IOSR Journal of Pharmacy and Biological Sciences (IOSR-JPBS)
e-ISSN: 2278-3008, p-ISSN:2319-7676. Volume 11, Issue 1 Ver. I (Jan. - Feb. 2016), PP 91-100
www.iosrjournals.org

Evaluation of the bioactive compounds of fresh as well as processed broccoli and cauliflower as hypoglycemic and hypocholesterolemic agents

Mona Mohamed Abdel Magied[1], Ahmed Mahmoud Allan[1], Nesren EL-Sayed Mohamed[1]
[1] *(Department of food science, Faculty of Agriculture, Cairo University, Egypt)*

Abstract: *The objective of this study was to investigate the effect of different cooking methods (boiling, blanching and steaming) on the total phenols, antioxidant activity, vitamin C and sulforaphane content of broccoli and cauliflower. Cooking by steaming had the least reductive effect on the bioactive compounds followed by blanching and boiling methods . The effect of pure sulforaphane , fresh and steamed broccoli or cauliflower extracts were evaluated in alloxan induced diabetic rats as hypoglycemic and hypocholesterolemic agents. Fresh broccoli and steamed broccoli extracts were used in the concentration of 0.175 and 0.525 mg / kg / bw of rat / day for G4, G5,G6 and G7 of rats. Moreover, fresh and steamed cauliflower extracts were used in the concentration of 4.05, 8.11 and 24.3 mg/kg/bw of rat/day for G8, G9,G10,G11,G12 and G13 of rats. Pure sulforaphane was uesd in the concentration of 0.3 mg / kg / bw of rat / day as G3 of rats. The lowest value of serum glucose ,serum albumin and Malondialdehyde was with the group G3 of rats those adminstrated pure sulforaphane.However, The highest value of glutathione peroxidase was also noticed in G3 that recorede 68.98 U/ml. Levels of serum Cholesterol, LDL and Triglycerides for the " G11" "group of rats adminstrated 4.05 mg/kg/bw of rat/day steamed cauliflower extract " were significantly low compared with the groups of rats (G4,G5,G8,G9 and G10) those had fresh broccoli or cauliflower extracts . The HDL level in groups G3, G5 and G10 were significantly higher than the G2"diabetic rats"*

Keywords: *Broccoli, Cauliflower, Hypocholesterolemic, Hypoglycemic, Sulforaphane.*

I. Introduction

Adiet rich in cruciferous vegetables such as broccoli (Brassica oleracea L. ssp. Italica) and cauliflower (Brassica oleracea L. ssp. Botrytis) can preventing some diseases such as cancer, cardiovascular disease, obesity, diabetes and hypertension by the fact that this foods contain nutritional antioxidants in their composition [1].The contribution of the cruciferous vegetables to health may be related to the antioxidant capacity of these vegetables due to the presence of phenolic compounds, carotenoids, flavonoids, vitamins, minerals and in particular a special group of phytochemicals named glucosinolates. Broccoli florets contain comparatively high levels of glucosinolates, particularly glucoraphanin, which are secondary plant metabolites containing sulphur and nitrogen, commonly found in cruciferous vegetables [2].Tissue disruption, such as that caused by chewing or cutting, allows glucosinolates to come into contact with myrosinase (b-thioglucoside glucohydrolase EC 3.2.3.1) which causes rapid hydrolysis to form glucose and a range of intermediates, such as isothiocyanates, thiocyanates and nitriles. Depending on conditions, glucoraphanin (GR) forms the isothiocyanate sulforaphane [1-isothiocyanate-(4R)-(methylsulfinyl) butane] or sulforaphane nitrile (SFN) upon hydrolysis [3]. Epidemiological studies and experimental researches with cell and animal models have shown that isothiocyanates have the health promoting effects, e.g., cancer protection [4]. Most vegetables are commonly cooked before being consumed. In general, vegetables are prepared at home on the basis of convenience and taste preference rather than retention of nutrient and health-promoting compounds [5].It is known that cooking induces significant changes in chemical composition, affecting the bioavailability and content of chemopreventive compounds in vegetables. The glucosinolate content in vegetables depends on the cooking method, degree of raw material disintegration, and on the raw material itself [6]. Diabetes mellitus (DM) is a set of alterations that culminates in hyperglycemia, and the progress of these alterations is directly related to pancreatic ß-cell loss of function [7].Epidemiological studies have shown that the incidence of DM patients is rising at a pandemic level worldwide, and it is estimated that by the year 2025, more than 300 million people will be inflicted [8]As a consequence, hyperglycemia promotes impairment of the liver, kidneys, eyes, vascular system, peripheral nerves, and even brain functions [9,10]. Abnormalities in lipid metabolism are also a very common feature of diabetes, generating an appropriate environment for atherosclerosis, most of the time due to elevated levels of cholesterol, triacylglycerols , and lower levels of HDL cholesterol presented by diabetic individuals. The aim of this work was to study chemical composition of broccoli and cauliflower florets , and study the effect of different cooking processing (boiling, blanching, steaming), on the total phenols,

ascorbic acid, antioxidant activity and sulforaphane content of broccoli and cauliflower extracts as well as to study the effect of broccoli and cauliflower extracts as hypoglycemic and hypocholesterolemic agents.

II. Materials and methods

2.1. Materials

Fresh broccoli bunches (Brassica oleracea L. ssp. Italica) and fresh cauliflower heads (Brassica oleracea L. ssp. Botrytis) were obtained from the farm located in Bani-sowif governorate (Egypt) through January and March 2013. The plants were harvested at full maturity. The samples were authenticated by prof. Saed shihate, Vegetables Crop Department, Faculty of Agriculture, Cairo University, Egypt. The broccoli bunch was separated into florets. The heads of cauliflower were carefully stripped of their outer leaves and divided into individual florets. All the samples were packed into perforated films and kept in the refrigerator at (5ºC) for maximum 3 days until processing and analysis. Sulforaphane (>95%), DPPH (1.1-diphenyl 2-picryl hydrazyl), methylene chloride, anhydrous sodium sulfate and alloxan monohydrate were purchase from Sigma Aldrich company. Seventy eight male albino rats weighing about 180-210 g were purchased from the Research Institute of Ophthalmology, Giza, Egypt. Diagnostic kits were purchased from Bio-Diagnostic, Cairo-Egypt.

2.2 processing treatments

Different processing treatments were carried out for broccoli and cauliflower florets according to the method described by [11] . For the boiling treatment, 300 g of vegetable samples were added to 1000g of boiling water (100ºC). The water temperature was reduce up to 70 ºC directly after addition of samples and reached boiling within 90s. Cooking took 5 min for broccoli and 8 min for cauliflower. The boiled Samples were drained off and cooled at room temperature for a few minutes. Blanching treatment was carried out by immersing 300 g of florets into 3000 g of boiling water (100ºC). Cooking took 2 min for broccoli and 5 min for cauliflower after boiling. Samples were drained for 1 min, cooled in 3000 g of ice water for 2 min and finally drained for 1 min. Steaming treatment was carried out in a closed vessel using a stainless steel steam insert with a single layer of the broccoli or cauliflower florets suspended above 400 g of boiling water. Cooking took 6 min for broccoli and 10 min for cauliflower after boiling . Samples were drained off and cooled at room temperature for a few minutes. All the prepared samples were subjected to different analysis.

