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Antioxidant activities and bioactive compounds content of some plant parts : applications in obese rats

النشاط المضاد للأكسدة والمحتوى من المركبات النشطة حيويا لبعض الأجزاء النباتية: تطبيقات على الفئران المصابة بالسمنة

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Abstract:

The present study aims to explore the effect of three byproducts that result from food industries, namely orange peel powder (OPP), cauliflower leaves powder (CLP) and tomato pomace (TPP) and their mixture (Mix) on complication caused by obesity in rats. Such bioactive compound include phenolics, carotenoids, dietary fiber, vitamin A, vitamin C, vitamin E and essential oil were recorded in high quantity in all selected plant parts. Also, selected plant parts and their mixture showed significantly ($p \leq 0.05$) differences in antioxidant activity ranged 61.56 to 79.56% compared to α-tocopherol. Feeding of rats on diet induced obesity (DIO) leads to increase the BW than the

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control group. At the end of the experiment (8 weeks), rats of the normal group recorded % of baseline for the BW while obese group was 128.50% of baseline. The addition of the rat's diets with 5% of CLP, OLP, TPP and their mixture induced significant ($p\leq0.05$) decreasing on BW of the obese rats from 128.50% to 99.45, 109.53, 98.71 and 86.72% of baseline, respectively. The higher effect on weigh decreasing was recorded for the plant parts mixtures followed by TPP, CLP and OPP, respectively. On the other side data has demonstrated the potency of the all selected food industries byproducts and their mixture to ameliorate the liver functions, serum glucose, serum lipid profile and oxidative stress parameters. These findings provide a basis for the use of the selected food industries byproducts for the prevention and early treatment of obesity. Also, the data support the benefits of dietary modification, including food industries byproducts supplementation, in alleviating complications associated obesity.

Keywords: Body weight, orange peel, cauliflower leaves, tomato pomace, liver functions, serum glucose, serum lipid profile, oxidative stress.

الملخص العربي :

تهدف الدراسة الحالية إلى استكشاف تأثير ثلاثة من المنتجات الثانوية الناتجة عن الصناعات الغذائية ، وهي مسحوق قشر البرتقال (OPP)، ومسحوق أوراق القرنبيط (CLP)وثفل الطماطم (TPP)ومخلوطهم على المضاعفات التي تسببها السمنة في الفئران. ولقد أظهرت نتائج التحليل الكيميائى احتواء جميع أجزاء النبات المختارة على الكثير من المركبات النشطة بيولوجيًا وهى البوليفينولات والكاروتينات والألياف الغذائية وفيتامين أ وفيتامين ج وفيتامين هـ والزيوت

الطيارة والتي تم تسجيلها بكميات عالية. كما أظهرت الأجزاء النباتية المختارة ومخلوطها اختلافات معنوية ($p \le 0.05$) في نشاط مضادات الأكسدة تراوحت بين ٦١,٥٦ إلى ٧٩,٥٦٪ مقارنة مع المركب القياسى α-tocopherol ، كما أدى تغذية الفئران المصابة بالسمنة التي يسببها النظام الغذائي (DIO) إلى زيادة وزن الجسم مقارنة بالمجموعة الضابطة. في نهاية التجربة (٨ أسابيع) ، سجلت فئران المجموعة الطبيعية٪ من خط الأساس للوزن البيولوجي بينما كانت المجموعة البدينة ١٢٨,٥٠٪ من خط الأساس. أدت التغذية على وجبات الفئران التي تحتوي على ٥٪ من CLP و OLP و TPP وخليطهم إلى انخفاض معنوي ($p \le 0.05$) على وزن الفئران البدينة من ١٢٨,٥٠٪ إلى ٩٩,٤٥ و ١٠٩,٥٣ و ٩٨,٧١ و ٨٦,٧٢٪ من خط الأساس ، على التوالي. تم تسجيل التأثير الأعلى على انخفاض الوزن لخلائط أجزاء النبات تليها TPP و CLP و OPP على التوالي. على الجانب الآخر ، أظهرت البيانات فاعلية جميع المنتجات الثانوية للصناعات الغذائية المختارة وخليطها لتحسين وظائف الكبد ، وجلوكوز الدم ، وصورة دهون في الدم ، ودلائل الإجهاد التأكسدي. توفر هذه النتائج أساسًا لاستخدام المنتجات الثانوية للصناعات الغذائية للوقاية والعلاج المبكر من السمنة. أيضًا ، تدعم البيانات فوائد تعديل النظام الغذائي ، بما في ذلك مكملات المنتجات الثانوية للصناعات الغذائية في التخفيف من المضاعفات المرتبطة بالسمنة.

الكلمات المفتاحية: وزن الجسم ، قشر البرتقال ، أوراق القرنبيط ، ثفل الطماطم ، وظائف الكبد ، جلوكوز الدم ، صورة دهون الدم ، الإجهاد التأكسدي.

Introduction

Obesity is a complex disease that results from the inappropriate control of the body’s energy balance due to overfeeding and/or a sedentary way of life. In this context, both hypocaloric diets (decreased energy intake) and increased physical activity (increased energy output) result in loss of body weight and body fat. With these traditional approaches to weight loss, potential therapeutic agents could be important tools in preventing and/or treating obesity and associated metabolic diseases. Although a number of pharmacological approaches have been investigated in recent years, few therapeutically effective and safe products have been developed (Jandacek and Woods, 2004). From ancient to modern times, some plants have been utilized as medicinal agents (Samuelsson et al., 1991). These medicinal agents initially took the form of crude drugs such as tinctures, teas, poultices, powders, and other herbal formulations. The specific plants to be used and the methods of application for particular ailments were passed down through oral history. Eventually information regarding medicinal plants was recorded in herbals (Cox and Balick, 1994).

In more recent history, the use of plants as medicines has involved the isolation of bioactive compounds, beginning with the isolation of morphine from opium in the early 19th century. For example, (Itokawaet al., 2008) reported that many important bioactive compounds have been discovered from natural sources using bioactivity-directed fractionation and isolation. These bioactive compounds are mostly secondary plant metabolites, and many naturally occurring pure compounds have become medicine, dietary supplements, and other useful commercial products.

One of the most popular categories of nutrition supplements is often referred to as ‘fat burners’. The reasons for the popularity of these supplements generally include the proposed improvements in health, improvements in performance, weight loss or a combination of these factors. The term ‘fat burner’ is used to describe nutrition supplements that are claimed to acutely increase fat metabolism or energy expenditure, impair fat absorption, increase weight loss, increase fat oxidation during exercise, or somehow cause long-term adaptations that promote fat metabolism (Venuto, 2013). Often, these supplements contain a number of ingredients, each with its own proposed mechanism of action. It is often claimed that the combination of a number of these substances will have additive effects. The advertisements for many of these supplements are often accompanied by too good-to-be-true before and after photographs of individuals.

Phytochemicals are the bioactive compounds of plants that do not deliver energy and are not yet classified as essential nutrients but possess healthful properties beyond their use as macronutrients or micronutrients. Plants usually produce such low-molecular-weight ingredients for their protection against pests and diseases, for the regulation of their growth, or as pigments, essence, or odor (Perez-Vizcaino and Duarte., 2006). Scientists have identified thousands of phytochemicals, including flavonoids, glucosinolates (isothiocyanates and indoles), phenolic acids, phytates, and phytoestrogens (isoflavones and lignans), in vegetables, fruits, grains, legumes, and other plant sources. A vast variety of phytochemicals that are present in the daily human diet have been found to possess substantial antimutagenic and anticarcinogenic properties (Surh, 2002). The chemopreventive effects of the majority of edible phytochemicals are often attributed to their antioxidative or anti-inflammatory activities (Surh et al., 2001). Besides the edible chemopreventives in vegetables, fruits, herbs, and spices, some phytochemicals in diverse plants also have other beneficial health effects such as anti-obesity, lipid-lowering, and/or antidiabetic properties.

Among plant materials, food processing by-products contain not only phenolic compounds that belong mainly to the flavonoids family, but also phenolic acids. The name “phenolic acids” generally describes phenols that possess only one carboxylic acid nationality (Crozier et al., 2009). Phenolic acids exhibit acidic properties due to the presence of the carboxylic acid group. Phenolic acids are aromatic econdary plant metabolites that are widely spread throughout the plant kingdom (Hsu and Yen, 2008). Phenolic acids are present in plant-based foods such as fruits, vegetables, grains, tea, coffee, and spices, and are consumed by most humans every day. Hydroxybenzoic acids (C6–C1) and hydroxycinnamic acids (C6–C3) are phenolic acids that are predominantly found in plants. The estimated daily consumption of phenolic acids ranges from 25 mg to 1 g, depending on the diet. Most phenolic acids have shown excellent scavenging activity with respect to active oxygens such as superoxide anion radicals, hydroxyl radicals, and singlet oxygen. They have also been reported to exert antiinflammatory, antimutagenic, and anticarcinogenic activities (Crozier et al., 2009). Phenolic acids are currently being investigated for their potential anti-obesity activities. Some of them (gallic acid, capsaicin, curcumin, and coumaric acid) have anti-obesity properties.

Industrialization of agriculture in the Arab world represent a large proportion of waste was estimated at18.14 million tonnes per year and represent remnants offruit and vegetables manufacture about 6.14% of this amount. Processing of fruits and vegetables are resulting in high amounts of waste materials/py-products such as peels, seeds, stones, meals etc. It is well known that agroindustrial by-products are rich in dietary fibers, some of which contain appreciable amounts of colorants, antioxidant compounds or other substances with positive health effects, while some of them, like the oilseed meals, are rich in proteins reviewed in (Vasso and Constantina, 2007). Some major source of food by-products are mango, onion and tomato some of the most popular vegetables and fruits.

Orange is the citrus (Citrus sinensis L.) and an ever greenf lowering tree (Bailey and Bailey, 1976). Orange trees are widely cultivated in tropical and subtropical climates for the delicious sweet fruit, which is peeled or cut (to avoid the bitter rind) and eaten whole, or processed to extract orange juice, and also for the fragrant peel. In 2008, 68.5 million tons of oranges were grown worldwide, primarily in Brazil and the state of Florida in the US. Oranges probably originated in Southeast Asia and were cultivated in China by 2500 BC. The fruit of citrus sinensis is called sweet orange to distinguish it from citrus aurantium, the bitter orange. The name is thought to derive ultimately from the sanskrit for the orange tree, with its final form developing after passing through numerous intermediate languages. Citrus is most commonly thought of as a good source of vitamin C. However, like most other whole foods, citrus fruits also contain an impressive list of other essential nutrients, including both glycaemic and non-glycaemic carbohydrate (sugars and fiber), potassium, folate, calcium, thiamin, niacin, vitamin B6, phosphorus, magnesium, copper, riboflavin, pantothenic acid and a variety of phytochemicals. In addition, citrus contains no fat or sodium and, being a plant food, no cholesterol. The average energy value of fresh citrus is also low which can be very important for consumers concerned about putting on excess body weight (Whitney and Rolfs, 1999). investigated the effect of orange peel essential oil on oxidative stress in acute otitis media rats animals. It was showed that orange peel essential oil treatment could decrease serum malondialdehyde (MDA), immunoglobulin A (IgA), immunoglobulin G (IgG), immunoglobulin M (IgM) levels and increase antioxidant enzymes activities.

