpm for 1 hour at room temperature in an orbital shaker (Unimax 1010, Heidolph Instruments GmbH & Co. KG, Germany). Filtration via Whatman No. 1 filter paper separated the extract from the residue. The leftover residue was extracted twice more, and the two extracts were then mixed. A rotary evaporator was used to extract the residual solvent at 55°C under decreased pressure (Laborata 4000; Heidolph Instruments GmbH & Co. KG, Germany). Chemical studies could be performed on any aqueous extract.

Chemical analysis of control and composite wheat flour samples

Moisture, protein (T.N. 6.25, micro - kjeldahl method utilising semiautomatic apparatus, Velp company, Italy), fat (soxhelt miautomatic apparatus Velp company, Italy, petroleum ether solvent), ash, fibre, and dietary fibre levels were determined using the procedures indicated in the AOAC (1995). Differences in carbohydrate calculations:

Carbohydrates (percentage) = 100 - (percentage of moisture + protein + fat + Ash + fibre).

Determination of nutritional value of control and composite wheat flour samples

Total energy value

Total energy (Kcal/100 g) of control and composite wheat flour samples was calculated according to Insel *et al*, (2002) using the following equation: Total energy value (Kcal/100 g) = 4 (Protein % + carbohydrates %) + 9 (Fat %)

Satisfaction of the daily needs of adult man (25-50 year old) in protein

Grams consumed (G.D.R. g) of food (wet weight basis) to cover the daily requirements of adult man (63 g) in protein was calculated using the RDA (1989) values. Percent satisfaction of the daily requirement of adult man in protein (P.S./80 g, %) when consuming the possibly commonly used portions in Egypt i.e. one loaf (80 g weight), was also calculated.

Satisfaction of the daily requirements of adult man (25-50 year old) in energy

Grams consumed of food (wet weight basis) to cover the daily requirements of man in energy (G.D.R. g) were calculated using the RDA (Recommended dietary allowances) which are 2900 Kcal /day for man as given by RDA (1989) . The percent of satisfaction (P.S., %) of the daily needs of adult man (25 -50 year old , 79 Kg weight and 176 cm height) in energy upon consumption the commonly used portion at homes in Egypt, i.e. i.e. one loaf(80 g weight), was also calculated.

Antioxidant activity

β-carotene bleaching (BCB) assay

Following a modification of Marco's technique (1968), the antioxidant activity (AA) of plant extracts and standards (-tocopherol and BHT) was measured using the BCB assay.

DPPH radical scavenging assay

The ability of control and composite wheat flour extracts to scavenge free radicals was determined using the DPPH radical scavenging assay established by Desmarchelier *et al,* (1997).

Determination of total phenolics and carotenoids

According to Singleton and Rossi, total phenolics in BA extracts were measured using the Folin-Ciocalteu reagent

(1965). The total carotenoids in an 80 percent acetone extract were determined using Litchenthaler's technique (1987).

Determination of total flavonoids

Total flavonoids contents in BA extracts were estimated using colorimetric assay described by Zhisen *et al.*, (1999).

Biological Experiments

Ethical approval

The biological experiments for this study were approved by the Scientific Research Ethics Committee (Animal Care and Use), Faculty of Home Economics, Menoufia University, Shebin El-Kom, Egypt (Approval no. 07- SREC- 5-2021).

Animals

Adult male albino rats (145-155 g) were procured from Helwan Station, Ministry of Health and Population, Helwan, Cairo, Egypt, for this investigation.

Basal Diet

Protein (ten percent), corn oil (ten percent), vitamin mixture (one percent), mineral combination (four percent), choline chloride (0.2 percent), methionine (0.3 percent), cellulose (five percent), and corn starch (five percent) make up the basic diet, according to (AIN, 1993). (69.5 percent). Casein (23.3 percent), L-cystine (0.35 percent), corn starch (8.48 percent), maltodextrin (11.65 percent), sucrose (20.14 percent), soybean oil (2.91 percent), lard fat (20.69 percent), mineral mixture (1.17 percent), dicalcium phosphate (1,52 percent), calcium carbonate (0.64 percent), potassium citrate, according to Research Diets, Inc. NJ (Table 1). 1.92 percent H2O, 1.17 percent vitamin combination, and choline bitartrate (0.23 percent). The components of the employed vitamins

(Table 2) and salt combinations (Table 3) were formulated according to AIN, 1993.

Experimental design

All experiments followed the Institute of Laboratory Animal Resources, Commission on Life Sciences, National Research Council guidelines (NRC, 1996). Rats weighing 145-155g were housed separately in wire cages in a room with a temperature of 27.50°C, a relative humidity of 55.5%, a 12-hour lighting cycle, and were kept in normal healthy conditions. For acclimatization, all rats were fed a baseline diet (BD) for one week before beginning the experiment. After one week, the rats were separated into two groups: group one (Group 1, 6 rats) was still fed BD, and group two (36 rats) was fed a high fat diet (HFD, protein, 20%; carbohydrates, 35% and fat, 45% of total calories, Research Diets, Inc. NJ, USA) for 8 weeks and were separated into sex subgroups as follows: HFDs containing composite WF plus 5, 10, 15, and 20% oat flour (OF) were fed to groups (4-7) accordingly. Body weight gain (BWG, expressed as a percentage of beginning weight) in rats was recorded every week.

Blood samples collection

Blood samples were taken at the end of the 8-week trial via the abdominal aorta after a 12-hour fast, and rats were scarified under ether anaesthesia. Blood samples were collected into glass centrifuge tubes, centrifuged at 3000 rpm for 10 minutes, and serum was separated and used for lipid analysis (Stroev and Makarova, 1989).

Hematological analysis

Blood lipids profile

After a 12-hour fast, blood samples were obtained via the abdominal aorta, and rats were scarified under ether anaesthesia at the end of the 8-week trial. Blood samples were obtained and centrifuged at 3000 rpm for 10 minutes, after which serum was extracted and used for lipid analysis (Stroev and Makarova, 1989).

Statistical Analysis

All measurements were taken in triplicate and the average and standard deviation were calculated. The Student t-test and the MINITAB 12 computer programme were used for all statistical analysis (Minitab Inc., State College, PA).