2.3 Determination of chemical composition of fresh broccoli and cauliflower

Fresh broccoli as well as cauliflower were subjected to chemical composition including moisture content, ash, total carbohydrate, protein, crude fiber, and fat content according to the methods described by A.O.A.C [12].

2.4 Preparation of broccoli or cauliflower extracts

The extract of broccoli or cauliflower was prepared according to the method described by [13] . Ten gram of fresh or processed samples were homogenized with 15 ml of 80% methanol. The homogenate was filtered through four layers of cheesecloth and the residue was treated with 15 ml of 80% methanol for two successive extractions. The filtrates were combined and centrifuged at 4000g for 10 min. The supernatant of the methanol extract was collected to determine total phenolic and antioxidant activity.

2.5 Determination of total phenols

The total phenolic content was determined in the previous extracts of broccoli and cauliflower by a colorimetric assay based on the method described by [14] with some modification of [13]. 0.5 ml of the extract was mixed with 0.5 ml of 0.2 M Folin-Ciocalteu's phenol reagent. After 3 min 0.5 ml of 7% aqueous sodium carbonate solution was added and the final volume was adjusted to 5 ml with distilled water. Mixture was kept in darkness at room temperature for 90 min, and then absorbances were determined at 725 nm against distilled water as a blank. Results are expressed as the microgram of gallic acid equivalents/0.5 ml of extract (GAEs) through the calibration curve of gallic acid and calculated as mg gallic acid/100 g FW sample.

2.6 Antioxidant activity

Antioxidant activity was determined by the 1,1-diphenyl-2-picryl-hydrazyl (DPPH) radical scavenging method of [15] with some modifications of [13]. 4 ml of 0.1 Mm DPPH (in 80% methanol) solution was treated with 0.2 ml of the broccoli or cauliflower extract. The control sample was prepared by using 4 ml DPPH solution and 0.2 ml of distilled water, instead of the extract . The mixture was stirred and then left at room temperature for 3 min. The absorbance of the DPPH solution was determined as 521 nm. Antioxidant activity was expressed as the percentage of DPPH decrease using the equation:

$$AA\ (\%) = \frac{\text{Control absorbance} \quad \text{Sample absorbance}}{\text{Control absorbance}}$$

2.7 Determination of Vitamin C content

Ascorbic acid was determined by [15]. 10 g of fresh or processed samples were homogenized with 15 ml of 5% metaphosphoric acid. The homogenate was filtered with four layers of cheesecloth and the residue was treated with 10 ml of 5% metaphosphoric acid for two successive extractions. The filtrate was combined and centrifuged at 4000g for 10 min. The supernatant was collected and made up to 50 ml and then filtered through a 0.45µm Advantec filter and analyzed by reversed- phase HPLC in a Hewllett packard 1050 system, a UV-Vis detector and an HP-3365 series Π chemstation. The analytical Colum used was a tracer sphevisorb ODS2 C18 (250×4.6 mm ID.,5µm particle size) protected with a guard catridge (Tracer, C 18, 5µl); 300 µl of 0.56% (w/v) meta-phosphoric acid solution were added to special centrifuge and filtration tube, shaken for 30 sc and centrifuged at 10 ºC (10 min, 3000×g). The column temperature was 25 ºC. Ascorbic acid was identified by comparing the retention time of sample peak with that of the ascorbic standard at 254 nm.

2.8 Determination of sulforaphane in broccoli as well as cauliflower

Sulforaphane was extracted and determined according to the method described by [16]

2.8.1 Extraction of sulforaphane

Sulforaphane was determined by HPLC method described by [16]. Five grams of fresh broccoli or cauliflower samples were homogenized for 5 min. The meal was left to autolyze at room temperature for 30 min. Then the meal was extracted two times with 50mL methylene chloride, that was combined and salted with 2.5 g anhydrous sodium sulfate. The methylene chloride fraction was dried at 30 ºC under vacuum on a rotary evaporator. The residue was dissolved in acetonitrile and was then filtered through a 0.22 mm membrane filter prior to injection into HPLC.

2.8.2 HPLC Conditions

The aformentioned extract was determined by using HPLC technique as described by [16]. The samples were analyzed with HPLC knauer, Germany, Gemini C18, Phenomenex USA, Column. The solvent system consisted of 20% acetonitrile in water; this solution was then changed linearly over 10 min to 60% acetonitrile, and maintained at 100% acetonitrile for 2 min to purge the column. The column oven temperature was set at 30 ºC. The flow rate was 1mL/min, and 10 mL portions were injected into the column. Sulforaphane was detected by absorbance at 254 nm. The quantity of sulforaphane in samples was based on the standard curve of sulforaphane.

2.9 Antidiabetic effect of broccoli or cauliflower extracts

2.9.1 Biological Design

Seventy eight male albino rats, weighing about 180-200 g were used throughout this study. The rats were obtained from the Research Institute of Ophthalmology, Giza, Egypt. The animals were fed on a basal diet for 14 days as an adaptation period .The composition of basal diet was prepared according to AOAC [18] Salt mixture and vitamin mixture were prepared as described in [17, 18] respectively. Food and water were given adlibiitum.

2.9.2 preparation of broccoli or cauliflower extracts

The extract of broccoli or cauliflower was prepared according to the method described [19]. A mixture of ethanol and water in the ratio of 7:3 was prepared then 500g of the broccoli or cauliflower fresh or processed florets were extracted by maceration method for three days. The extracted material was filtered and the filtrated material was concentrated under vacuum evaporated until dryness.

— **2.9.3. Experimental Design**

— The rats (78 rats) were divided into 13 groups, each contain 6 rats, namely:(G1) control basal diet, the rest of the groups made diabetic by a single intravenously (marginal ear vein) injection of alloxan monohydrate 5% (w /v) in normal saline at a dose of 140 mg /kg body weight .Then 5 days later, blood samples collected and glucose level were determined to confirm the development of diabetes .The rats with serum glucose level >300 mg /dl were consider to be diabetic according to the recommendation of [20] The previous mentioned groups were administrated orally by stomach tube with different tested samples . (G2) was named as diabetic control, (G3) was administrated with Sulforaphane 0.3 mg /kg / bw/ day described by [21]. The groups of rats G4 and G5 were administrated with broccoli ethanol extract without process at concentration of 0.175 g/kg/bw/day and 0.525 g/kg/bw /day to be equal to 0.1 mg/kg/bw/day and 0.3 mg/kg/bw/day sulforaphane respectively as described by [16]. The groups of rats G6 and G7 were had broccoli ethanol extract steamed process at concentration of 0.175 g/kg/bw/day and 0.525 g/kg/bw/day respectively. The groups of rats G8 G9, and G10 were administrated with cauliflower ethanol extract at 4.05 g/kg/bw/day, 8.11 g/kg/bw/day and 24.3

g/kg/bw/day respectively (equivalent to 0.05 mg/ kg/bw/day , 0.1mg/ kg/bw/day and 0.3 mg/kg/bw for the pure sulforaphane). The groups of rats G11 , G12 and G13 were had cauliflower ethanol extract steamed process at concentration of 4.05 g/kg/bw/day, 8.11 g/kg/bw/day and 24.3 g/kg/bw/day. (equivalent to 0.05 mg/ kg ,0.1mg/ kg and 0.3 for the pure sulforaphane).