Brassica vegetables such as cauliflower and broccoli are popular and are among the most consumed vegetables in the world. Many epidemiological studies have indicated that a diet rich in these vegetables is associated with reduced risk of a several type of cancers, type 2 diabetes, and cardiovascular diseases. Additionally, Brassicas are known to possess antioxidant activity The non-edible parts of cauliflower (Brassica oleracea L. var.botrytis), consisting of outer leaves, stems and pods, are important by-products from the cauliflower harvest. These residues still contain high amounts of bio-actives e.g., phenolic compounds, vitamins, that are known for their bioactivities, such as the potential prevention of health risks as cardiovascular diseases, obesity, diabetes and cancer (Kashaf, 2018).

Tomato juice represents one of the most important vegetable juice with respect to per capita consumption. Such as reported by (Otto and Sulc, 2001), about 3-7% of the raw material is lost as waste during tomato juice processing. Tomato pomace consists of the dried and crushed skins and seeds of the fruit (Avelino et al., 1997). Lycopene is the principal carotenoids causing the characteristic red hue of tomatoes. Most of the lycopene is associated with the water-insoluble fraction and the skin (Sharma and Maguer, 1996). Therefore, skin extracts are especially rich in lycopene. (Baysal et al., 2000) clearly stated that a large quantity of carotenoids is lost as waste in tomato processing. Lycopene is an especially powerful antioxidant because its multiplicity of conjugated double bonds makes it a good quencher of free radicals. Lycopene is also usually one of the most common carotenoids in the blood serum. Therefore, it can be an important part of the antioxidant defense system and may function as an anticancer agent, lower heart disease risk and inhibits cholesterol synthesis (Betty, 2002). Also, the antioxidant defense system of other bioactive compounds found in tomato pomace includes vitamins (C, E), minerals (selenium, copper), phytonutrients (β-carotene, lutein), and biological products (bilirubin, coenzyme Q10) that protect tissues from oxidative damage (Jacob and Burri, 1996).

Several studies reported that all of the previous plant parts are rich sources of bioactive compounds including vitamins (C, E and β-carotene), polyphenols, organo-sulphur compounds, dietary fiber etc (Schieber et al., 2001;Pushp and Marleny, 2011; Sabeena et al., 2012 and Elhassaneen et al., 2016). Varied bioactive components at different levels may be responsible for the offered health protection. A number of experiments indicate that such by-products added to laboratory animals diet had positive effects on serum lipid profile, liver and kidney functions and serum glucose (Coskunet al., 2005; Gorinstein et al., 2006; and Matsunaga et al., 2014).The purpose of this study is to determine the bioactive compounds content and their antioxidant activities of some plant parts/ food processing by-products including orange peel, tomato pomace and cauliflower leaves. Also, evidence for the use of these proposed plant parts to enhance fat burning, as well as their potential effects on obesity-related complications will be in the scope of this study.

Materials and Methods

Materials

Food fruits

Orange (Citrus sinensis L.), Cauliflower (Brassica oleracea) and tomato (Lycopersicon esculentum MILL.) fruits were obtained from Benha local market, Qulibia Governorate, Egypt during the 2020 harvesting period. The collected samples was transported to the laboratory and used immediately for peels, leave and pomace preparation, respectively.

Chemicals

Casein was obtained from Morgan Chemical Co., Cairo, Egypt. The rest of chemicals, reagents and solvents were of analytical grade and purchased from El-Ghomhorya for Drugs, Chemicals and Medical Instruments Trading Co. (Cairo, Egypt).Vitamins standards (A, C, and E) and thiols compounds (GSH) were purchased from Sigma Chemical Co., St. Louis, MO, USA. All other reagents and solvent were of analytical or HPLC grade were purchased from (Fisher, UK). De-ionized water (Milli-Q 18.2 M□) was used in the preparation of the mobile phases, reagent solutions and standards. All chemicals, solvents and buffers (except mentioned on site) were purchased from Al-Gomhoryia Company for Trading Drugs, Chemicals and Medical Instruments, Cairo, Egypt.

Methods

Preparation of food by-products peel powder Cauliflower leaves powder (CLP)

Cauliflower leaves were washed and then dried in a hot air oven (Horizontal Forced Air Drier, Proctor and Schwartz Inc., Philadelphia, PA) at two stages 50 0C for 6 hrs followed by 40 0C for 10 hrs. The dried peels were ground into a fine powder in high mixer speed (Moulinex Egypt, Al-Araby Co., Egypt). The material that passed through an 80 mesh sieve was retained for use.

Orange peel powder (OPP)

Orange fruits were washed and peeled manually. The collected peels were dried in a hot air oven (Horizontal Forced Air Drier, Proctor and Schwartz Inc., Philadelphia, PA) at two stages 50 0C for 4 hrs followed by 40 0C for 6 hrs. The dried peels were ground into a fine powder in high mixer speed (Moulinex Egypt, Al-Araby Co., Egypt). The material that passed through an 80 mesh sieve was retained for use.

Tomato pomace powder (TPP)

Tomato fruits were minced by using high speed mixer machine (ElAraby Toshiba, Benha, Egypt) and sieving by using stainless- steel sieve,10 mesh/inch2. The resulted pomace were collected and dried in a hot air oven (Horizontal Forced Air Drier, Proctor and Schwartz Inc., Philadelphia, PA) at 55 0C until arriving by the moisture in the final product to about 10%. The dried pomace was ground into a fine powder in high mixer speed (Moulinex Egypt, Al-Araby Co., Egypt). The material that passed through an 80 mesh sieve was retained for use.

Equipment's

Throughout this study a SP Thermo Separation Products Liquid Chromatography (Thermo Separation products, San Jose, CA, USA) was used with a Consta Metvic 4100 pump, a Spectra Series AS100, Spectra System UV 1000 UV/Visible Spectrophotometer Detector, Spectra System FL 3000 and a PC 1000 system software. The columns used (Alltech, Deerfield, IL, USA) were a Spherosorb ODC-2 (5 µm, 150 x 4.6 mm I.d.) for glutathione fractions. Also, absorbance and fluorescence for different assays were measured using Labo-med. Inc., spectrophotometer, CA and Schematzu fluorescence apparatus, Japan, respectively.

Analytical methods

Chemical analysis of plant parts

Plant parts were analyzed for moisture, protein (T.N. × 6.25, micro - kjeldahl method using semiautomatic apparatus, Velp company, Italy) , fat (soxhelt miautomatic apparatus Velp company, Italy , petroleum ether solvent), ash and fiber contents were determined using the methods described in the A.O.A.C. (1995). Carbohydrates calculated by differences: Carbohydrates (%) = 100 - (% moisture + % protein + % fat + % Ash + % fiber).

Determination of nutritional value

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.%) when consuming the possibly commonly used portions in Egypt i.e. three loves (one loave, 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 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. three loves (one loave, 80 g weight)), was also calculated.

Antioxidant activity

Antioxidant activity (AA) of plant extracts and standards (□-tocopherol and BHT) was determined according to the BCB assay following a modification of the procedure described by Marco, (1968). Antioxidant activity (AA) was all calculated as percent inhibition ralative to control using Al-Saikhan et al., (1995) equation as follow: $AA = (R\ control - R\ sample) / R\ control \times 100$, Where: R control and R sample were the bleaching rates of β-carotene in reactant mixture without antioxidant and with plant extract, respectively.

Total phenolics, carotenoids and Total dietary fiber

Total phenolics, carotenoids and total dietary fiber in by-products samples were analyzed as follow: one gram of each by-product powder samples was extracted with 80% acetone and centrifuged at 10,000g for 15 min. For bread samples, one gram of bread powder was extracted with 20 ml of 80% acetone and centrifuged at 8000g at room temperature. The supernatant obtained from both samples were used for the analysis of total phenolics, and carotenoids.

Total phenolics were determined using Folin-Ciocalteu reagent (Singleton and Rossi, 1965). The total carotenoids in 80% acetone extract were determined by using the method reported by Litchenthaler (1987). Total dietary fiber was determined using the methods

Vitamins

All vitamins (A, C, and E) were extracted and analyzed by HPLC techniques as follow: Vitamin A was extracted by adaptation the method of Epler et al., (1993).

Vitamin E (□-tocopherol) was extracted by adaptation the method of Hung et al., (1980). Vitamin C (ascorbic acid) was extracted according to the method of Moeslinger et al., (1994).

The percent recoveries of vitamins were also studied by adding each vitamin to serum after sample preparation and HPLC determination. Under such chromatographic conditions, the Mean □SD values of vitamins A, C and E recoveries were 92.06 □ 3.78, 89.56 □ 2.13, and 86.76 □ 4.31, respectively.

Biological Experiments

Ethical approval

Biological experiments for this study were ethically approved by the Scientific Research Ethics Committee (Animal Care and Use), Faculty of Home Economics, Menoufia University, Shebin El-Kom, Egypt.

Animals

Animals used in this study, adult male albino rats (140-150 g per each) were obtained from Research Institute of Ophthalmology, Medical Analysis Department, Giza, Egypt.

Basal Diet

The basic diet prepared according to the following formula as follow: protein (10%), corn oil (10%), vitamin mixture (1%), mineral mixture (4%), choline chloride (0.2%), methionine (0.3%), cellulose (5%), and the remained is corn starch (69.5%). The used vitamin and metals mixture component (Tables2 and 3) was formulated

Experimental design

All biological experiments performed a complied with the rulings of the Institute of Laboratory Animal Resources, Commission on life Sciences, National Research Council (NRC, 1996). Rats (n=36 rats), were housed individually in wire cages in a room maintained at 25 ± 2 0C and kept under normal healthy conditions. All rats were fed on basal diet for one-week before starting the experiment for acclimatization.