Results and Discussion

Chemical composition of control and composite wheat flour

The chemical analysis of control samples of wheat flour and oat additions was approximated using the data in Table 1. In compared to the control sample, the value of crude fat, fibre, ash, and carbs increased significantly (p0.05) as the amount of oat flour was increased up to 20%. (wheat flour). Moisture and total protein content were measured in the reverse order. On the other hand, such chemical composition changes may alter the nutritional qualities of control and composite wheat flour samples (Table 2). Total energy (Kcal/100g), adult man's daily requirements from energy (GDR/energy) and protein (GDR/protein), and percent satisfaction of adult man's daily requirements in energy (P.S./energy) and protein (P.S./protein) are among these qualities. In compared to the control sample, the value of total energy, GDR/energy, and GDR/protein in the sample changed significantly when the amount of oat flour was increased up to 20%. The findings of this study are consistent with those of many other writers, such as Chan (2020), who discovered that oats contain a variety of vital nutrients (see table). Oats contain 1,630 kJ (389 kcal) of food energy in a 100 g (3+12 oz) dose and are a good source of protein (34 percent DV), dietary fibre (44 percent DV), several B vitamins, and a variety of dietary minerals, particularly manganese (233 percent DV). Also, according to Kim et al., (2021), oats (Avena sativa L.) are high in fibre. As a result of adding oats to wheat flour sampes, the crude fibre content of the sampes increases dramatically. This characteristic has numerous nutritional and therapeutic applications. Soluble fibre, which dissolves in water, can help lower blood glucose levels and cholesterol levels. Insoluble fibre, or fibre that does not dissolve in water, can aid in the movement of food through your digestive system, improving regularity and preventing constipation (Pereira et al., 2004). Fiber appears to lower the risk of heart disease, diabetes, diverticular disease, and constipation, among other disorders. In the case of heart disease, a higher fibre intake has been associated to a lower risk of metabolic syndrome, a set of characteristics that raises the risk of heart disease and diabetes. High blood pressure, high insulin levels, excess weight (particularly around the abdomen), high triglycerides, and low HDL (good) cholesterol are some of these risk factors. A higher fibre intake, according to several studies, may provide protection against this illness (McKeown et al., 2002; and McKeown et al., 2004). Diets low in fibre and heavy in foods that cause rapid elevations in blood glucose may increase the risk of acquiring type 2 diabetes in people with the disease (Liu et al, 2000; Fung et al., 2002; Schulze et al., 2004). Krishnan et al., (2007) reported similar findings. Furthermore, investigations in colon cancer have mostly failed to demonstrate a relationship between fibre and colon cancer. One of these studies, which tracked over 80,000 female nurses for 16 years, concluded that dietary fibre was not strongly linked to a lower risk of colon cancer or polyps (a precursor to colon cancer) (Fuchs et al., 1999). Furthermore, arvid et al., (2016) discovered that eating more fibre lowers the risk of breast cancer, implying that fibre intake during adolescence and early adulthood is especially essential. Women who consume more high-fiber foods, such as vegetables and fruit, during adolescence and young adulthood may have a decreased risk of breast cancer than those who eat less dietary fibre. Finally, constipation is the most frequent gastrointestinal ailment in the world, and fibre ingestion appears to treat and prevent it. Oat fibre is thought to be more effective than fibre found in fruits and vegetables. Experts advise progressively increasing fibre consumption rather than abruptly increasing fibre intake, and because fibre absorbs water, beverage intake should be increased as fibre intake increases (Pereira et al., 2004).

Table 1. Chemical composition of control and composite wheat flour

Component	Wheat flour (WF, 85%)	Oat flour (OF, 85%)	Composite wheat flour							
			OF (5%)		OF (10%)		OF (15%)		OF (20%)	
			g/100g	% of change	g/100g	% of change	g/100g	% of change	g/100g	% of change
Water	12.54 [a]	10.33	12.51 [a]	-0.24	12.29 [a]	-1.99	12.18 [a]	-2.87	11.98 [a]	-4.47
Total Protein	13.02 [a]	12.45 [a]	12.89 [a]	-1.00	13.01 [a]	-0.08	12.94 [a]	-0.61	12.79 [a]	-1.77
Fat	1.41 [f]	6.63 [a]	1.67 [e]	18.09	1.93 [d]	37.02	2.24 [c]	58.87	2.51 [b]	78.01
Fiber	0.91 [f]	3.71 [a]	1.04 [e]	14.73	1.21 [d]	32.97	1.37 [c]	50.55	1.51 [b]	65.93

Ash	0.87 ^{d}	2.06 ^{a}	0.94 ^{d}	8.05	0.96 ^{d}	10.34	1.07 ^{c}	22.99	1.21	39.08 ^{b}
Carbohydrates	71.25 ^{a}	64.82 ^{b}	70.93 ^{a}	-0.45	70.61 ^{a}	-0.90	70.29 ^{a}	-1.35	69.96 ^{a}	-1.80

Values with the superscript letters in the same raw were significant different at $p \leq 0.05$.

Table 2. Nutritional evaluation of control and composite wheat flour

Parameter	Wheat flour (WF, 85%)	Oat flour (OF, 85%)	Composite wheat flour							
			OF (5%)		OF (10%)		OF (15%)		OF (20%)	
			g/100g	% of change	g/100g	% of change	g/100g	% of change	g/100g	% of change
Energy (Kcal/100g)	349.77^{b}	368.75^{a}	350.72^{b}	0.27	351.67^{b}	0.54	352.62^{b}	0.81	353.57^{b}	1.09
G.D.R. (g) for protein (63 g)	483.87^{c}	506.02^{a}	484.98^{b}	0.23	486.09^{b}	0.46	487.19^{b}	0.69	488.30^{b}	0.92
G.D.R. (g) for energy (2900 Kcal)	829.12^{a}	786.44	826.98^{a}	-0.26	824.85^{a}	-0.51	822.71^{a}	-0.77	820.58^{a}	-1.03

P.S./80 g (One loaf, %) For protein (63g)	16.53^{a}	15.81^{b}	16.37^{a}	-1.00	16.52^{a}	-0.08	16.43^{a}	-0.61	16.24^{a}	-1.77
P.S./80 g (One loaf, %) For energy (63g)	9.65^{b}	10.17^{a}	9.68^{ab}	0.27	9.70^{b}	0.54	9.73^{b}	0.81	9.75^{b}	1.09

Values with the superscript letters in the same raw were significant different at $p \leq 0.05$.