Blood samples were collected from eye plexuses by a fin capillary glass tubes per week for 4 weeks of each treatment .The samples were centrifuged for 10 min. at 3000 rpm and the serum was collected. serum glucose level , serum total cholesterol, HDL and LDL cholesterol, triglycerides, albumin, malondialdehyde, blood glutathione peroxidase were measured by using the diagnostic kits.

2.10. Statistical analysis

Results were statistically analyzed by the least significant differences (L.S.D) at the level of probability procedure according to [22].

III. Results and Discussion

Chemical composition of broccoli and cauliflower florets could be seen in Table (2). Results expressed as g/100 g dry wt. basis. It could be shown from the results that the protein content of broccoli is higher than that of cauliflower those recorded 20.79 and 18.40 (g/100g dry wt) respectively. However the ash content of cauliflower recorded 10.73% that is higher than the corresponding content in broccoli florets which is only 9.19% and it was in significant difference. Results in table (2) also show that the total lipid of both broccoli and cauliflower was insignificant difference and broccoli recorded higher percentage of total lipids than cauliflower . Moreover, crude fiber of both broccoli and cauliflower was in non significant difference. Total carbohydrates content of broccoli was less than that of cauliflower florets. The moisture content of fresh broccoli as well as cauliflower florets was recorded 81.76 and 88.64% respectively. Our results are in accordance with those reported by [23,24] who reported that the protein content, total lipids and ash of broccoli florets were recorded 21.79 , 2.56 and 9.19 % on dry wt basis respectively. Meanwhile cauliflower contained 18.40% protein, 0.70% lipids and 10.73% ash.
(Table 2).

Results for the effect of different processing treatments on the bioactive compounds those represented as boiling, blanching and steaming process for fresh broccoli and cauliflower florets is shown in table (3).Total phenols (mg/100g FW) for both broccoli and cauliflower changed during subjecting the florets to the different processing treatments and they were in significant difference. The highest value was with the fresh one followed by the steaming process. The lowest value was with the boiling thermal process. The depletion of total phenolic content after boiling could be due to phenolic breakdown during cooking [24,25] Meanwhile, [26] reported that steaming was the only method that retained the total phenolics content in cauliflower and broccoli. They also found that during steaming it may be that the temperatures were lower than in the other two methods and therefore did not affect the phenolic content as much. Results in table 3 also show the changes in Vit.C content for broccoli and cauliflower as a result of thermal processing. Steaming process showed lesser reduction on Vit.C content than the other two thermal processing for both broccoli and cauliflower. On the contrare, Boiling led to deteriorate on the Vit.C content. Blanching treatment was not as good as steaming, but not as bad as for boiling treatment. [11] reported that , the reduction in Vit.C levels in cauliflower florets was most pronuced when boiled and the lowest when steamed. Moreover, [27] reported some reduction in Vit.C when broccoli was boilied. They also found that blanching caused less reduction than boiling was observed. Sulforaphane content of different thermal processing technique used for broccoli and cauliflower was dramatically changed and it was in significant difference for all the tested samples as shown in table (3). Steaming process recorded the lowest reduction in sulforaphane content of broccoli (1.38 mg/100 g FW).However, blanching and boiling thermal treatment were in non significant difference ,but they were in significant difference with steaming process for both broccoli and cauliflower florets. [2**8**] reported that when broccoli cooked by boiling, sulforaphane remained largely unaltered for the first 1.5 min and then declined, meanwhile, steamed broccoli retained high sulforaphane (> 60%) up to 2 min before decling. Our results are in agreement with the results of [29, 2**8**]who reported that the best cooking method for time dependent retention of sulforaphane production in broccoli and cauliflower is steaming cooking. Results in table (3) also show the antioxidant activity (DPPH%) of the extracts fresh and thermal processed broccoli and cauliflower florets. The values of antioxidant were statistically in significant difference. The highest values were with the fresh broccoli and cauliflower. Throughout the thermal processing technique, steaming process had the highest value either for broccoli or cauliflower. This indicate that steaming is the best thermal processing that could be protect the availability of these vegetables. [11] reported that thermal processing of cauliflower affected the levels of antioxidant capacities. Boiling reduced the antioxidant capacity , however, blanching also reduced this value but to a lesser extent. Moreover, [30] measured the antioxidant capacity by the DPPH assay in blanched cauliflower and reported some reduction, corresponding well with our findings. [27] found more reductions in boiled

broccoli than the blanched samples for the DPPH assay. They also investigated the antioxidant capacities in steamed broccoli, finding increases for DPPH. (Table 3).