After one week period, the rats were divided into two main groups, the first group (Group 1, 6 rats) still fed on basal diet and the other main group (30 rats) was feed with diet-induced obesity (DIO, product no.D1245, Research Diets, Inc. NJ, Protein, 24 g/100 g (Kcal, 20%) carbohydrates, 41 g/100 g (Kcal, 35%) and fat, 24g/100 g (Kcal, 45%) for 8 weeks which classified into sex sub groups as follow: group (2), fed on DIOas a positive control; group (3), fed on DIO containing 5 % CLP; group (4), fed on DIO containing 5 % TPP; group (5), fed on DIO containing 5 % OPP, group (6), fed on DIO containing 5 % mixture, CLP + TPP+ OPP by equal parts.

Blood sampling

At the end of experiment period, 8 weeks, blood samples were collected after 12 hours fasting using the abdominal aorta and rats were scarified under ether anesthetized. Blood samples were received into clean dry centrifuge tubes and left to clot at room temperature, then centrifuged for 10 minutes at 3000 rpm to separate the serum according to Drury and Wallington, (1980). Serum was carefully aspirate, transferred into clean covet tubes and stored frozen at -20oC until analysis.

Hematological analysis

Serum glucose

Enzymatic determination of serum glucose was carried out colorimetrically according to Yound, (1975).

Blood lipids profile

Triglycerides (TG), Total cholesterol (TC) and HDL-Cholesterol were determined in serum using specific kits purchased from El-Nasr Pharmaceutical Chemicals Company, Cairo, Egypt. Low density lipoprotein cholesterol (LDL-c) and very low density lipoprotein cholesterol (VLDL-c) were assayed according to the equations ofFniedewald et al., (1972) as follow: Very low density lipoprotein (VLDL cholesterol) = TG/5, LDL cholesterol = Total cholesterol – HDL cholesterol – V LDL cholesterol

Glutathione (GSH) content

Reduced glutathione (GSH) was measured colorimetrically in **serum samples**

Malonaldehyde (MDA) content

MDA content was measured as described by Buege and Aust, (1978) using a standard curve of known concentrations of malondialdehyde.

Statistical Analysis

All data were statistically analyzed using a computerized cost at program by one-way ANOVA. Results were given as means ± Standard Deviation (SD). Differences between treatments at $P \leq 0.05$ were considered significant

Results and Discussion

Proximate chemical composition of selected plant parts (food processing by-products)

The chemical composition of the selected plant parts and their mixture is shown in Table (1). From such date it could be noticed that the moisture content was ranged 7.15 - 9.50%, total protein was 3.65 -13.35%, crude fat was 2.45-3.52, crude fiber was 13.86-25.86%, ash content was 2.10-3.10% and carbohydrates were 55.37-60.77%. The CLP was recorded the highest content of protein and ash while the highest values of crude fat and fiber were recorded for OPP as well as highest values of carbohydrates for TPP. The proximate chemical composition reported was partially accordance with that observed by Sayed Ahmed, (2016), Elhassaneen, et al., (2018), Emam et al., (2018), Kashaf, (2018), El-Harby, (2019) , Elhassaneen et al., (2019),Elhassaneen et al., (2020), Khadega, (2020), Essa, E.M. (2021), and Alqallaf, (2021). Also, Marcoset al., (2006) reported that samples of tomato pomace were analyzed for moisture content, total and soluble sugars, protein, fat, soluble and total fiber, as well as mineral content. From the results obtained we can conclude that tomato pomace composition (in dry weight basis) is as follows: 59.03% fiber, 25.73% total sugars, 19.27% protein, 7.55% pectins, 5.85% total fat and 3.92% minerals. All the previous studies confirmed that varieties of plant, species, geographic conditions, site affected well on the chemical composition of plant parts including peels, skins, pomace etc.

Table 1. Proximate chemical composition (g.100g^{-1}) of selected plant parts (food processing by-products)

Parameters	Orange peel powder (OPP)		Culiflower leaves powder (CLP)		Tomato pomace powder (TPP)		Mixture (Mix, OPP+CLP+TPP)	
Moisture	9.50	±1.23^{a}	7.15	±1.11^{b}	8.60	±1.56^{a}	8.51	±0.99^{a}
Total protein	3.65	±0.98^{c}	13.35	±2.11^{c}	5.13	±0.76	8.04	±2.01^{b}

Crude fat	3.52	±0.37^{a}	2.91	±0.14^{ab}	2.45	±0.42^{b}	3.01	±0.67^{a}
Crude fiber	25.86	±2.67^{a}	13.86	±1.17^{c}	20.23	±5.67^{b}	18.99	±3.17^{b}
Ash	2.10	±0.65^{a}	3.10	±0.87^{a}	2.81	±0.45^{a}	2.55	±0.71^{ab}
Carbohydrates (by difference)	55.37	±5.78^{b}	59.62	±3.75^{a}	60.77	±4.32^{a}	58.90	±3.88^{a}

Each value represents the mean of ten replicates ±SD. Mean values with the different superscript letters in the same raw mean significantly different at level $p \leq 0.05$. Mix, mixture of OPP, CLP and TPP by equal parts

Nutritional evaluation of selected plant parts (food processing by-products)

The nutritional evaluation of the selected plant parts and their mixture is shown in Table (2). From such date it could be noticed that the total energy was ranged 267.75 - 318.11 Kcal/100g, G.D.R. (g) for protein (63 g) was ranged 471.84-1726.03 g, G.D.R. (g) for energy (2900 Kcal) was ranged 911.62 - 1083.10, P.S./ 100 g (Supposed quantity) For protein (63g) was ranged 5.79-21.19% and P.S.100 g (Supposed quantity) For energy 2900 Kcal) was ranged 9.23- 10.97%. The CLP was recorded the highest content Total energy, P.S./ 100 g (Supposed quantity, %) For protein (63g) and .S.100 g (Supposed quantity, %) For energy 2900 Kcal) while the highest values of G.D.R. (g) for protein (63 g) and G.D.R. (g) for energy (2900 Kcal) were recorded for OPP. The nutritional evaluation reported was partially accordance with that observed by **Marcos*et al.*, (2006**), **Sayed Ahmed, (2016),**

Elhassaneen, et al., (2018), Kashaf, (2018),Khadega, (2020), Essa, E.M. (2021), and Alqallaf, (2021). All the previous studies confirmed that varieties of plant parts chemical composition affected well on the nutritional evaluation of plant parts including peels, skins, pomace etc. Data of the present study (Tables 4-5) with the others confirmed that such selected plant parts could be used successfully in food technology and/or nutritional applications due to their high nutritional value, good sources for protein, fiber and ash.

Table 2. Nutritional evaluation of selected plant parts (food processing by-products)

Parameters	Orange peel powder (OPP)	Cauliflower leaves powder (CLP)	Tomato pomace powder (TPP)	Mixture (Mix, OPP+CLP+ TPP)
Total energy (Kcal/100g)	267.75^{bc}	318.11^{a}	285.68^{bc}	294.85^{b}
G.D.R. (g) for protein (63 g)	1726.03^{a}	471.84^{d}	1227.80^{b}	783.58^{c}
G.D.R. (g) for energy (2900 Kcal)	1083.10^{a}	911.62^{d}	1015.11^{b}	983.55^{c}
P.S./ 100 g (Supposed quantity, %) For protein (63g)	5.79^{d}	21.19^{a}	8.14^{c}	12.76^{b}
P.S.100 g (Supposed quantity, %) For energy 2900 Kcal)	9.23^{a}	10.97^{a}	9.85^{a}	10.17^{a}

Each value represents the mean of three replicates. Mean values with the different superscript letters in the same raw mean significantly different at level $p \leq 0.05$. Mix, mixture of BPP, TPP and OPP by equal parts.

Bioactive compounds content of selected plant parts (food processing by-products)

The bioactive compounds content of selected plant parts are shown in Table (3). The results showed that the total phenolics (mg GAE/100g, d.b.), carotenoids (mg.100g^{-1}), dietary fiber (g.100g^{-1}), vitamin A (mg/100g), vitamin C (mg/100g), vitamin E (mg/100g) and essential oil (g/100g)were recorded the highest values for CLP, OPP, OPP, mixture, CLP, CLP and OPP, respectively. Such data are partially in accordance with that observed by Sayed Ahmed, (2016), Elhassaneen, et al., (2018), Emam et al., (2018), Kashaf, (2018), El-Harby, (2019). Essa, E.M. (2021), Alqallaf, (2021). Elhassaneen et al., (2019) and Elhassaneen et al., (2020). For example, Sayed-Ahmed, (2016) found that the total carotenoids was 92.43-412.14 mg.100g^{-1} and total phenolics was 1104-7129 mg EGA.100 g^{-1} in different food by-products including cauliflower leaves. Also, Essa, (2021) found that the total carotenoids content in plant parts including cauliflower leaves and orange peel was 159.24± 5.76 to 397.65 ± 14.97 mg.100g^{-1} and total phenolics was 913 ± 87 to 1270 ± 110 mg EGA.100 g$^{-1.}$

Table 3. Bioactive compounds content of selected plant parts (food processing by-products)

Parameters	Orange peel powder (OPP)		Culiflower leaves powder (CLP)		Tomato pomace powder (TPP)		Mixture (Mix, OPP+CLP+TPP)	
Total phenolics (mg GAE/100g, d.b.)	987.45	±21.17^{b}	1154.34	±28.19^{a}	1098.22	±19.11^{a}	1087.00	±30.56^{ab}
Total carotenoids (mg.100g^{-1})	513.65	± 12.78^{a}	273.94	± 10.09^{c}	489.11	± 20.90^{a}	376.56	± 13.76^{b}
Total dietary fiber (g.100g^{-1})	34.78	±2.98^{a}	25.34	±1.89^{c}	32.56	±0.98^{a}	30.11	±3.11^{ab}
Vitamin A (mg/100g)	32.67	±4.11^{b}	7.56	±3.91^{c}	46.87	±2.76^{a}	33.17	±2.43^{b}
Vitamin C (Ascorbic acid, mg/100g)	520.76	±19.67^{a}	420.56	±17.08^{b}	210.24	±21.76^{d}	391.23	±11.87^{bc}
Vitamin E (mg/100g)	2.13	±0.34^{c}	111.56	±0.21^{a}	2.34	±0.54^{c}	40.56	±5.65^{b}
Essential oil (g/100g)	2.11	±0.19^{a}	1.04	±0.24^{b}	1.12	±0.32^{b}	1.51	±0.31^{b}

Each value represents the mean of ten replicates ±SD. Mean values with the different superscript letters in the same raw mean significantly different at level $p \leq 0.05$. Mix, mixture of OPP, CLP and TPP by equal parts