Mineral composition of control and composite wheat flour

Data in Table (3) indicated the mineral composition of control samples of wheat flour as well as additives to oats. With the increasing addition of oat flour up to 20%, the value of several minerals including Ca, K, Mg, P, Fe, Zn, Na, Mn and Cu in the sample were significant ($p \leq 0.05$) increasing in comparison with the control sample (wheat flour). The high significant increasing was recorded for Mg, P and Fe which recorded 74.33, 65.53 and 175.66% when compared with the control wheat flour samples. Also, increasing was noticed for some important trace metals such Zn, Mn and Cu. The present data are accordance with that reviewed by Prasad et al (2015) and Devendra et al., (2021). Also, Chan (2020) Oats contains numerous dietary minerals, especially manganese (233% DV). Mg is essential for the proper functioning of various body organs, including the heart, bones, muscles, nerves, and others. These organs fail if they don't get enough magnesium. This is supported by studies, which shows that magnesium deficit or a low magnesium diet might cause health issues. Although epidemiological research demonstrate that higher magnesium diets are linked to lower disease rates, clinical trials indicating that Mg supplementation can help these conditions have mixed outcomes. It could be because a Mg-rich diet contains more other nutrients that work together to prevent disease than a supplement that only contains one nutrient (Orchard et al., 2014).

Table 3. Mineral composition of control and composite wheat flour

Mineral	Wheat flour (WF, 85%)	Oat flour (OF, 85%)	Composite wheat flour							
			OF (5%)		OF (10%)		OF (15%)		OF (20%)	
			g/100g	% of change	g/100g	% of change	g/100g	% of change	g/100g	% of change
Ca	21.45 ^{d}	60.45 ^{a}	24.18 ^{c}	12.73	25.77 ^{bc}	20.13	27.75 ^{b}	29.37	29.73 ^{b}	38.61
K	141.04 ^{d}	361.	150.	6.39	166.	17.9	177.	25.8	188.	33.8

		00^{a}	05^{c}		33^{bc}	3	55^{b}	9	77^{b}	4
Mg	27.11^{d}	123.98^{a}	33.19^{c}	22.43	37.41^{bc}	38.00	42.34^{b}	56.16	47.26^{b}	74.33
P	112.56^{f}	484.15^{a}	131.14^{e}	16.51	149.27^{d}	32.61	167.79^{c}	49.07	186.32^{b}	65.53
Fe	1.52^{f}	14.63^{a}	2.25^{e}	48.03	2.86^{d}	88.16	3.52^{c}	131.58	4.19^{b}	175.66
Zn	2.01^{c}	4.03^{a}	2.17^{c}	7.96	2.23^{bc}	10.95	2.31^{b}	15.07	2.41^{b}	20.10
Na	4.05^{b}	5.27^{a}	4.09^{b}	0.99	4.17^{b}	3.01	4.29^{b}	5.93	4.29^{b}	6.02
Mn	1.94^{c}	5.05^{a}	2.07^{b}	6.70	2.27^{b}	17.01	2.41^{b}	24.05	2.52^{b}	29.90
Cu	0.81^{c}	1.74^{a}	0.86^{bc}	6.17	0.91^{b}	12.35	0.96^{b}	18.52	0.90^{b}	20.99

Values with the superscript letters in the same raw were significant different at $p \leq 0.05$.

P is a mineral that can be found in a variety of foods and is also available as a supplement. It has a variety of functions in the body. Bones, teeth, and cell membranes all contain it. It aids in the activation of enzymes and maintains a normal blood pH. Phosphorus governs the regular operation of nerves and muscles, including the heart, and is also a component of DNA, RNA, and ATP, the body's primary source of energy (Institute of Medicine , 1997). Fe's primary function is to transport oxygen in red blood cells' haemoglobin, allowing cells to make energy. Through myoglobin, Fe also enhances oxygen storage. Iron-containing protein called myoglobin delivers and stores oxygen in your muscles. It is also required for DNA synthesis and plays a crucial role in the human immune system (Nazanin et al., 2014 and Jun et al., 2021). Mn is involved in the metabolism of lipids and lipoproteins, as well as the pathophysiology of atherosclerosis and a variety of other cardiovascular illnesses (Jun et al., 2021). Cu helps the body generate red blood cells by combining with iron. It also supports the health of the blood vessels, neurons, immune system, and bones (Edward, 2020). Zn is a trace mineral, which means it is only required in small amounts by the body, yet it is required by almost 100 enzymes to carry out critical chemical reactions. It plays an important role in the formation of DNA, cell development, protein synthesis, tissue repair, and immune system support (Institute of Medicine , 2001). Zinc is necessary during periods of fast growth, such as childhood, puberty, and pregnancy, since it aids cell growth and multiplication. The perceptions of taste and smell are also affected by zinc (Prakash et al., 2015).