Results in table (4) show the effect of different concentrations of broccoli as well as cauliflower florets extracts as well the pure sulforaphane 0.3 mg/kg/bw/day on the glucose content of the different groups of rats either those had the basel diet or the others those were induced with alloxan and had the aforementioned extracts all the results were in significant difference .The highest value of serum glucose was with the group (G2) "diabetic rats" followed by G11 there diabetic rats had cauliflower extract representing 4.05 g/kg/bw/day. In contrary, the lowest value was with G1 and G3 of rats, that they had basal diet and sulforophane (0.3 mg/kg/bw/day) respectively. In addition, the groups of rats " G4 and G5" representing as fresh recorded lower values of serum glucose, that they were 140.54 and 110.54 mg/kg/bw/day. Steaming process affected negatively on the efficiency of broccoli and cauliflower as lowering rats serum glucose. Results also show that cauliflower extracts G8 up to G13 were not in the efficiency for lowering serum glucose as with the corresponded groups of rats those had broccoli G4 up to G7 in spite of the groups of cauliflower had high amount of extracts. This could be attributed to the glucoraphanin content in both broccoli and cauliflower florets, [31] they reported that sulforaphane (SF) is derived from the hydrolysis of glucoraphanin that is found naturally in broccoli and cauliflower, but in different concetration. Moreover, [32] determined the concentration of glucoraphanine in raw broccoli and cauliflower they found that, the content of glucoraphanin in broccoli was 29.4 µmol/100 g fresh weight, meanwhile it was only 0.31 µmol/100 g fresh weight. Although most of the evidence of sulforaphane benefits is related to the prevention and inhibition of the carcinogenesis process [33]. Recent data show other functions related to this compound, such as neuroprotective properties, besides preserved pancreatic function in streptozotocin diabetic rats [34 ,35]. The diabetic mellitus is a disease characterized by hypoglycemia caused by increased oxidative stress in various tissues, with evidence of increased levels of oxidized DNA, proteins, and lipids [36].In additions, oxidative stress also triggers aseries of cellular responses, including the activation of protein kinase C and the transcription factor nuclear factor-kB, and so forth. Inappropriate activations of those important regulatory molecules would have deleterious effects on cellular functions leading to the pathogenesis of various diabetic complications including retinopathy, nephropathy and neuropathy. Science oxidative stress also contributes to several deleterious changes caused by STZ, antioxidant substantially attenuate STZ toxicity. The hyperglycemia causes toxic effects on the structure and function of organs, including the pancereatic islets, by multiple biochemical pathways and mechanisms of action such as glucose autoxidation , protein kinase C activation, methyglyoxal formation, glycation, hexosamine metabolism, sorbitol formation, and oxidative phosphorylation. As hyperglycemia worsens, ß cells steadily undergo deterioration, secrete less and less insulin, and become part of a downward spiral of function loss.Furthermore, glucose possesses a reactive aldehyde moiety that reacts non enzymatically with the amino groups of proteins, forming slowly reversible amadori products. Accordingly, the elevation of glycosylated protein products has been implicated in diabetic complications[37]. Therefore, hyperglycemia has an important role in the pathogenesis of diabetes and its complications by increasing protein glycation [38]. The oral administration of the BUOH fraction that containing sulforaphane to diabetic rats dose dependently reduced serum level of glucose, indicating an improvement in abnormal glucose metabolism and the reduced toxicity of excessive glucose[20]. It could be shown from the results in table 4 that serum albumin of experimental rats affected positively with different degrees dependent on the weather broccoli or cauliflower extracts were in the form of fresh or steamed. "G2" diabetic rats" had only 1.53 g/dl serum albumin, it was in significant difference with all the tested groups of rats. Significant difference could be shown throughout the values. Control sample of rats G1" basal diet", G3 " rats had sulforaphane" , and G5 " rats had frsh broccoli extract equivalent to 0.3mg sulforaphane / kg /bw/ day had the highest values of serum albumin and they were in non significant difference through their values, meanwhile, they were in significant difference with the other tested groups of rats. The lowest values were with the steamed broccoli as well as steamed cauliflower and also fresh cauliflower containing 0.05 mg sulforaphane, they were in significant difference with the other samples of experimental rats. [20] the serum level of albumin in diabetic control rats decreased compared to normal rats, while oral administration of the broccoli ethanol extract to diabetic rats slightly increased the serum level of albumin, indicating that albumin loss induced by urinary elimination under diabetic conditions was attenuated by oral administration of the broccoli ethanol extract. Therefore, they attributed the increase in the serum albumin level by broccoli flower extract administration as a sign of the alleviation of diabetic pathological conditions. Results in table (4) also show the effect of broccoli and cauliflower florets extracts on serum malondialdehyde (nmol/ml/serum) levels in the different groups of rats with alloxan induced diabetes. So, diabetes leads to the disturbance of lipid profiles, especially an increased susceptibility to lipid peroxidation [39]. In particular, lipid peroxidation products such as malondialdehyde are formed when polyunsaturated fatty acyl chains are attacked by hydroxyl radicals, So, they are frequently used to determine the oxidant and antioxidant balance.Our results indicated the elevation of lipid peroxidation under diabetes. Results in table (4) show that, the lowest value of malondialdehyde was with the control group of rats (G1) that recorded 4.35 nmol/ml. In contrast, G2" diabetic

group of rats had the highest value of malondialdehyde. All the samples were in significant difference. Group (3) of rats those had 0.3 mg/kg/bw sulforaphane could decrease the level of malondialdehyde to the lowest extend (6.80).However, this value was in nonsignificant difference with the groups of rats representing in G4,G5,G9 and G10.This could indicate about the powerful of fresh broccoli and cauliflower in the concentrations of 0.1 and 0.3 of sulforaphane mg/kg/bw in each one.The group of rats (G8) those had freshly cauliflower in the concentration of 0.05 mg sulforaphane/kg/bw could also reduced the concentration of malondialdehyde,but, it was not comparable with G9 and G10. The processed "steaming" of either broccoli or cauliflower could also reduced the concentration of malondialdehyde at both levels 0.1 and 0.3 .However, steamed broccoli was superior to the corresponded cauliflower for the two levels of sulforaphane "0.1 and 0.3 mg/kg/bw". The decrease in lipid peroxidation by butanol fraction from the broccoli flower implies a protective role against diabetic oxidative stress induced by streptozotocin [20]. They also demonstrated that butanol fraction has the strongest antioxidative effect among the fractions by scavenging radicals and inhibiting protein oxidation induced by radicals. Furthermore, the effect of the broccoli flower against oxidative stress induced by diabetes was also confirmed under an in vivo system. Results in table(4) also show the change in glutathione peroxidase levels (U/ml) of blood rats, those affected by the broccoli and cauliflower florets extracts of those rats with alloxan induced diabetes. Results show that " G1" normal group of rats recorded the highest value of glutathione peroxidase 70.98 U/ml. On the opposite side "G2" diabetic group of rats recorded the lowest value (23.03 U/ml). Great improvement could be seen as a result of having "G3" sulforaphane (0.3 mg/kg body wt rat), the value increased up to 68.98 U/ml. The groups of rats had fresh broccoli G4 and G5, the glutathione peroxidase also increased up to 58.11 and 63.74 respectively. Meanwhile groups of rats had steamed broccoli were not in their value of glutathione as the corresponded fresh broccoli and they were in significant difference with the rest of groups The other groups of rats G8,G9 and G10 there had fresh cauliflower in the range of 0.05, 0.1 and 0.3 successively, noticed some improvement in their glutathione peroxidase but not as for fresh broccoli. Moreover, groups of rats represented as G11,G12 and G13 those had steamed cauliflower in the ratio of 0.05, 0.1 and 0.3 of sulforaphane respectively recorded lower value of glutathione peroxidase compared with the corresponded fresh cauliflower. So, in this respect, [40] reported that GSH "glutathion" primary agent involved in redox regulation of protein thiols. More over, there is a consensus that reduced/oxidized glutathione ratio is lower in diabetes [41,42]. In hyperglycemic conditions, glucose is preferentially used in the polyol pathway [43], that consumes NADPH which is necessary for GSH regeneration by the glutathione reductase enzyme. Hyperglycemia is therefore indirectly the cause of GSH depletion .As GSH is an important molecule, its depletion leads to the increase of oxidative stress. As the key intracellular antioxidant, GSH reacts with electrophilic compounds and serves as a reductant for eliminating hydrogen peroxides [43]. The main function of exogenous GSH is to suppress lipid peroxidation which occurs in the plasma membrane and damages the structure and permeability of membrane. [**45**]showed that red blood cell GSH levels decreased in our diabetic patients parallel to the increase of MDA .However, there was not a significant difference between the diabetic groups. Their results are consistent with those of other studies on antioxidant status of diabetic patients [**46**].Antioxidant molecule, GSH, significantly decreased as shown in other studies [**47**]. [**48**] Confirm the relationship between the period of illness and GSH depletion. In long term hyperglycemic conditions, GSH depletion was more significant than those of newly diagnosed patients. (Table 4)