In general, data of the present study with the others confirmed that such selected plant parts could be constituted a good position in food sciences and nutritional applications through their high content of bioactive compounds including vitamins (A, C and E), phytochemicals (total phenolics, carotenoids and essential oils) and nutrients (dietary fibers). In this context, **Al-Weshahy and Rao (2012)and Alqallaf, (2021)** reviewed that dietary fiber (DF) is well known as a bulking agent, increasing the intestinal mobility and hydration of the feces. Several authors have reviewed the importance of consumption of moderate amounts of DF for human health (Ballesteros *et al.*, 2001 and **Kashaf, 2018),**). It is a broad term that includes several carbohydrates; cellulose, hemicelluloses, lignins, pectins, gums etc. **(Gallaher and Schneeman, 2001).** The studies of **Camire *et al.*, (1993), Elhassaneen*et al.*, (2019) and Elhassaneen et al., (2020)**concluded that DF are primarily insoluble, and can bind bile acids *in-vitro*. It is believed that binding of bile acids is one of the mechanisms whereby certain sources of DF lower plasma cholesterol. Also, Lazarov and Werman, (1996) studied the hypocholesterolemic effect of DF from potato peels and found that after four weeks of feeding on their, rats showed 40 % reduction in plasma cholesterol content and 30% of hepatic fat cholesterol levels were reduced as compared with animals fed only with cellulose supplemented diet. Defects of DF on lipid-profile influence several health related issues. High concentrations of low-density lipoprotein (LDL) cholesterol, other dyslipidemia (high concentration of triglycerides and low concentration of high-density lipoprotein [HDL] cholesterol), leads to blood platelets aggregation **(Bagger *et al.*, 1996),** risk factors for cardiovascular diseases (CVD) **(Erkkila and Lichtenstein, 2006 and Alqallaf, 2021))**, and hypertension **(Alonso *et al.*, 2006).** Moreover, high intake of DF has a positive influence on blood glucose profile and it is related health complications, in healthy and diabetic individuals of both types. By altering the gastric emptying time, dietary fibers are able to affect the absorption of other simple sugars. The effect of dietary fibers on blood glucose and insulin response has been demonstrated by many other authors as well **(Onyechi *et al.*, 1998 , Chandalia *et al.*, 2000, Al-Weshahy and Rao, 2012, El-Harby, 2019, Elhassaneen*et al.*, 2019 -2020 and Alqallaf, 2021).**

On the other side, phenolic compounds and carotenoids are found by significant amounts in all selected plant parts shows a variety of pharmacological and nutritional effects such as growth-inhibition of tumor and microbial cells, immunostimulatoryproperties, enhancing reproduction, improving the growthperformance (body weight gain, feed consumption, and feed conversion), reduction of cancer risk and protection against cardiovascular diseases, diabetesas well as ageing (**Teyssier *et al.*, 2001; Furusawa *et al.*, 2003; Kamal and Daoud 2003; Campos *et al.*, 2003; Gabler *et al.*, 2003; Ismail *et al.*, 2003; Wang *et al.*, 2005; and sayed-**

Ahmed, 2016; El-Harby, 2019; Elhassaneen*et al.*, 2019 - 2020 and Alqallaf, 2021). Also, the ability of these compounds to acts as antioxidants has been demonstrated in the literature. Several researchers have investigated the antioxidant activity of phenolic compounds such as flavonoid and have attempted to define the structural characteristics of flavonoids that contribute to their activity (**Nieto *et al.*, 1993; Foti *et al.*, 1996 and Alqallaf, 2021)**. Also, Phenolic acids, such as caffeic, chlorogenic, ferulic, sinapic, *p*-coumaric acids, vanillic, syringic and *p*-hydroxybenzoic appear to be active antioxidants (**Larson, 1988 and El-Sadany, 2001**). Antioxidant activity is fundamental property important for life. Many of the biological functions, such as antimutagenicity, anticarcinogenicity, antiaging and antiobesity, among others, originate from this property (**Cook and Samman, 1996; Elhassaneen *et al.*, 2016, Elmaadawy *et al.*, 2016; and Alqallaf, 2021).**

On the other side, there are the antioxidant nutrients such as vitamins C, E and β-carotene (found in selected plant parts) for which there are Dietary Reference Values (DRVs). However, there are thousands of other bioactive compounds in te selected plant parts that have antioxidant activity but are not classified as "nutrients". Also, many studies indicated that there was a positive and significant ($p \leq 0.05$) relationship between all of the previous bioactive compounds /vitamins and the antioxidant activity in different plant parts (Khoneem, 2009; Jaggi, 2012;Elhassaneen *et al.*, 2013; **Elhassaneen and Abd Elhady, 2014; Elhassaneen et al., 2016; Elmaadawy et al.,**

2016; Salama *et al.,* 2017 and **Alqallaf, (2021).** Plant-based foods generally are considered important sources of antioxidants in the diet. Antioxidants help protect cells from the potentially damaging physiological process known as "oxidative stress" (damage to healthy cells or DNA by unpaired electrons known as free radicals). Oxidative stress is thought to be associated with the development of chronic diseases including cancer, heart disease, diabetes, rheumatoid arthritis, obesity, conditions of ageing including neurodegenerative diseases such as Parkinson's and Alzheimer's disease (Halliwell, 1991, Chaitanya *et al.,* 2010; Elmaadawy *et al.,* 2016 and Salama *et al.,* 2017**;** Mahran **et al., 2018; Elhassaneen et al., 2020 and Alqallaf, (2021**). For this reason and others, the selected plant parts could be used successfully in many different therapeutic applications.

Antioxidant activity of selected plant parts (food processing by-products)

The antioxidant activities (AA) of three plant parts and their mixture are shown in Table (4). From such data it could be noticed that the selected plant parts and their mixture showed significantly ($p \leq 0.05$) differences in (61.56 – 79.56%). All of the selected plant parts and their mixture showed strong activity because of their high phytochemicals content (phenolic compounds, carotenoids, essential oils, vitamins etc). Such data are in accordance partially with that observed by Elhassaneen *et al.,* (2016); **Sayed-Ahmed, (2016);**and **Essa**, (2020) who found that some food processing by-products including cauliflower leaves, tomato pomace, orange peel and others high in their antioxidant activity due to their phenolic compounds high content. In similar study, **Velioglu *et al.*, (1998)** reported that the correlation coefficient between total phenolics and antioxidative activities of 28 plant products, including plant by-products was statistically significant. Also, many studies indicated that there was a positive and significant ($p \leq 0.01$) relationship between total phenolics and AA in different plant parts **(El-Mokadem, 2010; ElSafty, 2008; Hegazy, 2009; Ahmed, 2010; Elhassaneen *et al.*, 2016 and Sayed-Ahmed, 2016**).

Table 4. Antioxidant activity of selected plant parts (food processing by-products)

Parameters	Orange peel powder (OPP)		Culiflower leaves powder (CLP)		Tomato pomace powder (TPP)		Mixture (Mix, OPP+CLP+TPP)	
AA (%)	61.56	±3.23 ^{c}	67.67	±2.11 ^{c}	71.67	±1.67 ^{b}	79.56	±3.04 ^{a}
AA [% of BHT (50 mg/ml)]	69.73	± 2.87	76.65	± 1.98	81.18	± 1.76	90.11	±0.99
AA [% of BHT (100 mg/ml)]	64.97	±1.77	71.42	±1.90	75.64	±2.76	83.97	±2.76
AA [% of a-tocopherol (50 mg/ml)]	63.05	±0.86	69.31	±0.89	73.41	±0.99	81.49	±0.83
BHT (50 mg/ml)	88.29	±0.55	88.29	±0.87	88.29	±0.34	88.29	±019

BHT (100 mg/ml)	94.75	±0.70	94.75	±0.91	94.75	±0.83	94.75	±0.45
a-tocopherol (50 mg/ml)	97.63	±0.78	97.63	±0.67	97.63	±0.43	97.63	±0.50

Each value represents the mean of ten replicates ±SD. Mean values with the different superscript letters in the same raw mean significantly different at level $p \leq 0.05$. Mix, mixture of OPP, CLP and TPP by equal parts

Biological studies

The effect of selected plant parts on body weight of obese rats

The effect of selected plant parts powderon body weight of obese rats was shown in Figure (1). From such data it could be noticed that feeding of rats on high fat diet (HFD) leads to increase the body weight gain (BWG) than the normal control negative group. At the end of the experiment (8 weeks), rats of the normal control negative group recorded 265.06g (74.95%) for the BW while obese group was 346.18 (128.50%). The addition of the rat's dietswith 5% of CLP, OLP, TPP and their mixture induced significant ($p \leq 0.05$) decreasing on BW of the obese rats from 128.50% to 99.45, 109.53, 98.71 and 86.72%, respectively. It is clear that the higher effect on body weight decreasing was recorded for the mixture followed by TPP, CLP and OPP, respectively. Such data are in accordance with that observed by**El-Nashar, (2007); Bonet *et al.*, (2015); Sayed Ahmed, (2016); Elhassaneen *et al.*, (2018); Emam *et al.*, (2018); Kashaf, (2018); El-Harby, (2019); Essa, (2021);**

Alqallaf, (2021); Elhassaneen *et al.*, (2019) and Elhassaneen*et al.*, (2020).