Vitamins content of control and composite wheat flour

The vitamins content of control samples of wheat flour as well as oat additions were shown in Table (4). In compared to the control sample, the value of numerous vitamins such as thiamine (B1), riboflavin (B2), niacin (B3), pyridoxine (B6), folate (B9), cyanocobalamin (B12), and vitamin E increased significantly (p0.05) as the amount of oat flour was increased up to 20%. (wheat flour). When compared to control wheat flour samples, the rates of increase ranged from 33.87 to 67.36 percent. The current findings support Kim et al., (2021), who said that oats are high in many nutrients, including vitamins (B, C, E, and K) (Mariarita et al., 2022). Vitamin B9 (folate), for example, is vital in the aetiology of neurological illnesses because it provides the methyl groups required for DNA methylation. Serine, methionine, glycine, and histidine are among the amino acids involved in its metabolism. Low intakes of these three vitamins (B6, B9, and B12), especially B9 (folate), are inversely related to plasma homocysteine concentrations, and elevated plasma homocysteine concentrations (>15 μ) are associated with several dangerous diathesis. Dementia, particularly Alzheimer's disease, is another disorder being researched as a possible link to low folate levels (Ravaglia et al., 2005). Folate appears to affect memory and intellectual thinking. Plasma homocysteine concentrations, which are affected in part by folate status, have been linked to cognitive impairment and dementia (Selhub, 2002 and Anita et al., 2020). Folate deficiency or poor folate status has also been linked to the onset of various malignancies, particularly colon and colorectal cancers. In terms of structure and function, Vitamins B are a diverse group. Vitamin B1 is a water-soluble vitamin that can be found naturally in some foods, as well as added to them and sold as a supplement. Thiamin is required for the growth and operation of many cells. A shortage in thiamin can create a variety of disorders in the brain and heart that require a continual source of energy (NIH, 2019). Vitamin B9 is not synthesised by mammalian cells, and its lack has been linked to a range of diseases. Many studies have focused on the health advantages of increasing folate intakes, and many nations have required folate enrichment programmes. A number of recent studies have found that large intakes of B9, the chemically produced version, but not natural folates, can have negative consequences in some people, including concealing haematological symptoms of vitamin B12 insufficiency, leukaemia, arthritis, bowel cancer, and ectopic pregnancies (Suitor et al., 2000; and Ramya and Tomar, 2009). Oat flour, on the other hand, is high in vitamin E. Vitamin E is a lipid-soluble component of the cell's antioxidant defence mechanism that can only be absorbed through food. Because of its antioxidant activity, it plays a variety of critical roles in the body. Vitamin E has been demonstrated to be beneficial against oxidation, which has been connected to a variety of ailments and diseases, including cancer, ageing, arthritis, and cataracts. Vitamin E can assist to prevent platelet hyperaggregation, which can contribute to atherosclerosis; it also helps to limit the formation of prostaglandins like thromboxane, which cause platelet clumping (Saliha et al., 2014).

Table 4. Vitamins content of control and composite wheat flour

Component	Wheat flour (	Oat flour (OF,	Composite wheat flour							
			OF (5%)		OF (10%)		OF (15%)		OF (20%)	
			g/100 g	% of cha	g/100 g	% of cha	g/100 g	% of cha	g/100 g	% of cha

	WF, 85 %)	85 %)		nge		nge		nge		nge
Thiamine (B1)	0.171 [c]	0.682 [a]	0.200 [b]	16.71	0.226 [b]	31.88	0.251 [b]	47.05	0.277 [b]	62.23
Riboflavin (B2)	0.192 [e]	0.751 [a]	0.218 [b]	13.32	0.245 [c]	27.72	0.273 [cd]	42.12	0.301 [d]	56.52
Niacin (B3)	0.189 [d]	0.793 [a]	0.224 [b]	18.41	0.253 [b]	33.67	0.285 [bc]	51.04	0.316 [c]	67.36
Pyridoxine B6	0.09 [d]	0.281 [a]	0.102 [b]	12.32	0.112 [b]	22.93	0.124 [bc]	35.75	0.131	44.17 [c]
Folate (B9)	0.028 [c]	0.069 [a]	0.029 [b]	5.20	0.031 [b]	12.37	0.033 [b]	19.55	0.037 [b]	33.87
Cyanocobalamin (B12)	0.049 [c]	0.117 [a]	0.054 [b]	9.30	0.058 [b]	18.44	0.061 [b]	23.49	0.064 [b]	30.58
Vitamin	0.051 [c]	0.16	0.058	12.87	0.064	24.58	0.069	35.30	0.077	51.91

E		9 [a]	b		b		b		b	

Values with the superscript letters in the same raw were significant different at $p \leq 0.05$.

Bioactive compounds and dietary fiber content in wheat and oat flours

Bioactive compounds in in wheat and oat flours were shown in Table (5). From such data it could be noticed that dietary fiber was the most largest compound (7.45 ± 0.67 and 12.44± 0.1.02 mg. 100 g^{-1}) followed by carotenoids (2.76 ± 0.27 and 4.97 ± 0.18 mg. 100g^{-1}),_β-glucans , 0.45 ± 0.11and 4.46± 0.42_mg. 100g^{-1}),_ flavonoids (1.98 ± 0.42 and 2.36 ± 0.30 mg catechin equivalent. 100 g^{-1}), and Phenolics (2.14 ± 0.37 and 3.35 ± 0.28 mg gallic acid equivalent. 100 g^{-1}) in wheat and oat flours, respectively. Oats comprise 66 percent carbs, 11 percent dietary fibre, and 4 percent beta-glucans, according to Chan (2020). Oats are unique among cereals, according to Alsom Varma et al., (2016). It is high in total proteins, carbs (such as starch), crude fat, dietary fibre (nonstarch), antioxidants, vitamins, and minerals. They also contain esterlinked glycerol conjugates, esterlinked alkyl conjugates, ether and esterlinked glycerides, anthranilic acids, and AVEs, among other phenolic chemicals. These chemicals have a lot of antioxidant properties. These antioxidants are concentrated in the bran part of the oat grain's outer layer of the kernel. Dietary fibres (DFs) were abundant in oat samples from a nutritional standpoint. DF's are good for human health as they make an excellent intestinal environment by favoring the growth of intestinal microflora, including probiotic species so they can be considered as prebiotic Fibers are primarily insoluble and can bind bile acids, according to Camire et al.