Results of the effect of broccoli and cauliflower florets extracts on cholesterol, triglycerides, HDL and LDL levels in the serum of rats with alloxan induced diabetes as shown in table (5). Serum cholesterol (mg/dl)of different groups of rats under investigation were in significant difference. "G2" the diabetic group of rats had the highest value of total cholesterol 131.24 mg/dl. This value was reduced up to 91.16 mg/dl for "G3" group of rats had sulforaphane in the range of 0.3 mg/kg body wt. The groups of rats G4 and G5 had fresh broccoli in the range of 0.1 and 0.3 sulforaphane could also improve the serum cholesterol level that reduced up to 96.20 mg/dl for G5.However, groups of rats had steamed broccoli G6 and G7 were recorded higher values of total cholesterol than the corresponded fresh broccoli. Groups of rats had fresh cauliflower were not in comparable with the corresponded groups had steamed cauliflower, that the first groups were better than the later groups. Serum triglycerides (mg/dl) of different groups of rats is also show in table(5)." G " control group of rats had the lowest value "53.20 mg/dl". On contrare G2 of rats recorded the highest value of triglycerides 86.05 mg/dl. This value was reduced up to 55.98 mg/dl for " G3" group of rats had sulforaphane in the range of 0.3 mg/kg/body wt. This reduction was extended to the other groups of rats, The groups of rats G4 and G5 had fresh broccoli in the range 0.1 and 0.3 mg sulforaphane could also reduced the serum triglycerides level up to 60.96 and 57.47 mg/dl for G4 and G5 respectively. Moreover, groups of rats had fresh cauliflower had lower value of triglycerides compared to the processed ones. Results also show the changes in serum HDL (mg/dl) of different groups of rats. The diabetic group of rats recorded the lowest value 21.06 mg/dl. Addition of sulforaphane in the range of 0.3 mg/kg body wt of rat to there diet improve the level of HDL that increased up to 50.97 "G3", This improvement was extended to the other groups of rats either the fresh broccoli or cauliflower or the corresponded steamed for both cultivars. However groups of rats had fresh broccoli were

superior to the other groups of rats had fresh cauliflower. Serum LDL (mg/dl) of different groups of rats is also shown in Table (5). "G1" control group of rats had the lowest values"31.02 mg/dl". On contrare G2 of rats recorded the highest value of LDL "92.70 mg/dl". The reduction in the values of LDL could be noticed for the other groups of rats, however, "G3" group of rats had pure sulforaphane and also G5 were in comparable for lowering LDL level, that they were the best groups of rats. Groups of rats had fresh cauliflower had lower values of LDL compared to the processed ones. Broccoli extract inhibited the lipoprotein lipase activity in adipose tissue, decreased gene expression, and the activity of key lipogenic enzymes, including diacylglycerol acyltransferases, fatty acid synthase, and acyl-CoA-cholesterol acyltransferase [49]. In addition, indole glucosinolates reduced apolipoprotein B secretion as a primary apolipoprotein of LDL [50]Another mechanism in relation to the lipid-lowering effect of broccoli sprouts may be associated with sulforaphane capacity to induce the Nrf2 (is a protein that regulates the rxpression of antioxidant proteins that protect against oxidative damage triggered by injury and inflammation) pathway. Nrf2 activation directly targets lipogenic gene expression such as PPARɣ (peroxisome proliferator-activated receptors: are a group of nuclear receptorproteins that function as transcription factors regulating the expression of genes. PPARs play essential roles in the regulation of cellular differentiation, development, and metabolism carbohydrate , lipid, protein and tumorigenesis of higher organisms) and subsequently modulates hepatic lipid homeostasis [51]. Interestingly, recent studies suggest that activation of PPARɣ might decrease atherosclerosis progression and an increase in the insulin sensitivity might be a potential therapeutic target for the treatment of a type 2 diabetes and lipid disorders [52]. (Table 5)

IV. Conclusion

Retention of antioxidant activity total phenols, vitamin C, antioxidant activity and sulforaphane content of broccoli and cauliflower was influenced by the different cooking processing method(boiling, blanching ,steaming) . it is better to consume fresh broccoli and cauliflower that will add higher benefits to the diet than the consumption of cooking broccoli or cauliflower. However cooking by steaming was the better processing method. So we concluded that the consumption of fresh as well as steamed broccoli and cauliflower will protect the body from the incidence of diabetic or hypercholesterolemic symptoms.

References

[1]. C. Lin, and C. Chang, Textural change and antioxidant properties of broccoli under different cooking treatments, Food Chemistry, 90(1,2), 2005, 9–15.

[2]. M. M. Kushad, A. F. Brown, A. C. Kurilich, J. A. Juvik, P.Klein, and M. A.Wallig, Variation of glucosinolates in vegetable crops of Brassica oleracea. Journal of Agriculture and Food Chemistry, 47(4), 1999, 541–1545

[3]. B. A. Halkier, and J.Gershonzen, Biology and biochemistry of glucosinolates, Annual Review of Plant Biology, 57, 2006, 303–333.

[4]. M.Traka, R. Mithen, Glucosinolates, isothiocyanates and human health. Phytochemistry Reviews, 8(1), 2009, 269-282.

[5]. M.A. Masizal, D.W.Giraud, and J.A.Driskell, Retention of vitamin C, iron ,and beta-carotene in vegetable prepared using difference cooking methods. Journal of Food Quality, 20 (5),1997,403-418.

[6]. E. A.S. Rosa, and R. K. Heaney, The effect of cooking and processing on the glucosinolate content: Studies on four varieties of portuguese cabbage and hybrid white cabbage , Journal of the Science of Food and Agriculture 62 (3), 1993, 259–265.

[7]. R. A. DeFronzo, From the triumvirate to the ominous octet: a new paradigm for the treatment of type 2 diabetes mellitus, Diabetes, 58(4), 2009, 773–795.

[8]. NCEP(2002): Third report of the national cholesterol education program: Expert panel on detection, evaluation, and treatment of high blood cholesterol in adults (adult treatment panel III) final report. Circulation 106, 2002, 3143–3421.

[9]. M. J. Chapman, Metabolic syndrome and type 2 diabetes: lipid and physiological consequences, Diabetes ‗and Vascular Disease Research, 4 (3), 2007, 5–8

[10]. I. Bourdel-Marchasson, E. Lapre, H. Laksir, and E. Puget, Insulin resistance, diabetes and cognitive function: consequences for preventative strategies. Diabetes Metabolism, 36(3), 2010, 173–181.

