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Fortification of instant noodles using Brassica oleracea to high nutrition value and lowering diabetics in rats

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ABSTRACT

Broccoli (Brassica oleracea) powder is an edible food that contains a high proportion of indigestible compounds which are included dietary fiber content. The objective of this study was to use broccoli powder as an ingredient to make dried noodle products of high nutritional quality and lowering blood glucose level. The effect of wheat flour substitution with broccoli powder was investigated in terms of the chemical, physical as cooking qualities and color characteristics and sensory attributed of noodle and its formulae. Five additional dried noodles were prepared by substituting wheat with 10, 20, 30, 40, and 50% broccoli powder. The results showed that the broccoli powder had 24.5% of crude protein, 5.8% of crude fat, 11.0% of crude fiber, 2.68% of ash, total dietary fiber 16.15% and 56.02% of total carbohydrates. Meanwhile the formulae were increased in the chemical composition by increasing broccoli powder in instant noodles. Moreover the physical properties illustrated that the optimum cooking times of all noodle samples ranged from 13.0 to 15.5 min as well as an increase in the cooking loss with noodles containing broccoli powder increased. The color of dried and cooking noodles indicated that as the amount broccoli powder increased, the appearance of the raw sheet and the cooked noodles supplemented with broccoli powder grew darker. The sensory properties showed that the noodles formulae prepared with 10, 20 and 30% broccoli powder were most like by the taste panelists. At the end of biological experimental after four weeks the results illustrated that the hyperglycemic rats fed on noodle made from 40 and 50% broccoli powder, the total cholesterol had the lowest (205.3 and 190.5 mg/dl) contained and nearly the negative healthy control 184.7 mg/dl fed on basal diet. The LDL, HDL, triglycerides, total lipids and blood glucose level were decreasing by increasing broccoli powder in noodles formulae and the risk ratio was occurred the obviously results. From the obviously results it could conclude and recommended the broccoli is one of the richest sources in protein, fat and total dietary fiber. Therefore, the broccoli powder was added at levels 10, 20, 30, 40 and 50% to give five formulae noodles. The noodles acceptability was 10, 20 and 30% broccoli powder to hypoglycemia in blood.

INTRODUCTION

Broccoli (Brassica oleracea) belongs to the family Cruciferae and over 100 hybrid cultivars of Brassica commercially exist. All plants of the genus Brassica like broccoli, Brussels sprouts, cabbage, cauliflower, collard greens and kohlrabi contain glucosinolates. Glucosinolates are known to have fungicidal, bactericidal and cancer protective characteristics (Fahey, 2003). Further, Fahey (2003) has reported that the broccoli is one of the richest sources of health promoting glucosinolates, antioxidants and essential nutrients like total dietary fiber (3.0 g/100 g), calcium (48 mg/100 g), magnesium (25 mg/100 g), selenium (3.0 µg/100 g), zinc (0.4

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mg/100 g), ascorbic acid (93.2 mg/100 g), folate (71 µg/100 g) and β-carotene (779 µg/100 g). Thus broccoli has high amount of antioxidants such as vitamin C, Zn, Se and β-carotene. Carotenoids are the major group of vitamins present in broccoli followed by vitamin E and biotin (Souci *et al*., 2000). Besides, broccoli contains a recognizable amount of flavonoids which are associated with decreasing lipid oxidation, arthritis, cancer and cardiovascular disease. Chu *et al*. (2002) showed that broccoli is a vegetable with the highest amount of total phenolic content as compared to other commonly eaten vegetables like carrot, spinach, onion or cucumber.

Broccoli is known as the "Crown Jewel of Nutrition" since it posses all the nutrients namely vitamins, minerals, secondary metabolites and fiber proclaiming its exceptional health benefits. The breakdown products of the sulfur containing glucosinolates, isothiocyanates are the active principles in exhibiting the anticancer property at every stage (Hannah *et al*., 2009). The edible portion of broccoli has high water content (89.30%), and is low in fat (0.37%). Other constituents are proteins (2.82%), total dietary fiber (2.60%) and carbohydrates (6.64%). It is a rich source of minerals such as potassium, phosphorus, calcium and sodium. Additionally, broccoli provides vitamins, especially vitamin C, vitamin A and folic acid (US Department of Agriculture, 2008). There are many varieties of green leafy vegetables which are rich in micronutrients, but are usually discarded or not used for human consumption. Broccoli leaves are one of them, which are available at no cost and are rich in all the macronutrient. It is an exceptionally nutritious vegetable with a variety of potential uses.