In general, the effect of different selected plant parts in the control negative group of obesity is the main subjects of many studies. The positive effects of such plant parts regarding the control of the obesity could be attributed to their high level content of different classes phytochemical compounds including phenolics, flavonoids, anthocyanins, alkaloids, terpenoids, carotenoids, organosulfur compounds, essential oils and phytosterolsetc (**Velioglu *et al*., 1998, Beattic *et al.*, 2005, lmaadawy et al., 2016, Sayed Ahmed, 2016, Emam et al., 2018,Kashaf, 2018, Mahran et al., 2018, Yousif, 2019, Elhassaneen et al., 2016, Elhassaneen et al., 2020, and Alqallaf, 2021).**Such bioactive compounds and their conversion products have been shown to impact gene expression and cell (including adipocyte) function through multiple mechanisms including: interacting with several transcription factors of the nuclear receptor superfamily, interfering with the activity of other transcription factors, modulating signaling pathways which are associated with inflammatory and oxidative stress (OS) responses; and through extragenomic actions including antioxidative activity and scavenging of reactive species such oxygen reactive species (ROS), nitrogen reactive species (NRS) etc **(Bonet *et al.*, 2015; Sayed Ahmed, 2016 and Almutairiu, 2020, Alqallaf, 2021 and Mehram et al., 2021).**

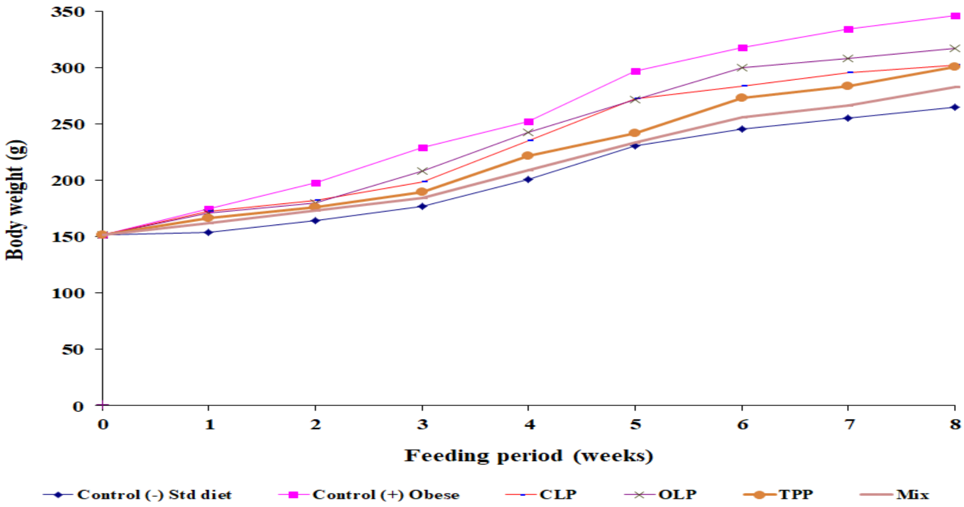

Figure 1. The effect of selected plant parts (Food processing by-products) powder on body weight gain (g)of obese rats *

* OPP, orange peel powder;; TPP, tomato pomace powder; BPP, banana peel powder extracts and Mix, mixture extracts of OPP, TPP and BPP by equal parts.

Effect of selected plant parts (Food processing by-products) powder on serum glucose level of obese rat

Glucose level in serum of obese rats consumed selected plant parts (Food processing by-products) powder was shown in Table (5). From such data it could be noticed that obesity induced a significant ($p \leq 0.05$) increased ($p \leq 0.05$) in serum glucose by 25.22% compared to the normal control group. The addition of the rat's dietswith 5% of CLP, TPP, OPP and their mixture induced significant ($p \leq 0.05$) decreasing on serum glucose levels which recorded 9.58, 9.12, 13.06 and 7.09 (% of normal control negative group), respectively. The higher protection effect in serum glucose level rising induced by obesity in rats was recorded for the mixture treatment followed by CLP, TPP, and OPP, respectively. Such data are in accordance with that observed by **Sayed Ahmed (2016),Younis, (2016), Aly et al., (2017), Kashaf, (2018), El-Harby, (2019). Essa, (2021) and Alqallaf, (2021).**

The decreasing in serum glucose level as the result of feeding selected plant parts was the subject of many studies. For example, significant ($p \leq 0.05$) research has been done on the effect of cauliflower leaves consumption on diabetic conditions. The organosulfur compounds found in cauliflower leaves were linked to significant amelioration of weight loss, hyperglycemia, low liver protein and glycogen, and other characteristics of diabetes mellitus in rats **(Sayed Ahmed, 2016 and Alqallaf, 2021).**Feeding obese rats with bread samples supplemented with food processing by-products including cauliflower leaves **(Sayed, 2016)**. Also, in most cases, citrus is most commonly thought of as a good source of vitamin C (ascorbic acid). However, like most other whole foods, citrus fruits also contain an impressive list of other essential nutrients, including both glycaemic and non-glycaemic carbohydrate (sugars and fiber), potassium, folate, calcium, thiamin, niacin, vitamin B_6, phosphorus, magnesium, copper, riboflavin, pantothenic acid and a variety of phytochemicals (**Sayed, 2020).**Furthermore, **Whitney and Rolfs, (1999**) found that citrus contains no fat or sodium and, being a plant food, no cholesterol. The average energy value of fresh citrus is also low which can be very important for consumers concerned about putting on excess body weight. For tomato pomace, the antioxidant defense system of other bioactive compounds found in tomato pomace includes vitamins (C and E), minerals (selenium, copper), phytonutrients (β-carotene, lutein), and biological products (bilirubin, coenzyme Q_{10}) that protect tissues from oxidative damage induced in diabetic cases (**Jacob and Burri, 1996** and **Aly*et al.*, 2017)**. Additionally, the mixture treatment gave maximum hypoglycemic effect when compared with the all selected plant parts individually. It could be mean that a combination of different plant parts may be more efficient for reducing the serum glucose level because the interactive effects occurred by different categories of bioactive compounds of different plant parts used. Such data are in accordance with that observed by **Sayed Ahmed, (2016)**, **Aly *et al.*, (2017),and Kashaf, (2018).**

In general, **Avenell *et al.*, (2004) and Vettor *et al.*, (2005)** found that in patients with type-2 diabetes, weight loss of around 5 kg is associated with a reduction in fasting blood glucose of between 0.17 mmol/L to 0.24 mmol/L at 12 months. Data of the present study with the others indicated that might improve glucose response and insulin resistance associated with type 2 diabetes by alleviating metabolic dysregulation of free fatty acids, suppressing oxidative stress, up-regulating glucose uptake at peripheral tissues, down-regulating inflammatory gene expression in liver and/or improvement the antioxidant defense system in the body (**Younis, 2016, Sayed**

Ahmed et al., 2016, Aly et al., 2017, Kashaf, 2018, El-Harby, 2019, and Essa, 2021).

Table 5. Effect of selected plant parts (Food processing by-products) powder on serum glucose concentration (mg/dL) of obese rats*

Value	Control (-) Std diet	Control (+) Obese diet	Plant parts powder (5%, w/w)			
			CLP	TPP	OPP	Mix
Mean	98.67	123.55	108.12	107.67	111.56	105.67
SD	9.09	10.38	7.96	9.92	8.27	10.56
% of Change	0.00	25.22	9.58	9.12	13.06	7.09

* CLP, cauliflower peel powder ; TPP, tomato pomace powder; OPP, orange peel powder and their Mix, mixture extracts of CLP, TPP, and OPP by equal parts. Means in the same row with different superscript letters are significantly different at p≤ 0.05.

Effect of selected plant parts (food processing by-products) powder on serum lipids profile concentration of obese rats

The effect of selected plant powder on serum lipids profile concentration of obese ratswas shown in Table (6). From such data it could be noticed that obesity induced a significant ($p \leq 0.05$) increased in TG (42.11%), TC (38.52), LDL (100.10%), and VLDL (42.11%) while significant ($p \leq 0.05$) decreasing in HDL (-33.25%) compared to normal control group. The addition of the rat's dietswith 5% of CLP, TPP, OPP and their mixture induced significant ($p \leq 0.05$) improvements on serum lipid profile through decreasing their

TG, TC, LDL and VLDL levels by different ratios. The addition of the rat's dietswith 5% of CLP, TPP, OPP and their mixture induced significant ($p \leq 0.05$) decreasing on serum TG, TC, LDL and VLDL levels which recorded 28.70, 22.52, 28.57 and 16.32; 17.68; 15.01; 20.55 and 10.02; 49.36, 42.24, 58.42 and 26.65; and 28.70, 22.52, 28.57 and 16.32% (of normal control negative group), respectively. The opposite direction was observed for the HDL levels. The higher effects of improving of the serum lipid profile disorders induced by obesity in rats were recorded for the mixture treatment followed by TPP, CLP and OPP, respectively. Such data are in accordance with that observed by**Elhassaneen, et al., (2018), Emam et al., (2018), Alqallaf, (2021), Elhassaneen et al., (2019) and Elhassaneen et al., (2020).** Also, **El-Harbi, (2018), Elbasouny et al., (2019), Almutairiu, F. M. (2020) and Alqallaf, (2021)**recorded the same results when feeding obese rats with bread samples supplemented with food processing by-products including cauliflower leaves, and tomato pomace powders. In the same context, modeling based on systematic reviews of RCTs suggests that modest and sustained weight loss (5-10 kg) in patients with overweight or obesity is associated withreductions in LDLP, TC and TG and with increased levels of HDL (**Avenell *et al.*, 2004; Poobalan *et al.*, 2004; Christensen *et al.*, 2007; Bales and Buhr, 2008; and Elhassaneen ad Salem, 2014)**.

In general, coronary heart disease (CHD) is a major health problem in both industrial and developing countries including Egypt. Many studies have now shown that blood elevated concentrations of TC or LDL-c in the blood are powerful risk factors for CHD, whereas high concentrations of HDL-c or a low LDL-c (or total) to HDL . The composition of the human diet(s) plays an important role in the management of lipid and lipoprotein concentrations in the blood. Reduction in saturated fat and cholesterol intake has traditionally been the first goal of dietary therapy in lowering the risk for cardiovascular disease. In recent years, however, the possible hypocholesrerolemic effects of several dietary components, such as found in our selected plant parts (TPP, CLP and OPP) including, phenolics, flavonoids, anthocyanins, alkaloids, terpenoids, carotenoids, organosulfur compounds, essential oils and phytosterolsetc have attracted much interest. Data of the present study with the others indicated that might improve serum lipid profile subsequently beneficial effects on cardiovascular health through the antioxidant and anti-inflammatory activities induced by the previous bioactive compounds in particular phenolic compounds and carotenoids **(El-Harbi, 2018, Emam et al., 2018, and Kashaf, 2018).**

Effect of selected plant parts on serum antioxidant of obese rats

Biological antioxidant molecules i.e. reduced glutathione (GSH) concentration in serum of obese rats consumed the tested plant parts in diet were assessed and shown in Table (7). From such data it could be noticed that obesity induced a significant ($p \leq 0.05$) decreased in serum GSH by -28.46% compared to the

Table 6. Effect of selected plant parts (Food processing by-products) powder on blood lipids profile concentration of obese rats*

Value	Control (-) Std diet	Control (+) Obese diet	Plant parts powder (5%, w/w)			
			CLP	TPP	OPP	Mix
Triglycerides (TG, mg/dL)						
Mean	48.23	68.54	62.07	59.09	62.01	56.10
SD	4.99	5.54	5.92	4.64	4.32	5.90
% of Change	0.00	42.11	28.70	22.52	28.57	16.32
Total cholesterol (TC, mg/dL)						
Mean	108.21	149.89	127.34	124.45	130.45	119.05
SD	11.67	20.33	14.27	10.88	12.69	13.14
% of Change	0.00	38.52	17.68	15.01	20.55	10.02
High density lipoprotein (HDL, mg/dL)						
Mean	45.78	30.56	36.09	37.55	34.43	40.98
SD	4.21	2.88	3.00	3.11	2.11	2.56
% of Change	0.00	-33.25	-21.17	-17.98	-24.79	-10.48
Low density lipoprotein (LDL, mg/dL)						
Mean	52.78	105.62	78.84	75.08	83.62	66.85
SD	3.56	6.62	7.18	4.84	7.62	5.09
% of	0.00	100.10	49.36	42.24	58.42	26.65