[11]. J. Volden, G.I.A. Borge, M. Hansen, T. Wicklund , and G.B. Bengtsson, Processing (blanching, boiling, steaming) effects on the conten of glucosinolates and antioxidant-related parameters in cauliflower (Brassica oleracea L. ssp. botrytis), Lwt-Food Science and Technology, 42(1), 2009, 63–73.

[12]. A.O.A.C, Official methods of analysis of association of official analytical chemists, Official Method 945.38, A.O.A.C, Washington, DC, USA, 2005

[13]. Y. Porter, Antioxidant properties of green broccoli and purple-sprouting broccoli under different cooking conditions, Bioscience Horizon,5 2010,1-11.

[14]. V. L.Singleton, and J.A. Rossi, Colorimetric of total phenols with phosphomolybdic-phosphotungstic acid reagents, American Journal of Enology and Viticulture, 16 (3),1965, 144–158.

[15]. D.Zhang, and Y. Hamauzu, Phenolics, ascorbic acid, carotenoidsand antioxidant activity of broccoli and their changes duringconventional and microwave cooking, Food Chemistry, 88 (4).2004, 503–509.

[16]. H.Liang, Q.P.Yuan, H.R.Dong, and Y.M. Liu, Determination of sulforaphane in broccoli and cabbage by high-performance liquid chromatograph, Journal of Food Composition and Analysis, 19(5),2006, 473–476.

[17]. A.O.A.C, Official methods of analysis of association of official analytical chemists, Official Method, A.O.A.C, Washington, DC, USA, 2005

[18]. A.O.A.C, Official methods of analysis of association of official analytical chemists, Official Method 982.30, A.O.A.C, Washington, DC, USA, 2000.

[19]. K.Farahmandi, S.Khazdoozy, S.,Barati, and S.Farahmandi, The Effect of Hydro-Alcoholic Extract of Broccoli Leaves on Sugar and Lipids in Serum of Diabetic Rats, Asian Journal of Biomedical and Pharmaceutical Sciences, 3(16), 2013, 24-26.

[20]. E.J. Cho, Y. A lee, H.H. Yoo, and T.Yokozawa, Protective Effects of Broccoli (Brassica olerace) against Oxidative Damage in Vitro and Vivo, JournalNurtitional Science Vitaminol,52(6), 2006, 437-444.

[21]. C.G. De Souza, J.A. Sattler, A.M. De Assis, A.Rech, M.L.S. Perry, and D.O. Souza, Metabolic Effects of Sulforaphane Oral Treatment in Streptozotocin-Diabetic Rats, Journal of Medical Food,15(9) , 2010, 795–801.

[22]. G.W. Sendecor, and W.G. Cochran, Statistical Methods Oxfored and J.B.H publishing com, 7th edition.1980

[23]. O.N.,Campas-Baypoli, D.I. Sanchez-Machado, C. Bueno-Solano, j.A. Nunez-Gastelum, C.Reyes-Moreno, and J.Lopez-Cervantes, Biochemical composition and physicochemical properties of broccoli flourts,International, Journal of Food Science and Nutrition,60(4), 2009,163-173.

[24]. L.C.R. Dos Reis, V.R. De Oliveira , M.E.K. Hagen, A. Jablonski, S.H. Flôres, and A.O. Rios, Effect of cooking on the concentration of bioactive compounds in broccoli (Brassica oleraceavar. Avenger) and cauliflower (Brassicaoleraceavar. Alphina F1) grown in an organic system, Food Chemistry, 172(1), 2015,770–777.

[25]. R. Lo Scalzo, A. Genna, F. Branca, M.Chedin, and H.Chassaigne, Anthocyanin composition of cauliflower (Brassica oleraceaL.var. botrytis) and cabbage (B. oleracea L. var. capitata) and its stability in relation to thermal treatments, Food Chemistry, 107(1), 2007, 136–144.

[26]. S.Wachtel-Galor, K.W. Wong, and I.F.F, Benzie, The effect of cooking on Brassica vegetables, Food Chemistry, 110(3), 2008, 706–710.

[27]. A.Gliszczyńska-swiglo, E. Ciska, K. Pawlak-Lemańska, J. Chmielewski, T. Borkowski, and B. Tyrakowska, Changes in the content of healthpromoting compounds and antioxidant activity of broccoli after domestic processing, Food Additives and Contaminants, 23(11).2006, 1088–1098.

[28]. S. Saha, w.Hollands, B. Teucher, P.w. Needs, A. Narbad, C.A. Ortori, Barrett, D.A.,ossiter,J.T., R.F. Mithen, and P.A, Kroon, Isothiocyanate concentrations and interconversion of sulforaphane to euric in human subjects after consumption of commerical frozen broccoli compared to fresh broccoli, Molecular Nutrition and Food Research, 56(12),2012, 1906-1916.

[29]. G. C. Wang, M. Farnham, and E.H, Jeffery, Impact of Thermal Processing on Sulforaphane Yield from Broccoli(Brassica oleracea L. ssp. italica), Journal Agriculture and Food Chemistry, 60 (27), 2012, 6743−6748.

[30]. R. Puupponen-Pimià, S. T. Hàkkinen, M. Aarni, T. Suortti, T., Lampi, A. M. and M.Eurola, Blanching and long-term freezing affect various bioactive compounds of vegetables in different ways, Journal of the Science of Food and Agriculture, 83(14), 2003,1389–1402.

[31]. N. Hounsome, B. Hounsome , D.Tomos, and G.Edwards-Jones, PlantMetabolites and Nutritional Quality of Vegetables, Journal of Food Science, 73 (4), 2008, 48-65

[32]. L. Song, and J. Thornally, Effect of storage, processing and cooking on glucosinolates content of Brassica vegetables, Food and Chemical Toxicology, 45(2), 2007, 216-224.

[33]. J.D. Clarke, R.H. Dashwood, and E. Ho, Multi-targeted prevention of cancer by sulforaphane, Cancer Letters, 269 (2), 2008, 291–204.

[34]. M.Y. Sond, E. K. Kim, W.S. Moon, J.W. Park, H.J. Kim, H.S. So, R.K. Park, K. B. won, and B. H. Park, Sulforaphane protects against cytokineandstreptozotocin-induced beta-cell damage by suppressing theNF-kappaB pathway, Toxicol Appl Pharmacol, 235 (1), 2009, 57–67.

[35]. C. A. Danilov, K. Chandrasekaran, J. Racz, L. Soane, C. Zielke, and G. Fiskum, Sulforaphane protects astrocytes against oxidativestress and delayed death caused by oxygen and glucose deprivation, Glia,57(6), 2009, 645–656.