(1993) and Elbasouny et al. (2019). Bile acid binding is thought to be one of the processes by which certain DF sources reduce plasma cholesterol. Furthermore, high DF intake has a favourable effect on blood glucose profile and related health issues in both healthy and diabetic persons. DFs can affect the absorption of other simple sugars by changing the stomach emptying time (Chandalia *et al.,* 2000 and reviewed in Al-Weshahy and Rao, 2012). Other bioactive compounds i.e. Phenolics, flavonoids and carotenoids which were determined in oat flour play important biological roles in preventing and/or treating many diseases such as diabetes, atherosclerosis, cancer, obesity, bone, anemia and aging (Elhassaneen *et al.,* 2016 a, 2019, 2020). Such previous effects of these compounds are due mainly to their magical biological/antioxidant activities. The phenolics, which include their functional variants, are aromatic benzene ring compounds with one or more hydroxyl groups attached directly to an aromatic ring. These phytochemicals have a wide range of structures, ranging from simple moieties to polymers with high molecular weight, and they are biogenetically derived from two primary synthetic pathways: the shikimate pathway and the acetate pathway, both of which require carotenoids and chlorophylls to be bound to peptides in order to form pigment-protein complexes in the membrane during photosynthesis (Macpherson and Hiller, 2003; Neilson and Durnford, 2010).

Table 5. Total content of bioactive compounds and dietary fiber (Mean±SD) in wheat and oat flours

Component	Wheat flour (WF, 85%)	Oat flour (OF, 85%)
Dietary fiber ($g.100g^{-1}$)	7.45 ± 0.67^{b}	$12.44 \pm 0.1.02^{a}$

β-glucans (soluble fiber) (g.100g^{-1})	0.45 ± 0.11 ^{b}	4.46± 0.42 ^{a}
Phenolics (mg gallic acid equivalent. 100 g^{-1})	2.14 ± 0.37 ^{b}	3.35 ± 0.28 ^{a}
Flavonoids (mg catechin equivalent. 100 g^{-1})	1.98 ± 0.42 ^{a}	2.36 ± 0.30 ^{a}
Carotenoids (mg.100g^{-1})	2.76 ± 0.27 ^{b}	4.97 ± 0.18 ^{a}

*Each value represents the mean of three replicates ±SD. Means with the superscript letters in the same raw were significant different at $p \leq 0.05$.

Biological Activities

Antioxidant activities of aqueous control and composite wheat flour extracts

Antioxidant activity of aqueous control and composite wheat flour extract is tabulated in Table (6). From such data it could be noticed that Oat flour samples sample showed high antioxidant activity (AA, 63.78 ± 1.12%) and wheat flour showed low one (AA, 29.78 ± 1.56%). With the increasing addition of oat flour up to 20%, the value of AA in the samples were significant (p≤0.05) increasing in comparison with the control sample (wheat flour) which ranged 34.75 ± 1.70 to 46.76 ± 0.87%. The AA in OF is correlated with the reasonable content of different bioactive compounds such as phenolics, flavonoids and carotenoids. The variation in the AA values in composite flours may be possible due to the presence of different quantities of such specific bioactive compounds (Elhassaneen et al., 2014 a-b). Such findings are consistent with those of Kim et al., (2021), who found that oats are high in vitamins (B, C, E, and K) as well as bioactive chemicals (beta-carotene, polyphenols, chlorophyll, and flavonoids), all of which have antioxidant activity. Oats also contain a substantial quantity of unique antioxidant, vitamin, mineral, and phenolic compounds such as esterlinked glycerol conjugates, esterlinked alkyl conjugates, ether and esterlinked glycerides, anthranilic acids, and AVEs, according to Varma et al., (2016). These chemicals have a lot of antioxidant properties.

Table (6). Antioxidant activity (AA) of control, composite wheat flour and standards

Factor	Value (Mean ±SD)
Antioxidant activity (Wheat flour, WF)	29.78 ± 1.56 [e]
Antioxidant activity (Oat flour, OF)	63.78 ± 1.12 [c]
Antioxidant activity (WE+ 5% OF)	34.75 ± 1.70 [e]
Antioxidant activity (WE+ 10% OF)	38.89 ± 1.23 [de]
Antioxidant activity (WE+ 15% OF)	43.56 ± 0.98 [d]
Antioxidant activity (WE+ 20% OF)	46.76 ± 0.87 [d]
α-tocopherol (Standard, 50 mg/L)	98.34 ± 0.26 [a]
Butalyted hydroxyl toluene (BHT,Standard, 50 mg/L)	87.56 ± 0.19 [b]

[*] Each value represents the mean of ten replicates ±SD. Mean values with the different superscript letters in the same column mean significantly different at level p≤0.05.

DPPH radical scavenging activity

The free radical scavenging activity (RSA, %) of aqueous control and composite wheat flour extract and standard (BHT) are shown in Figure (1) and Table (7). Such data indicated that Oar flour possessed the highest scavenging activity while wheat flour samples exhibit the lowest one.With the increasing addition of oat flour up to 20%, the value of RSA in the samples were significant ($p \leq 0.05$) increasing in comparison with the control sample (wheat flour) which ranged. The RSA of wheat and oat flours were 26.12 and 60.96 percent, respectively, at a concentration of 100 g/mL, whereas the standard BHT was 90.29 percent. The oat flour sample had an IC50 of 44.80 g/mL, while the control and composite wheat flour samples were undetectable. BHT (standard) had an IC50 of 88.93 g/mL.

The following is a list of the free radical scavenging activity of the many examined samples and the standard: Oat flour > composite flour > wheat flour > standard (BHT). DPPH approach has been successfully employed to test the antioxidant activity/oxidative stability of various plant components in several research. many studies reviewed that the free radical scavenging activity are very important to prevent the adverse role of free radicals in different diseases including obesity, cancer, cardiovascular, diabetes, neurological, pulmonary diseases (Elbasouny et al., 2019). The results of this study suggest that oat flour showed free radical scavenging activity which due to their high content of different categories of bioactive compounds (antioxidants) including phenolics, carotenoids, β-glucans, flavonoids etc.