Change						
Very low density lipoprotein (VHDL, mg/dL)						
Mean	9.65	13.71	12.41	11.82	12.40	11.22
SD	0.78	0.92	0.78	1.80	0.63	0.67
% of Change	0.00	42.11	28.70	22.52	28.57	16.32

* CLP, cauliflower peel powder ; TPP, tomato pomace powder; OPP, orange peel powder and their Mix, mixture extracts of CLP, TPP, and OPP by equal parts. Means in the same row with different superscript letters are significantly different at $p \leq 0.05$.

normal control group. The addition of the rat's dietswith 5% of CLP, TPP, OPP and their mixture induced significant ($p \leq 0.05$) increasing on serum GSH concentration which recorded -11.86, -10.96, -14.54 and -8.74 (% of normal control negative group), respectively. The higher protection effect in serum GSH concentration rising induced by obesity in rats was recorded for the mixture treatment followed by CLP, TPP and OPP, respectively. Such data are in accordance with that observed by**Elhassaneen et al., (2016), Elmaadawy et al., (2016), El-Harbi, (2018), Emam et al., (2018), Mahran et al., (2018), Yousif, (2019), Elhassaneen et al., (2020), Alqallaf, (2021).** Also, **Kashaf, (2018), and Essa, (2021),** recorded the same results when feeding obese rats with bread samples supplemented with food processing by-products including cauliflower leaves, and tomato pomace powders.

Reduced glutathion (GSH) is a tripeptide-thiol (γ-glutamyl cysteinyl-glycine) that has received considerable attention in terms of its biosynthesis, regulation, and various intracellular functions **(Reed and Beatty, 1980; and Elhassaneen, 1996).** Among of these function are two constructing roles in detoxifications, as a key conjugate of electrophilic intermediates, principally via glutathione-*s*-transferase activities in phase II metabolism, and as an important antioxidant. The antioxidant functions of GSH includes its role in the activities of GSH enzymes family including glutathione peroxidase (GSH-Px) and peroxiredoxins (PRXs). In addition, GSH can apparently serve as a nonenzymatic scavenger of oxyradicals **(Halliwell and Gutteridge, 1985, elhassaneen 1996 and Elhassaneen *et al.*, 2016).** In this context, reported that various enzymes inside the cells including adipocytes can also produce reactive oxygen species (ROS). The selected plant parts (TPP, CLP and OPP) in the present study and their mixtures feeding are rich in bioactive compounds including, phenolics, flavonoids, anthocyanins, alkaloids, terpenoids, carotenoids, organosulfur compounds, essential oils and phytosterolsetc which exhibited antioxidant effects against ROS formation as the obesity development through several mechanism of action including the raising of redox status including GSH in the body **(Elhassaneen et al., (2016), Emam et al., 2018, Kashaf, 2018, Mahran et al., (2018), Elhassaneen et al., 2020), Alqallaf, 2021).**Also, similar findings were observed by **ElMaadawy *et al.*,(2016)** and El-Harbi (2018) who studied the oxidative stress (OS) and antioxidant defense systems status in obese rats feeding some selected food processing by-products including tomato pomace, eggplant peel, pomegranate peel and onion skin) applied in bread.

Table 7. Effect of selected plant parts (Food processing by-products) powder on plasma reduced glutathione (GSH, µmol /L) concentration of obese rats*

Value	Control (-) Std diet	Control (+) Obese diet	Plant parts powder (5%, w/w)			
			CLP	TPP	OPP	Mix
Mean	11.21	8.02	9.88	9.98	9.58	10.23
SD	0.95	0.88	1.11	1.84	0.81	1.03
% of Change	0.00	-28.46	-11.86	-10.96	-14.54	-8.74

* CLP, cauliflower peel powder ; TPP, tomato pomace powder; OPP, orange peel powder and their Mix, mixture extracts of CLP, TPP, and OPP by equal parts. Means in the same row with different superscript letters are significantly different at p≤ 0.05.

Effect of selected plant parts powder on serum oxidants of obese rats

Oxidative stress (OS) status in obese rats feeding some selected plant parts was assessed by measuring an important oxidant concentration in serum i.e malonaldehyde, MDA (Table 8). From such data it could be noticed that obesity induced a significant ($p \leq 0.05$) increased in MDA concentration in serum by 32.75% compared to normal control negative group. The addition of the rat's dietswith 5% of CLP, TPP, OPP and their mixture induced significant ($p \leq 0.05$) increasing on serum

MDA levels which recorded 10.80, 16.72 and 9.41 (% of normal control negative group), respectively. The higher protection effect in serum MDA level rising induced by obesity in rats was recorded for the mixture treatment followed by CLP, TPP, and OPP, respectively. Such data are in accordance with that observed by **Elhassaneen et al., (2016), Elmaadawy et al., (2016), El-Harbi, (2018), Emam et al., (2018), Mahran et al., (2018), Yousif, (2019), Elhassaneen et al., (2020), Alqallaf, (2021).** Also, **Kashaf, (2018), and Essa, (2021),** recorded the same results when feeding obese rats with bread samples supplemented with food processing by-products including cauliflower leaves and tomato pomace powders. In the same context, clinical evidences for obesity-associated oxidative stress (OS) have been provided by measurement of either biomarkers or end-products of free radical-mediated OS **(Elhassaneen and Salem, 2014, Sayed Ahmed, 2016, El-Harbi, 2018 and Mahran et al., 2018).** For example, lipid peroxidation markers, MDA, one of the most important compounds and major products of the oxidation of polyunsaturated fatty acids (PUFA), lipid hydroperoxides and conjugated dienes are found to be increased in serum from obese subjects in many clinical studies **(Vincent and Taylor, 2006 and Elhassaneen and Salem, 2014).** The increase in biological oxidant (MDA) induced by obesity could be attributed to one or more of the following mechanisms: 1) systemic metabolic alterations associated with obesity contribute to the increase in OS i.e. hyperglycemia as a hallmark of type II diabetes, a metabolic complication of obesity, induces OS through activation of the polyol and hexosamine pathways, production of advanced glycation end-products (AGE), and increase of diacylglycerols (DAG) synthesis **(DCCTRG, 1993 and Le Lay *et al.*, 2014), 2)** Excess of circulating lipids induces ROS formation pathways, which contribute to the increase in lipid oxidation and protein carbonylation **(Jensen *et al.*, 1989 and Elhassaneen and Salem, 2014), and 3)** Leptin and angiotensin II, secreted at high levels by adipocytes, are inducers of ROS generation and might therefore promote inflammation and lipid peroxidation **(Bouloumie *et al.*, 1999).**

Several decades ago, interest in the possible significance of MDA on human health has been stimulated by reports that are mutagenic and carcinogenic compound **(Shamberger *et al.*, 1974)**. The positive effects of selected plant parts powder on oxidants formation/ concentration of obese rats could be attributed to several mechanisms induced by their bioactive components content. In this context, **Coskun *et al.*, (2005)** found that flavonoids such as found in our selected plant parts, have anti-oxidative and anti-inflammatory activities. Also phenolics found in tested plant parts metabolized in liver, inhibiting liver injuries induced by diabetes i.e. enhancing lipid metabolism, reducing OS may be particularly effective, consequently (**Elmaadawy et al., 2016, Emam et al., 2018, Kashaf, 2018, Mahran et al., 2018, Elhassaneen et al., 2016, Elhassaneen et al., 2020, and Alqallaf, 2021).** Additionally, the mixture treatment gave maximum reduction yield of serum MDA when compared with the tested plant parts separately. It could be mean that a combination of different plant parts may be more efficient for reducing serum MDA level, the biomarkers of oxidative stress and inflammation in the body, because the interactive effects occurred by different categories of bioactive compounds of different plant parts used.

Table 8. Effect of selected plant parts (Food processing by-products) powder on serum malonaldehyde (MDA, mol/mL) concentration of obese rats*

Value	Control (-) Std diet	Control (+) Obese diet	Plant parts powder (5%, w/w)			
			CLP	TPP	OPP	Mix
Mean	2.87	3.81	3.35	3.18	3.25	3.14
SD	0.66	0.89	0.87	0.65	0.56	0.39
% of Change	0.00	32.75	16.72	10.80	13.24	9.41

* CLP, cauliflower peel powder ; TPP, tomato pomace powder; OPP, orange peel powder and their Mix, mixture extracts of CLP, TPP, and OPP by equal parts. Means in the same row with different superscript letters are significantly different at p≤ 0.05.

In conclusion, the present study has demonstrated that the potency of the selected food industries byproducts including CLP, TPP and OPP to ameliorate the complications/disorders in obese rats. Those complications include the liver functions, serum glucose, serum lipid profile and oxidative stress parameters. These findings provide a basis for the use of the selected food industries byproducts in the prevention and early treatment of obesity. Also, the data support the benefits of dietary modification, including bioactive compounds in food industries byproducts supplementation, in alleviating the complications associated obesity. Finally, more research must be done on the future to elucidate the realized benefits from dietary plant parts intake, such food industries by products, on obesity disease and its complications.

References

- Ahmed, S. (2010). Biological evaluation of some food additives distributed in Egyptian local markets" M.Sc. Thesis in Nutrition and Food Science, Faculty of Home Economics, Minoufiya University, Egypt.
- Almutairiu, F.M. (2020). Potential effects of phyto-bioactive and aversive on obesity and its complications in rats". M.Sc. Thesis in Nutrition and Food Science, Faculty of Specific Education, Benha University, Benha, Egypt.
- Alonso A, Beunza JJ, Bes-Rastrollo M, Pajares RM, Martinez-Gonzalez MA.(2006): Vegetable protein and fiber from cereal are inversely associated with the risk of hypertension in a Spanish cohort. Archives of Medical Research 37(6):778-786.
- Alqallaf, J. H. (2021). "Effect of feeding fortified by some Brassicaceae family vegetables on biological ahanges of obesity rats induced". Ph.D. Thesis in Nutrition and Food Science, Faculty of Specific Education, Benha University, Benha, Egypt.
- Al-Saikhan, M. S.; Howard, L. R. and Miller, J. C., Jr. (1995). Antioxidant activity and total phenolics in

different genotypes of potato (Solanum tuberosum, L.). Journal of Food Science., 60 (2): 341-343.