[36]. J. A. Scott, and G. L. King, Oxidative stress and antioxidant treatment in diabetic, Annals of the New York Academy of Sciences,1031(1), 2004, 204-213.

[37]. R.P. Robertson, Chronic oxidative stress as a central mechanism for glucose toxicity in pancereatic islet beta cells in diabetes, The Journal of Biological Chemistry, 279(41), 2004, 42351-4.

[38]. N. Ahmed, Advanced glycation endproducts-role in pathology of diabetic complications, Diabetes Research and Clinical Practice Journal, 67(1), 2005, 3-21.

[39]. D. Giugliano, A. Ceriello, and G. Paolisso, Oxidative stress and diabetic vascular complications, Diabetes care,19(3),1996, 257-267.

[40]. L. Packer, E. H. Witt, and H. J. Trischler, Alpha-Lipoic acid as a biological antioxidant , Free Radical Biology and Medicine , 19(2),1995, 227-250.

[41]. T.A. Elhadd, F. Khan, G. Kirk, M. Mc Laren, R.W. Newton, S.A. Greene, and J.J. Belch, Influence of puberty on endothelial dysfunction and oxidative stress in young patients with type 1 diabetic, Diabetes Care, 21(11), 1998, 1990-1996.

[42]. U. Cakatay, A. Telci, R. Kayali, A.Sivas, and T.Akcay, Effect of alpha-lipoic acid supplementation on oxidative protein damage in the streptozotocin-diabetic rat, Research in Experimental Medicine, 199(4), 2000, 243-251.

[43]. A.Y. Lee, and S.S, Chung, Contributions of polyol pathway to oxidative stress in diabetic cataract, The FASEB J, 13(1),1999, 23-30.

[44]. S.Bannai, and N. Tateishi, Role of membrance transport in metabolism and function of glutathione in mammals, The Journal of Membrane Biology , 89(1), 1986,1-8.

[45]. H. Pasaoglu, B.Sancak, and N. Bukan, Lipid peroxidation and resistance to oxidation in patients with type 2 diabetes mellitus, The Tohoku Journal of Experimental Medicine,203(3), 2004, 211-218.

[46]. G. Gallou, A. Ruelland, B. Legras, D. Maugender, H. Allannic, and L.Cloarec, Plasma malondialdehyde in type 1 and 2 diabetic patients, Clinica Chimica Acta Journal, 214(2), 1993, 277-234.

[47]. J. Nourooz-Zadeh, A. Rahimh, J. Tajaddini-Sarmadi, H. Tritschler, P. Rosen, B.Halliwell, and D.J. Betteridge, Relationships between plasma measures of oxidative stress and metabolic control in NIDDM, Diabetologia, 40(6), 1997, 647-653.

[48]. R. K. Sundaram, A. Bhaskar, S. Vijayalingam, M. Viswanathan, R.Mohan, and K. R. Shanmugasundaram, Antioxidant stayus and lipid per oxidation in type I diabetes mellitus with and without complications, Clinical. Science, 90(4), 1996, 255-260.

[49]. S.E. Dunn, and G.A. LeBlanc, Hypocholesterolemic properties of plantindoles.Inhibition of acylCoA:cholesterolacyltransferase activityand reduction of serum LDL/VLDL cholesterol levels by glucobrassicin derivatives, Biochem Pharmacol, 47(2),1994, 359–364.

[50]. G. K. Maiyoh, J. E. Kuh, A. Casaschi, and A.G. Theriault, Cruciferous indole-3-carbinol inhibits apolipoprotein B secretion in HepG2 cells, Journal of Nutration, 137(10), 2007,2185–2189.

[51]. J. Huang, I. Tabbi-Anneni,V. Gunda, and L. Wang, Transcriptionfactor Nrf2 regulates SHP and lipogenic gene expression in hepatic lipid metabolism, American journal of physiology. Gastrointestinal and liver, 299(6), 2010, 1211–1221.

[52]. V. Tavares, M. H. Hirata, and R. D. Hirata, Peroxisome proliferatoractivated receptor gamma (PPARgamma): molecular study inglucose homeostasis, lipid metabolism and therapeutic, Arquivos Brasileiros de Endocrinologia and Metabologia 51(4), 2007, 526–533.

Table 1: Composition of basal diets (g/100g diet)

Ingerident	(G1) control basel diet	(G2) diabetic control	(G3) Sulforaphane 0.3 mg/kg/bw	G4) Broccoli extract 0.175 g/kg/bw/day	(G5) Broccoli extract 0.525 g/kg/bw/dayy	(G6) Steamed broccoli extract 0.175 g/kg/bw/day	(G7) Steamed broccoli extract 0.525 g/kgbw/day	(G8) cauliflower extract 4.05 g/kg/bw/day	(G9) cauliflower extract 8.11 g/kg/bw/day	(G10) cauliflower extract 24.3 g/kg/bw/day	(G11) Steamed cauliflower extract 4.05 g/kg/bw/day	(G12) Steamed cauliflower extract 8.11 g/kg/bw/da	(G13) Steamed Cauliflower extract 24.3 g/kg/bw/day
Starch	61.5	61.5	61.2	61.33	60.98	61.33	60.98	57.45	53.39	37.2	57.45	53.39	37.2
Casien	18.5	18.5	18.5	18.5	18.5	18.5	18.5	18.5	18.5	18.5	18.5	18.5	18.5
Corin oil	10	10	10	10	10	10	10	10	10	10	10	10	10
Cellulose	5	5	5	5	5	5	5	5	5	5	5	5	5
Vit Mix	1	1	1	1	1	1	1	1	1	1	1	1	1
Salt Mix	4	4	4	4	4	4	4	4	4	4	4	4	4
Sulforaphane mg/kg/bw/day	-	-	0.3	-	-	-	-	-	-	-	-	-	-
Broccoli extract g/kg/bw/day	-	-	-	0.175	0.525	-	-	-	-	-	-	-	-
Steamed Broccoli extract g/kg/bw/day	-	-	-	-	-	0.175	0.525	-	-	-	-	-	-
Cauliflower extract g/kg/bw/day	-	-	-	-	-	-	-	4.05	8.11	24.4	-	-	-
Steamed Cauliflower extract g/kg/bw/day	-	-	-	-	-	-	-	-	-	-	4.05	8.11	24.3

Casien conteint 81% protein

Table 2: Chemical composition of broccoli and cauliflower florets (g/100 g dry weight basis)

Chemical composition%	Broccoli	Cauliflower	LSD at 5%
Protein	20.79^{a} ± 0.938	18.40^{b} ±0.237	1.551
Ash	9.19^{b} ±0.112	10.37^{a} ±0.360	0.604
Total lipids	2.56^{a} ±0.491	0.70^{b} ±1.527	0.788
Crude Fiber	11.65^{a} ±0.498	11.52^{a} ±0.550	0
Total carbohydrates	55.81^{b} ±0.523	59.01^{a} ±0.535	1.199
Moisture of fresh florets	81.76^{b} ±0.577	88.64^{a} ±0.713	1.470