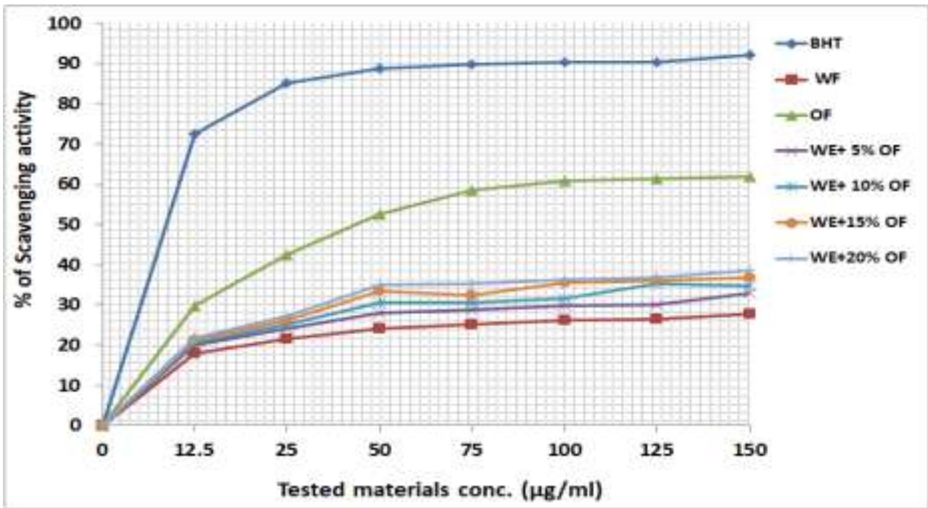

Figure 1. DPPH radical scavenging activity (%) of control, composite wheat flour and standard (BHT)*

* Each value represents the mean value of three replicates.

Table 7. IC_{50} (DPPH) of control, composite wheat flour and standard (BHT)*

Tested Materials	Butylated hydroxytoluene (BHT)	Wheat flour (WF)	Oat flour (OF)	WE + 5% OF	WE + 10 % OF	WE +15 % OF	WE +20 % OF
IC_{50} (µg/mL)	8.41	44.8	ND	ND	ND	ND	ND

* Each value represents the mean value of three replicates ±SD. Values with different superscript letters in the same raw are significantly did different at p≤0.05.

Biological studies

The effect of oat flour on body weight of obese rats

The effect of oat flour on body weight of obese rats was shown in Figure (2). From such data it could be noticed that feeding of rats on diet induced obesity (DIO) leads to increase the body weight (BW) than the control group. At the end of the experiment (8 weeks), rats of the normal group recorded 74.95% of baseline for the body weight while obese group was 128.50% of baseline. Alteration of diets starch with oat flour by the level of 5, 10, 15 and 20% exhibited significant ($p \leq 0.05$) decreasing on BW of the obese rats which recorded 109.53, 99.45, 91.78 and 79.18% of baseline, respectively. The higher effect on weigh decreasing was recorded dose-response effect for oat flour. The effect of oat flour in the control of obesity is the main topics of several studies (Penga et al., 2013, El Shebini et al., 2014; and Janda et al., 2019). Although several randomised controlled trials have shown that consuming Β-glucan oat fibre can increase satiety, other studies have not consistently shown that consuming oats results in significant weight loss (Hou et al., 2015; Rebello et al., 2015; and Li et al., 2016 Wanchai et al., 2016 Wanchai et al., 2016 Wanchai et al., 2016 Wanchai e (2018). El Shebini et al., (2014) also found that a dietary therapy consisting of whole grains of oat and wheat reduced body weight. The high presence of numerous categories of bioactive components in oat flour, such as Β-glucan, phenolics, flavonoids, and carotenoids, may explain their beneficial benefits on obesity control (Beattic *et al.,* 2005; Bedawy, 2008; Hassan, 2011; Penga et al., 2013; Mahran *et al.,* 2018-b and Janda et al., 2019). Such bioactive chemicals in oat flour have anti-obesity activities as a dietary supplement in both humans and experimental animals by reducing body fat deposition (fat burners). Furthermore, the ability of oats to minimise calorie density in the diet is the most promising method for weight loss (El Shebini et al., (2014). Furthermore, oat reduced visceral adipose tissue (VAT) in mice, which was linked to a decrease in 11 β -hydroxysteroid dehydrogenase type I (HSD11B1) expression in the liver and muscle. The NADPH-dependent enzyme HSD11B1, also known as cortisone reductase, is abundantly expressed in critical metabolic organs such as the liver, adipose tissue, and the central nervous system. HSD11B1 converts cortisone to cortisol, which activates glucocorticoid receptors in various organs (Morton, 2010). This gene produces a microsomal enzyme that converts the stress hormone cortisol to the inactive metabolite cortisone. The encoded protein can also accelerate the conversion of cortisone to cortisol in the opposite direction. A specific mutation in this gene has been linked to obesity and insulin resistance in children. For this gene, there are two transcript variants that encode the same protein (Pereira et al., 2002). Also, Stulnig and Waldhaus, (2004) explain the influence of 11β-dehy- drogenase to oxo-reductase reaction catalysed by 11β-HSD1 on adipose tissue biology (Figures 6 and 7). They discovered that during the development of visceral preadipocytes, 11-HSD1 switched from 11-dehydrogenase to oxo-reductase process. In obese visceral preadipocytes, the threshold for this flip appears to be higher than in non-obese subjects. As a compensatory mechanism against central and general adiposity, Chedid et al. (2019) found that obese persons may have lower intra-abdominal VAT HSD11B1 gene expression, resulting in decreased intra-abdominal cortisol levels. Additionally, bioactive compounds functional groups have been shown to influence gene expression and cell (including adipocyte) function by interacting with several nuclear receptor superfamily transcription factors, interfering with the activity of other transcription factors, modulating inflammatory and oxidative stress signalling pathways, and extra-genomic actions such as reactive species scavenging (Bray, 2004; Stulnig and Waldhaus, 2004, Nicholas and Jonathan, 2008; Bonet *et al.*, 2015; Elmaadawy *et al.*, 2016; Elhassaneen et al., 2020 and Mehram *et al.*, 2021). Therefore, all of these mechanisms participate to their action control of adipocyte function, adiposity and obesity.