- Al-Weshahy A and Rao V (2012). Potato Peel as a Source of Important Phytochemical Antioxidant Nutraceuticals and Their Role in Human Health - A Review, Phytochemicals as Nutraceuticals – Global Approaches to Their Role in Nutrition and Health, Dr Venketeshwer Rao (Ed.), InTech, Rijeka, Croatia.
- Aly, A.S., Ghada M. Elbassyouny and and yousif A. Elhassaneen (2017). Studies on the antioxidant properties of vegetables processing by-products extract and their roles in the alleviation of health complications caused by diabetes in rats. Proceeding of the 1st International Conference of the Faculty of Specific Education, Kafrelsheikh University, “Specific Sciences, their Developmental Role and Challenges of Labor Market” PP 1-24, 24-27 October, 2017, Sharm ElSheikh, Egypt.
- Avelino, A., Avelino, H. T., Roseiro, J. C., & Collaco, M. T. A. (1997). Saccharification of tomato pomace for the production of biomass. Bioresource Technology, 61: 159–162.
- Bagger M, Andersen O, Nielsen JB, Ryttig KR.(1996): Dietary fibres reduce blood pressure, serum total cholesterol and platelet aggregation in rats. British Journal of Nutrition 75(3):483-493.

- Bailey, R. G. 1976. Map: Ecoregions of the United States.USDA Forest Service, Intermountain Region, Ogden, Utah.Scale 1:7,500,000
- Baysal, T., Ersus, S., and Starmans, D. A. J. (2000). Supercritical CO2 extraction of b-carotene and lycopene from tomato paste waste. Journal of Agricultural and Food Chemistry, 48, 5507–5511.
- Beattic, J.; Crozier, A. and Duthie, G. (2005). Potential Health Benefits of berries. Current Nutrition and Food Science. 1: 71-86.
- Betty, J. (2002). Lycopene and Human Health In: Phytocemicals in nutrition and health. Edited by: Mark S., Wayne R., Audra J. and Stanley T., CRC Press LLC, N.W.
- Bonet, M.; Jose A.; Joan R. and Andreu P. (2015): Carotenoids and their conversion products in the control of adipocyte function, adiposity and obesity. Archives of Biochemistry and Biophysics, 572: 112–125.
- Bouloumie, A.; T. Marumo, M. Lafontan, and R. Busse, (1999): Leptin induces oxidative stress in human endothelial cells. FASEB Journal. 13(10): 1231–1238..
- Buege, J.A. and Aust, S.D. (1978): Microsomal lipid peroxidation in Packer L., (ed), Methods in enzymology, New York, NY, Academic, 52: 302 - 310.
- Camire ME., Zhao J., and Violette DA. (1993). In vitro binding of bile acids by extruded potato peels. Journal of Agricultural and Food Chemistry .41(12):2391-2394.

- Campos, K.; Diniz, Y.; Cataneo, A.; Faine, L., Alves, M. and Novelli, E. (2003). Hypoglycaemic and antioxidant effects of onion, Allium cepa: dietary onion addition, antioxidant activity and hypoglycaemic effects on diabetic Rats.Inter. J. Food Sci. Nutr., 54(3): 241-246.
- Chaitanya, K.V.; Pathan, A.A.K.; Mazumdar, S.S.; Charavarthi, G.P.; Parine, N. and Bobbarala, V. (2010): Role of oxidative stress in human health: An overview. Journal of Pharmacy Research. 3: 1330-1333.
- Chandalia M, Garg A, Lutjohann D, von Bergmann k, Grundy SM., and Brinkley LJ. (2000): Beneficial effect of high dietary fiber intake in patients with type 2 diabetes mellitus. The New England Journal of Medicine 342:1392-1398.
- Coskun, O.; Kanter, M.; Korkmaz, A. and Oter, S. (2005): Quercetin, a flavonoid antioxidant, prevents and protects streptozotocin-induced oxidative stress and beta-cell damage in rat pancreas. Pharmacol Res, 51:11.
- Cox PA and Balick MJ (1994):The ethnobotanical approach to drug discovery. Sci Am., 270: 82-7.
- Crozier A, Jaganath IB., and Clifford MN. (2009): Dietary phenolics: chemistry, bioavailability and effects on health. Nat Prod Rep 26: 1001-43.
- DCCTRG, The Diabetes Control and Complications Trial Research Group (1993): The effect of intensive treatment of diabetes on the development and progression of long-term complications in insulin-

dependent diabetes mellitus. The New England Journal of Medicine. 329 (14): 977-986..

- Defense committee member of the PhD. Thesis/ Khadega Mohamed Sayed," Chemical and Technological Studies on some Food Products Suppmenting with Cortices Fruit ". PhD Thesis in Nutrition and Food Science, Faculty of Specific Education, Minia University, Minia, Egypt (September, 2020).
- Drury, R.A. and Wallington, E.A. (1980): Carleton's Histological Technique. 5th Edition, Oxford University Press, New York.
- El-Harby, E. N. (2019). Nutritional and Technological Studies on some Plant Parts and their effects on Obesity Complications Induced in Experimental Animals ". MSc. Thesis in Nutrition and Food Science, Faculty of Specific Education, Benha University, Benha, Egypt
- Elhassaneen Y., Ragab S., El-Beltagi A., and Emad A. (2013): Mango peel powder: A potential source of phenolics, carotenoids and dietary fiber in Biscuits preparations 2nd International-16 th Arab Conference of Home Economics "Home Economics in the Service of Industry"10-11 September, Faculty of Home Economics, Minoufiya University, Shebin El-Kom, Egypt.
- Elhassaneen, A. and Abd Elhady, Y. (2014): Relationship between antioxidant activity and total phenolics in selected vegetables, fruits, herbs and spices commonly consumed in Egypt. J Am Sci., 10(6):74-86

- Elhassaneen, Y. A., Emad M. El-Kholie, Amal N. Zaki and Hend A. Yassen (2018). Potential Effects of Cauliflower Leaves Powder on obese rats. Proceeding of the Annual Conference (13th Arab; 10th International), 11-12 April, Faculty of Specific Education, Mansoura University, " Higher Education in Egypt and the Arab World in the Light of Sustainable Development Strategies", Mansoura, Egypt.
- Elhassaneen, Y. and Salem, A. (2014). Biochemical/Nutritional Studies on some Obesity Cases in Egypt. Journal of Home Economics, 24(1): 121-137.
- Elhassaneen, Y. Safaa El-Waseef, Naglaa Fathy and Sarah Sayed Ahmed (2016). Bioactive Compounds and Antioxidant Potential of Food Industry By-products in Egypt. American Journal of Food and Nutrition, 4 (1): 1-7.
- Elhassaneen, Y.. (1996) . Biochemical and technological studies on pollution of fish with pesticides and polycyclic aromatic hydrocarbons. Ph.D., Dept. of Agric. Biochemistry, Fac. of Agriculture, Mansoura University, Mansoura, Egypt
- Elhassaneen, Y.; ElKhamisy, A.; Sayed-Ahmed, R. and Marzouk, E. (2019). Using of Egyptian herbs extracts in food processing and therapeutic nutrition applications Port Saied Specific Research Journal (PSSRJ), 11 (1): 230-240.
- Elhassaneen, y.; El-Waseef, S.; Fathy, N. and Sayed Ahmed, S. (2016-a): Bioactive compounds and

antioxidant potential of food industry by-products in Egypt. American Journal of Food and Nutrition, 4 (1): 1-7.

- Elhassaneen, Y.; Sherif Ragab and Esraa Essa (2020). Chemical and nutritional studies on extracts of food processing by-products and their effects on obesity complications in rats. Journal of Home Economics, 30 (2): 1-26.

- Elhassaneen, Y.; Sherif Ragab and Esraa Essa (2020). Chemical and nutritional studies on extracts of food processing by-products and their effects on obesity complications in rats. Journal of Home Economics, 30 (2): 1-26.

- ElhassaneenY., Sherif R. and Reham B. (2016): Antioxidant activity of methanol extracts from various plant parts and their potential roles in protecting the liver disorders induced by benzo(a)pyrene. Public Health International, 2 (1): 38-50
- Elmaadawy A., Arafa R. and Elhassaneen Y. (2016): Oxidative Stress and antioxidant defense systems status in obese rats feeding some selected food processing by-products applied in bread. Journal of Home Economics, 26 (1): 1-38.
- El-Mokadem, K. (2010). The effect of technological treatments on phytochemical properties of some foods ". M.Sc. Thesis in Nutrition and Food Science, Faculty of Home Economics, Minoufiya University, Egypt.

- El-Nashar, N. G. (2007): Development of primary liver cell culture from fish as a valuable tool in nutrition and biotechnology research. Ph.D. Thesis, Faculty of Home Economics, Minoufiya University, Egypt.
- El-Safty A. (2008): Chemical, technological and nutritional studies on Marjoram (Majorana Hortensis) M. Sc. Thesis in Nutrition and Food Science, Faculty of Home Economics, Minoufiya University, Egypt.
- Emam, O., Ghada ElBasouny, Yousif Elhassaneen and Entsar Ebeed (2018). Effect of some food processing by-products on obesity complications induced in experimental animals. 6th International-20 th Arab Conference of Home Economics "Home Economics and Education Quality" 23-24 December, 2018, Faculty of Home Economics. Minoufiya University, Egypt. Journal of Home Economics (Special issue), 28 (4.
- Epler K.S.; Zeigler R.G. and Craft, N.E. (1993): Liquid chromatographic method for the determination of carotenoids, retinoids and tocopherols in human serum and in food. J Chromatog. 619: 37–48.
- Erkkila AT, Lichtenstein AH.(2006): Fiber and cardiovascular disease risk: how strong is the evidence? Journal of Cardiovascular Nursing 21(1):3-8. Potato Peel as a Source of Important Phytochemical Antioxidant Nutraceuticals and Their Role in Human Health – A Review
- Essa, E.M. (2021). Chemical and nutritional studies on extracts of food processing by-products and their effects

on obesity complications in rats". MSc. Thesis in Nutrition and Food Science, Faculty of Home Economics, Minoufiya University, Shebin El-Kom, Egypt.