The prevalence of diabetes has dramatically increased in the latter half of the 20th century, largely due to ready availability of large quantities of calorie rich foods and the technology driven reduction in routine daily exercise (Birnbaum, 2005). Obesity and physical inactivity independently contribute to the development of type-2 diabetes. However, magnitude of risk contributed by obesity is much greater than that imparted by lack of physical activity (Rana *et al*., 2007).

Noodles are widely consumed throughout the world and their global consumption is second only to bread. Instant noodles are widely consumed throughout the world and it is a fast growing sector of the noodle industry (Owen, 2001). This is because instant noodles are convenient, easy to cook, low cost and have a relatively long shelf-life. Wheat flour which is usually used to make instant noodles is not only low in fiber and protein contents but also poor in essential amino acid, lysine. Flour of hard wheat (Triticum aestivum L.) is the main primary ingredient (Fu, 2008) and the addition of alkaline salts can help strengthen the structure and hence improve the firmness of the final product (Hou and Kruk, 1998).

Noodles are one of the staple foods consumed in many Asian countries. Instant noodles have become internationally recognized food, and worldwide consumption is on the rise. The properties of instant noodles like taste, nutrition, convenience, safety, longer shelf-life, and reasonable price have made them popular. Quality factors important for instant noodles are color, flavor, and texture, cooking quality, rehydration rates during final preparation, and the presence or absence of rancid taste after extended storage. Microstructure of dough and noodles has been studied to understand the influence of ingredients and processing variables on the noodle quality by employing scanning electron microscopy. Applications of newer techniques like confocal laser scanning microscopy and epifluorescence light microscopy employed to understand the microstructure changes in dough and noodles have also been discussed. Sincere efforts of researchers are underway to improve the formulation, extend the shelf life, and promote universal fortification of instant noodles. Accordingly, many researchers are exploring the potential of noodle fortification as an effective public health intervention and improve its nutritional properties Gulia *et al*. (2014).

The aim of this investigation was carried out to try utilization of broccoli for fortification of instant noodles to give noodles formulae high nutrition value and lowering blood glucose level.

MATERIALS AND METHODS

Materials:

Broccoli (Brassica oleracea) and wheat flour (Triticum aestivum L.) were purchased from local market.

Kits of glucose and lipid parameters were obtained from Bicon Diagnosemittel GmbH and Co. KG Hecke 8 made in Germany.

Methods:

Preparation of broccoli powder:

Fresh broccoli floret was thoroughly washed to remove unwanted material and dirt, cut in small sizes, blanched in boiling water for 10-15 sec and dried at room temperature for 1-2 h by spreading on filter paper followed by drying in hot air oven 40 ±5˚C for 4-6 hours. Dried broccoli floret was mill to fine powder.

Dried noodle processing:

Noodles were prepared in the laboratory following the procedures of **Bui and Small (2007).** The basic ingredients used for making control dried noodle were: 100.0 g flour, 30.0 g water, 10.0 g egg powder, 3.0 g

salt, 2.0 g propylene glycol, 1.5 g sodium carbonate, and 0.2 g polyphosphate. Five additional were added to prepare dried noodle samples by substituting wheat flour with 10, 20, 30, 40 and 50% broccoli powder.

The different formulations were processed into noodles using a mixer and a small spaghetti maker consisting of two rolls with adjustable gap settings and a cutting roll attachment. In brief, salt, egg powder, propylene glycol, sodium carbonate, and polyphosphate were dissolved in the water and this solution was added to the flour in the mixer (set at speed 1). After that, the speed of the mixer was increased. The resultant dough had a crumbly consistency similar to that of moist breadcrumbs. The dough was first formed into a dough sheet by a process of folding and passing the crumbly dough through the rollers of the noodle machine several times. Then, this combined sheet was allowed to rest in a plastic bag at room temperature for 30 min. The sheet was cut into strands 2.0 mm wide using the cutting roll attachment of the noodle machine. The noodle strands were then cut to 25 cm in length before steaming over boiling water for 2 min. Subsequently, the steamed noodles were dried in an oven at 50 °C for a total drying time of 1.5 h.

Proximate of chemical composition:

Protein, fat, fiber and ash contents of the raw materials and dried noodle formulae were determined using standard methods AOAC. (2005). Total dietary fiber was determined of the raw materials and dried noodle formulae according to the methods described by Prosky (1988). Also, soluble and insoluble dietary fiber was determined with Lee and Prosky (1995).