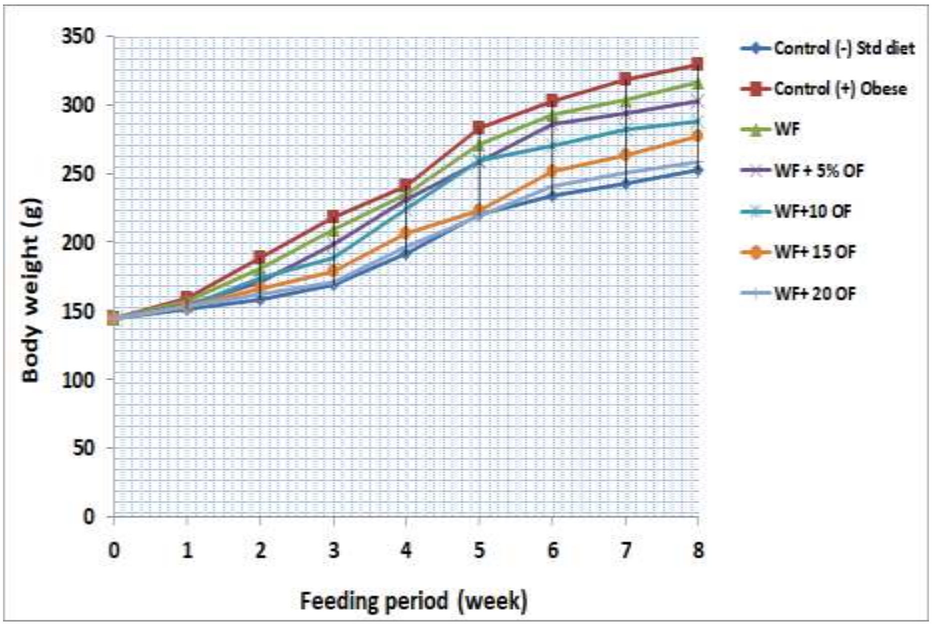

Figure 2. The effect of control and composite wheat bread on body weight gain (g) of obese rats WF, wheat four, OF, Oat flour.

Effect of control and composite wheat flour on serum lipid profile of obese rats

The effect of control and composite wheat flour on serum lipid profile of obese rats was shown in Table (8). From such data it could be noticed that obesity induced a significant increased (*p*≤0.05) in TG (41.70%), TC (37.60%), LDL (116.89%), VLDL (41.70%) while significant decreased (*p*≤0.05) in HDL (-36.92%) compared to normal controls. Replacement of wheat flour with oat flour by 5, 10, 15 and 20% induced significant (p≤0.5) improvements on blood lipid profile through decreasing the TG, TC, LDL and VLDL by the ratio of 29.36, 22.00, 19.43 and 14.48%; 29.16, 24.00, 15.63 and 14.26%; 88.36, 73.26, 52.42, 44.62; and 29.36, 22.00, 19.43 and 14.48%, respectively. The opposite direction was observed for the HDL levels. The improving of the blood lipid profile disorders induced by obesity in rats was increased with the increasing of oat wheat levels. In the same vein, modelling based on systematic reviews of RCTs reveals that modest and sustained weight loss (5-10 kg) in individuals with overweight or obesity is linked to lower levels of LDL, total cholesterol, and triglycerides, as well as higher levels of HDL. (Neter *et al*, 2003; Avenell *et al.*, 2004; Poobalan *et al.*, 2004; Christensen *et al.*, 2007; Bales and Buhr, 2008 and Williamson *et al.*, 2009; Elhassaneen and Salem 2014). Penga et al. (2013) also looked into whether oat could help with obesity, body fat, serum parameters, and liver lipid metabolism. Oat successfully lowered body weight and fat in rats fed a high-fat diet (HFD), as well as food efficiency but not appetite. Oat reduced hepatic TG and cholesterol, as well as serum glucose, free fatty acids (FFA), triacylglycerol (TG), cholesterol, and LDL-C/HDL-C, which were all raised by the HFD. The lipid synthesis indicators FAS, GPAT, and HMG CoA reductase were significantly lowered by 30% oat, but the oxidation markers

PPARa, CPT-1, and phosphorylated-AMPK were activated by 15% and 30% oat, respectively. Oat enhanced LDL receptor, which is good for decreasing serum lipids. Additionally, according to Kim et al., (2021), -glucan and avenanthramides strengthen the immune system, eliminate toxic chemicals from the body, lower blood cholesterol, and aid in dietary weight loss by improving the lipid profile and breaking down fat in the body.

Table 8. Effect of control and composite wheat bread on serum lipid profile of obese rats*

Value	Control (Ve-) Std diet	Control (Ve+) Obese diet	Obese +WF	OF (w/w)			
				5	10	15	20
Triglycerides (TG, mg/dL)							
Mean	51.05 [c]	72.34 [a]	69.12 [a]	66.04 [ab]	62.28 [b]	60.97 [b]	58.44 [b]
SD	3.11	6.03	2.67	5.13	3.65	6.32	6.45
% of Change	0.00	41.70	35.40	29.36	22.00	19.43	14.48
Total cholesterol (TC, mg/dL)							
Mean	103.67 [d]	142.65 [a]	136.61 [ab]	133.90 [b]	128.55 [b]	119.87 [bc]	118.45 [c]
SD	5.87	7.98	4.56	6.02	10.22	5..44	5.32
% of Change	0.00	37.60	31.77	29.16	24.00	15.63	14.26
High density lipoprotein (HDL, mg/dL)							
Mean	48.45	30.56	33.26	35.91	38.11	39.07	41.67

	^{a}	^{d}	^{cd}	^{c}	^{bc}	^{b}	^{b}
SD	2.56	3.21	4.03	3.05	1.89	2.17	2.56
% of Change	0.00	-36.92	-31.35	-25.88	-21.34	-19.36	-13.99
Low density lipoprotein (LDL, mg/dL)							
Mean	45.01^{e}	97.622^{a}	89.526^{b}	84.782^{bc}	77.984^{c}	68.606^{d}	65.09^{d}
SD	3.21	6.89	7.11	5.11	7.01	3.56	2.65
% of Change	0.00	116.89	98.90	88.36	73.26	52.42	44.62
Very low density lipoprotein (VHDL, mg/dL)							
Mean	10.21^{c}	14.468^{a}	13.824^{a}	13.208^{a}	12.456^{a}	12.194^{a}	11.688^{b}
SD	1.34	2.10	3.56	2.98	1.05	0.87	2.25
% of Change	0.00	41.70	35.40	29.36	22.00	19.43	14.48

WF, wheat flour, OF, oat flour. Means in the same row with different superscript letters were significantly different at $p \leq 0.05$.