Table 3: Effect of different thermal processing treatments on the bioactive compounds (mg/100g FW) and antioxidant activity (%) of broccoli and cauliflower florets

	Broccoli					Cauliflower				
	Fresh	Boiled (5 min/100°C)	Blanched (2min/100°C)	Steamed (6min/100°C)	LSD (5%)	Fresh	Boiled (8 min/100°C)	Blanched (5 min/100°C)	Steamed (10 min/100°C)	LSD (5%)
Total phenols	115.11^{a} ± 0.330	89.13^{d} ± 0.499	98.05^{c} ±0.794	105.87^{b} ± 0.553	1.07	70.53^{a} ± 0.902	43.05^{d} ± 0.495	59.13^{c} ± 0.772	68.28^{b} ±0.894	1.47
Vitamin C	109.11^{a} ± 0.840	45.77^{d} ± 0.162	67.44^{c} ±0.499	85.66^{b} ± 0.541	1.06	82.79^{a} ±0.369	35.63^{d} ± 0.577	50.69^{c} ± 0.441	65.78^{b} ±0.992	1.20
Sulforaphane	2.27^{a} ± 0.010	0.66^{c} ± 0.0057	0.71^{c} ±0.0057	1.38^{b} ± 0.015	0.20	0.053^{a} ± 0.010	0.012^{c} ± 0	0.014^{c} ± 0	0.035^{b} ± 0.010	0.01
Antioxidant activity (DPPH %)	82.47^{a} ± 0.977	58.29^{d} ± 0.548	69.66^{c} ±0.465	79.23^{b} ± 0.477	1.22	70.57^{a} ± 0.139	52.23^{d} ± 0.611	60.69^{c} ± 0.692	69.74^{b} ± 0.650	1.07

Table 4: Effect of broccoli and cauliflower florets extracts on serum glucose, albumin, malondialdehyde and blood glutathione peroxidase levels in the rats with alloxan induced diabetes

Experimental groups of rats	Biochemical Parameters			
	Serum glucose (mg/dl)	Serum albumin g/dl	Malondialdehyde (n mol/ml)	Glutathione peroxidase (U*/ml blood)
G1	97.34^{m}± 0.2795	4.99^{a}± 0.020	4.35^{h}± 0.577	70.98 ^{a}±0.7793
G2	405.43^{a}± 1.0680	1.53^{e} ± 0.0051	28.8^{a} ± 0.8660	23.03 ^{k}±0.7680
G3	105.00 $^{L-b}$0.6107	4.23^{ab} ± 0.4041	6.80^{g} ± 0.9624	68.98^{b}±0.8646
G4	140.54^{i} ± 0.7843	3.38^{bcd}±0.3671	7.67^{efg} ± 0.5773	58.11^{e}±0.5753
G5	110.54^{k}± 0.7381	3.92^{abc}± 0.5225	7.21^{fg}± 0.5773	63.74^{c}±0.9891
G6	180.58^{f} ± 0.6789	2.70^{bcde}± 0.0493	14.10^{c}± 0.7593	45.59^{h}±0.9120
G7	170.25^{g}± 0.49212	2.89 ^{bcde}±0.0643	8.71^{e}± 1.013	49.73^{g}±0.8364
G8	200.15^{d}± 0.5829	2.98^{bcde}± 0.1858	10.96^{d}± 0.7826	46.87^{h}± 0.9648
G9	159.83^{h}± 0.5448	3.61^{abcd} ± 0.1473	8.25^{efg} ± 0.623	55.87 ^{f}±0.8651
G10	135.94 ^{j}± 0.5779	3.91 ^{bcd}± 0.484	7.70^{efg} ± 1.010	60.81^{d}± 0.9499
G11	230.12^{b}± 0.6555	2.21^{de}± 0.262	16.35^{b}± 0.3914	39.73 ^{j}± 0.8088
G12	215.15^{c}± 0.7856	2.61^{cde}± 0.236	15.13^{b}± 0.5483	43.27 ^{I}± 0.6113
G13	198.15^{e}± 0.5762	2.85^{bcde}± 0.9999	11.09 ^{d}±0.2966	46.57 ^{h}±0.7039
LSD at 5%	1.12	1.57	1.21	1.38

Table 5. Effect of broccoli and cauliflower florets extracts on cholesterol, triglycerides, HDL and LDL The serum of rats with alloxan induced diabetes levels in

Experimental groups of rats	Biochemical Parameters			
	Serum cholesterol (mg/dl)	Serum triglycerides (mg/dl)	Serum HDL (mg/dl)	Serum LDL (mg/dl)
G1	88.46^{k}± 0.2538	53.20^{M}±0.5774	55.93^{a}±0.1482	31.02^{k}±0.7542
G2	131.24^{a}± 0.6389	86.05^{a}±0.8449	21.06^{L}±0.6228	92.70^{a}±0.9263
G3	91.16 ^{j}± 0.5144	55.98^{L}±0.9400	50.97^{b}±0.8451	60.04^{j}±0.6214
G4	105.09^{f}± 0.5779	60.96^{i}±0.4128	43.20^{e}±0.5772	66.16^{h}±0.3871
G5	96.20 ^{j}± 0.5770	57.47^{k}±0.4900	48.05^{c}±0.7779	60.82^{j}±1.018
G6	111.20^{f}± 0.5762	70.57^{e}±0.3351	36.13^{h}±0.7858	73.45^{e}±0.4446
G7	104.23^{f}± 0.6067	68.63^{f}±0.3697	39.05^{g}±0.6729	71.36^{f}±0.7375
G8	114.40 ^{c}± 0.5096	66.31^{g}±0.5091	31.03^{j}±0.7287	71.50^{f}±0.6411
G9	101.15^{g}± 0.4296	63.33^{h}±0.9777	40.95^{f}±0.8733	68.80^{g}±0.6446
G10	98.36^{h}± 0.2864	58.86^{j}±0.7849	46.06^{d}±0.8160	63.14^{i}±0.3314
G11	118.16^{b}±0.7395	79.77^{b}±0.6059	28.38^{k}±0.3554	80.93^{b}±0.6155
G12	110.09^{e}± 0.6187	73.60^{c}±0.5585	33.99^{i}±0.9266	75.71^{d}±0.3762
G13	104.52^{f}± 0.5846	72.41^{d}±0.5399	38.13^{g}±0.2595	78.78^{c}±0.6592
LSD at 5%	0.918	1.08	1.154	1.17

* broccoli extracts represents : fresh or steamed G4,G5,G6 and G7 were calculated as 0.175 and 0.525 those equal 0.1 and 0.3 mg sulforaphane/kg/bw of rats

*cauliflower extract represent: fresh or steamed G8,G9,G10,G11,G12 and G13 were calculated as 4.05, 8.11 and 24.3 those equal 0.05, 0.1 and 0.3 mg sulforaphane/kg/bw of rats