- Fniedewald W., Leve R., and Fredrickson D. (1972): Estimation of concentration of low density lipo protein separated by three different . Clin.Chem, 18:499-502.
- Furusawa M., Tsuchiya H., Nagayama M., Tanaka T., Nakaya K. and Iinuma M. (2003): Anti-Platelet and membrane rigidifying flavonoids in brownish scale of onion. J. of Health Sci., 49 (6): 475-480.
- Gabler, N.K.; Ostrowska, E.; Jones, R.B.; Imsic, M.; Jois, M.; Tatham, B.G.; Eagling, D.R. and Dunshea, F.R. (2003). Consumption of brown onion (Allium cepa) cultivars reduce the risk factors of cardiovascular disease. Australian postharvest horticulture conference, Brisbane, Australiapp. 178-179.
- Gallaher D,and Schneeman BO.(2001): Dietary fibre. In: Bowman AB, Russell MR, editors. Present knowledge in nutrition. Washington, DC, USA: ILSI; p 805.
- Gorinstein, S.; Leontowicz, H.; Leontowicz, M.; Drzewiecki, J.; Najman, K.; Katrich, E. and Barasch D. (2006): Raw and boiled garlic enhances plasma antioxidant activity and improves plasma lipid metabolism in cholesterol-fed rats. Life Sci., 78, 655-663.

- Halliwell, B. (1991): Reactive oxygen species in living systems: Source, biochemistry and role in human disease. American Journal of Medicine, 91: 14s-21s.
- Halliwell, B. and Gutteridge, J.M. (1985): Free radicals in biology and medicine. Clarendon Press. Oxford. UK.
- Hegazy et al., 2009 A .K . Hegazy , G.M . Fahm y , M .I . Ali , N.H. . GomaaVegetation diversity in natural and agro-ecosystems of arid landsCommunity Ecol., 5 (2009), pp. 163-176
- Hsu CL, Yen GC. (2008). Phenolic compounds: evidence for inhibitory effects against obesity and their underlying molecular signaling mechanisms. Mol Nutr Food Res., 52: 53-61.
- Hung, S.S.; Cho, Y.C. and Slinger, S.J. (1980): Hight performance liquid chromatographic determination of alpha-tocopherol in fish liver, J. Assoc. Off. Anal. Chem., 63 (4): 889 – 893
- Ismail, A.M.; Sedki, A.A.and Abdallah, A.G. (2003). Influence of black seed, garlic and onion supplementation on reproductive performance in rabbits. Egypt. J. Agric. Res., 81(3):1193-1207.
- Itokawa H, Morris-Natschke SL, Akiyama T, Lee KH. (2008). Plant-derived natural product research aimed at new drug discovery. Nat Med (Tokyo), 62: 263-80.
- Jacob, R.A. and Burri, B.J. (1996). Oxidative damage and defense, Am. J. Clin. Nutr., 63: 985S-990S.

- Jaggi, L. (2012). Turmeric, Curcumin and Our Life: A Review. Bull. Environ. Pharmacol. Life Sci.; 1 (7): 11 – 17.
- Jandacek RJ and Woods SC (2004). Pharmaceutical approaches to the treatment of obesity. Drug Discov Today, 9: 874
- Jensen, M.D.; Haymond, M.W.; Rizza, R.A.; Cryer, P.E. and Miles J.M. (1989): Influence of body fat distribution on free fatty acid metabolism in obesity. Journal of Clinical Investigation. 83 (4): 1168–1173.
- Kamal, A. and Daoud, J. (2003). Effect of onion and/or garlic as feed additives on blood, tissue constituents and growth performance in Muscovy ducks. Vet. Med. J., 51(2): 161-175
- Kashaf, H.Y. (2018), Effect of bioactive phytochemicals on obesity and its complications in rats". M.Sc. Thesis in Nutrition and Food Science, Faculty of Home Economics, Minoufiya University, Egypt
- Khoneem, A. (2009).Antioxidant activity of some vegetables, spices and herbs distributed in Egyptian local markets " M.Sc. Thesis in Nutrition and Food Science, Faculty of Home Economics, Minoufiya University, Egypt.
- Larson, R. A. (1988). The antioxidants of higher plants. Phytochem., 27(4), 969-978.
- Le Lay, S.; Gilles S.; Maria, C. and Ramaroson, A. (2014): Oxidative stress and metabolic pathologies: from

an adipocentric point of view. Oxidative Medicine and Cellular Longevity. volum: 1-18 (Article ID 908539).

- Litchenthaler, H.K. (1987). Chlorophylls and carotenoids: pigments of photosynthetic biomembranes. Methods in Enzymology 148, 350-383.
- Mahran, M. Z.; Abd Elsabor, R. G. and Elhassaneen, Y. A. (2018). Effect of feeding some selected food processing by-products on blood oxidant and antioxidant status of obese rats. Proceeding of the 1st Scientific International Conference of the Faculty of Specific Education, Minia University, “Specific Education, innovation and labor market” 16-17 Juli, 2018, Minia, Egypt.
- Marco, G. (1968). A rapid method for evaluation of antioxidants. J. Am. Oil Chem. Soc., 45: 594-598.
- Marcos D.; Montan˜a C. and Maria-Esperanza T. (2006). Chemical characterization of tomato pomace. J Sci Food Agric 86:1232–1236
- Matsunaga, S., Azuma, K., Watanabe, M., Tsuka, T., Imagawa, T., Osaki, T. and Okamoto, Y. (2014) Onion Peel Tea Ameliorates Obesity and Affects Blood Parameters in a Mouse Model of High-Fat-Diet-Induced Obesity. Experimental and Therapeutic Medicine, 7, 379-382.
- Moeslinger, T.; Brunner, M. and Spieckermann, G. (1994): Spectrophotometric determination of dehydroascorbic acid in biological samples. Analytical Biochemistry. 221: 290 - 296.

- NRC, National Research Council (1996). Guide for the Care and Use of Laboratory Animals Washington: National Academy Press.
- Onyechi UA, Judd PA, Ellis PR.(1998): African plant foods rich in non-starch polysaccharides reduce postprandial blood glucose and insulin concentrations in healthy human subjects. British Journal of Nutrition 80(5):419-428.
- Otto, K., and Sulc, D. (2001). Herstellung von Gemusesaften. In U. Schobinger (Ed.), Frucht und Gemusesafte (pp. 278–297). Stuttgart: Ulmer.
- Perez-Vizcaino F, and Duarte J, (2006). Andriantsitohaina R. Endothelial function and cardiovascular disease: effects of quercetin and wine polyphenols. Free Radic Res. 40: 1054-65.
- Pushp, P.S. and Marleny D.A. (2011). Subcritical water extraction of phenolic compounds from potato peel. Food Research International. 44(8): 2452-2458
- Putnam, JJ.and Allshouse, JE.(1999). Foo Reed, D.J. and Beatty, P.W. (1980): in Reviews in Biochemical Toxicology, Vol. 2, E. Hodgson, J.R. Bend and R. Phillpot, Eds., Elsevier/North Holland, New York, pp.213 – 241
- Sabeena, K.H.; Helene, D. G. and Charlotte, J. (2012): Potato peel extract as a natural antioxidant in chilled storage of minced horse mackerel (Trachurus trachurus): Effect on lipid and protein oxidation. Food Chemistry. 173(2): 97-104.

- Samuelsson G, Farah MH, Claeson P, (1991). Inventory of plants used in traditional medicine in Somalia. I. Plants of the families Acanthaceae-Chenopodiaceae. J Ethnopharmacol , 35: 25-63.
- Sayed Ahmed, S. (2016). Nutritional and technological studies on the effect of phytochemicals on obesity injuries and their related diseases by using experimental animals ". Ph.D. Thesis in Nutrition and Food Science, Faculty of Specific Education, Port Saied University, Port Saied, Egypt
- Schieber, A.; Stintzing, F. C.; and Carle, R., (2001): By-products of plant food processing as a source of functional compounds-recent developments. Trends in Food Science and Technology, 12(11):401-413
- Shamberger, R.J.; Andreone, T.L. and Willis, C.E. (1974): Antioxidants and cancer. IV. Malonaldehyde has initiating activity as a carcinogen. J. Natr. Cancer Inst. 53: 1771.
- Sharma, S. K., and Maguer, M. L. (1996). Lycopene in tomatoes and tomato pulp fractions. Italian Journal of Food Science, 2, 107–113.
- Singleton, V. and Rossi, J. (1965). Colorimetry of total phenolics with phosphomolybdic-phosphotungstic acid reagents. Am. J. Enol. Vitic., 16: 144-158.
- Surh YJ, Chun KS and Cha HH,. (2001). Molecular mechanisms underlying chemopreventive activities of anti-inflammatory phytochemicals: down-regulation of

COX-2 and iNOS through suppression of NF-kappa B activation. Mutat Res., 480: 243-

- Surh YJ. (2002). Anti-tumor promoting potential of selected spice ingredients with antioxidative and anti-inflammatory activities: a short review. Food Chem Toxicol 2002; 40: 1091-7.
- Teyssier C.; Amiot M. J., Mondy N., Auger J., Kahane R. and Siess M.H., (2001). Effect of onion consumption by rats on hepatic drug-metabolizing enzymes. Food and Chem. Toxicol., 39(10): 981-987
- Vasso O. and Constantina T. (2007). Utilization of Plant By-Products for the Recovery of Proteins, Dietary Fibers, Antioxidants, and Colorants. In: Utilization of By-Products and Treatment of Waste in the Food Industry. Ed. By: Vasso Oreopoulou and Winfried Russ. Springer ScienceBusiness Media, LLC, pp. 209–232.
- Velioglu, Y.S.; Mazza, G.; Gao, L. and Oomah, B.D. (1998). Antioxidant activity and total phenolics in selected fruits, vegetables and grain products. J. Agric. Food Chem., 46 (10): 4113-4117.
- Venuto, T. (2013). Burn the fat, fee the muscle. Harmony Books, New York.
- Vincent, H.K. and Taylor, A.G. (2006): Biomarkers and potential mechanisms of obesity-induced oxidant stress in humans. International Journal of Obesity. 30(3): 400-418.
- Wang B., Chen J., Liang Y., and Duh P. (2005): Effects of Welsh onion on oxidation of low-density lipoprotein

and nitric oxide production in macrophage cell line RAW 264.7. Food Chem., 91(1):147-155.

- Whitney SM, von Caemmerer S, Hudson GS, Andrews TJ (1999) Directed mutation of the Rubisco large subunit of tobacco influences photorespiration and growth. Plant Physiol 121: 579-588
- Yound D. S. (1975): Determination of GOT. Clin. Chem., 22 (5): 21-27.
- Younis, M. B. (2016). The effect of some plant parts extract on hyperglycemia in alloxan-induced Diabetic rats". M.Sc. Thesis in Nutrition and Food Science, Faculty of Specific Education, Port Saied University, Port Saied, Egypt.