Oats are linked to heart health advantages in general, however studies reveal varying degrees of benefit. Meta-analyses or reviews that evaluated different types of research or different oat forms could account for some of the difference (oat groats vs. instant). Some research looked at the intake of whole grains in general, not only oats. The type of oats utilised in other research was not specified. A systematic evaluation of nine randomised controlled trials found insufficient evidence that whole grain diets containing oats lowered the incidence of CVD or decreased blood cholesterol or blood pressure. The study authors did, however, acknowledge the modest sample numbers and short durations of the therapies (four months or less) (Kelly et al., 2017). In contrast, a meta-analysis of 18 research, mostly cohort studies, indicated that the greatest whole-grain intakes (containing various types of whole grains in addition to oats) were substantially related with a 21% lower risk of heart disease compared to the lowest intakes (Tang et al., 2015). Also, according to Penga et al., (2013), oat could be used as an adjuvant treatment for metabolic disorders by reducing obesity, body fat, and enhancing blood markers associated with metabolic control and liver lipid clearance.

Coronary heart disease (CHD) is a serious public health concern in both developed and developing nations, including Egypt. Many studies have now demonstrated that high blood levels of total or low density lipoprotein (LDL) cholesterol are potent risk factors for CHD, whereas high levels of high density lipoprotein (HDL) cholesterol or a low LDL (or total) to HDL ratio are not (reviewed in Bedawy, 2008; and Elhassaneen and Salem, 2014). The content of a person's food has a significant impact on lipid and lipoprotein concentrations in the blood. In recent years, however, the possible hypocholesrerolemic effects of several dietary components, such as found in oat including, phenolic acids, carotenoids, β-glucan, flavonoids etc have attracted much interest. Furthermore, bioactive chemicals contained in oat have antioxidant and anti-inflammatory properties that benefit cardiovascular health (Kuhlmann et al., 1998; Varma et al., 2016 and Kim et al., 2021). The early stages of atherosclerosis are thought to be influenced by LDL oxidation and endothelial cell injury

(Kaneko et al., 1994). In addition to the direct antioxidant impact, researchers discovered that phenolic compounds decreased alpha-tocopherol consumption (Hertog et al., 1992 and Kaneko et al., 1994) and protected human serum paraxonase (PON 1) activities *(*Aviram *et al., 1999).* Furthermore, McAnlis et al. (1999) claimed that phenolics, which have a strong affinity for protein, were bound to albumin and never integrated into the LDL particle. Finally, Janda et al., (2019) investigated the impact of oat products on human health, with a focus on the link between oat consumption and the development and treatment of illnesses such as type 2 diabetes, obesity, and cardiovascular disease.

In conclusion, the present study has demonstrated that the oat samples recorded high content of bioactive compounds including dietary fiber, phenolics, flavonoids and carotenoids respectively. Also, several very high biological activities which include antioxidant and radicals scavenging activities were observed. Such important bioactive compounds content and biological effects of oat played important roles in strategies to combat/treat obesity and its complications. As a result, the current study suggests that oat flour be included in our everyday meals and as a food supplement.

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التركيب الكيميائى والتقييم الغذائى ومحتوى المركبات النشطة حيويا لدقيق الشوفان (أفينا ساتيفا) وتأثيراته على السمنة فى الفئران

تهدف الدراسة الحالية إلى تقدير التركب الكيميائى والتقييم الغذائى ومحتوى المركبات النشطة حيويا في دقيق الشوفان (أفينا ساتيفا) وتأثيره على مضاعفات السمنة في الجرذان. كانت محتويات الشوفان من الرطوبة، البروتين الكلي، الدهون الخام، الألياف الخام، الرماد والكربوهيدرات في الشوفان ١٠.٣٣، ١٢.٤٥، ٦.٦٣، ٣.٧١، ٢.٠٦ و ٦٤.٨٢٪ على التوالي. أيضًا، إجمالي الطاقة (Kcal / 100g)، والاحتياجات اليومية للإنسان البالغ من البروتين / GDR) بروتين) والطاقة / GDR) الطاقة)، نسبة إشباع الاحتياجات اليومية للإنسان البالغ من البروتين / PS) البروتين) والطاقة (PS / Energy) والتي سجلت ٣٦٨.٧٥ و ٥٠٦.٠٢ و ٧٨٦.٤٤ و ١٥.٨١ و ١٠.١٧ على التوالي. علاوة على ذلك، أشار محتوى المركبات النشطة حيويا في دقيق الشوفان إلى أن الألياف الغذائية (١٠٠ جم -١)، البيتا-جلوكان (الألياف القابلة للذوبان) (جم ١٠٠ جم -١)، الفينولات (ملجم مكافئ حمض الجاليك. ١٠٠ جم -١)، الفلافونويد (معادل ملجم كاتشين .١٠٠ جم ١) والكاروتينات (ملجم ١٠٠ جم -١) كانت ١٢.٤٤ و ٤.٤٦ و ٣.٣٥ و ٢.٣٦ و ٤.٩٧ على التوالي. سجلت عينات الشوفان أيضًا العديد من الأنشطة البيولوجية المرتفعة والتي تشمل النشاط المضاد للأكسدة وأنشطة إزالة الجذور. كما لعبت مثل هذه المركبات النشطة الحيوية والتأثيرات البيولوجية لدقيق الشوفان أدوارًا مهمة في استراتيجيات مكافحة / علاج السمنة ومضاعفاتها. لذلك، أوصت الدراسة الحالية بإدراج دقيق الشوفان في وجباتنا الغذائية اليومية والمكملات الغذائية.

الكلمات المفتاحية: الشوفان، المعادن، الفيتامينات، النشاط المضاد للأكسدة، نشاط الشقوق الجذور الحرة، وزن الجسم، صورة دهون الدم.