Cooking qualities:

The qualities of the cooked dried noodles, cooking time and cooking loss were evaluated according to Chillo *et al*. (2008). Optimal cooking time was evaluated by observing the time of disappearance of the core of the noodle strand during cooking (every 30 s) by squeezing the noodles between two transparent glass slides. The cooking loss was determined by measuring the amount of solid substance lost to cooking water. A 10 g sample of noodles was placed into 300 mL of boiling distilled water in a 500 ml beaker. Cooking water was collected in an aluminum vessel which was placed in an air oven at 105 °C and evaporated to dryness. The residue was weighed and reported as a percentage of the starting material. For each optimal cooking time and cooking loss value, five determinations were performed to obtain the mean values.

Noodle color analysis:

The color of the dried noodle and the cooked noodle formulae were measured with the L, a and b values using a Hunter Lab. Colorimeter Model D25 according to Francis (1998).

Sensory evaluation:

The sensory evaluation was carried out in order to get consumer response for overall acceptability of the dried noodle formulae compared to the control noodles. The dried noodles were rehydrated in boiling water for 5 min and were served hot for the sensory evaluation. Products were evaluated by a panel of 10 semi-trained judges for different sensory attributes like appearance, flavor, taste, texture, mouth-fell, color and overall acceptability according to Desai *et al*. (2010).

Nutritional experiments:

Male adult rats (42 rats) weight ranging 170-180 g were purchased from National Organization for Drug and Control Research, Giza, Egypt. Animals were housed in individual cages with screen bottoms and fed on basal diet for eight days. The basal diet consisted of corn starch 70%, casein 10% corn oil 10%, salt mixture 4%, vitamin mixture 1% and cellulose 5% according AOAC (1995). After feeding on basal diet for eight days, rats were divided into two groups. The first group (6 rats) was fed on the basal diet for another four weeks (36 days) and considered as negative control. The second main group (36 rats) was fasted over night and injected with strepto zootocin (dissolved in 0.1M citric acid buffer and adjusted at pH 4.5) into the leg muscle (5mg /100g body weight) to induce diabetic rats according to Madar (1983). After 48 hrs of injection the second main group was divided into six subgroups (6 rats for each). The first one (6 rats) was continued to be fed on basal diet and considered as positive control. From the second to six subgroup (6 rats for each) were fed on 20% from dried noodle formulae as a substitute of corn starch in basal diet. Each rat was weighted every two days and the food consumption was calculated. At the end of experimental period (four weeks), the blood samples were taken with drawn from the orbital plexus and centrifuged at 3000 rpm to obtain the sera. After that, the sera were kept on a deep freezer at -20^{o}C until their analyses. Serum glucose, total lipids, total cholesterol and triglycerides were determined according to knight *et al*. (1972), Allain *et al*. (1974) and Fossati and Prencipe (1982) and Tietz (1986), respectively. High and low densitylipoprotein- cholesterol in serum was determined according to Burstein (1970) and Fruchart (1982).

Statistical analysis:

The obtained data were exposed to analysis of variance. Duncan's multiple range tests at ($P \leq 0.05$) level was used to compare between means. The analysis was carried out using the PRO ANOVA procedure of Statistical Analysis System (SAS, 2004).

RESULTS AND DISCUSSION

Broccoli (brassica oleracea) floret powder was analyzed chemically for proximate composition, available carbohydrates, mineral content, dietary fiber and anti-nutritional factors by using standard methods. The values have been calculated for 100 g of broccoli (brassica oleracea) floret powder.

Proximate composition raw materials and noodle formulae:

Chemical constituents and dietary fiber fractions were determined in broccoli powder and its formulae substituted with wheat flour 72% extraction at levels 10, 20, 30, 40 and 50%, respectively and the results are reported in Table (1). From the resultant it could be noticed that the broccoli powder had 24.5% of crude protein, 5.8% of crude fat, 11.0% of crude fiber, 2.68% of ash and 56.02% of total carbohydrates. Meanwhile the formulae were increased in the chemical composition by increasing broccoli powder in instant noodles. These results are agreement with Olga *et al*. (2009) has been revealed the chemical composition of broccoli floret and leaf flours i.e., 22.41 g and 12.31 g protein, 7.87 g and 14.67 g ash, 4.59 and 6.72g fat, 11.65 and 12.83 g crude fiber and 65.13 g and 66.48 g of carbohydrates.

Important increases in the total dietary fiber (TDF) levels were obtained in the noodles with the addition of broccoli powder. The control sample showed the lowest value of TDF (3.70%), while the noodles containing 50% broccoli powder possessed the highest values of TDF (11.86%), which were related to the high TDF, soluble and insoluble dietary fiber contents of broccoli powder (16.15, 4.50 and 11.56%, respectively).

Table 1: Chemical constituencies of noodle and its formulae on dry weight:

Chemical analysis	Broccoli powder	Control noodle	Noodle formulae made from broccoli powder				
			10%	20%	30%	40%	50%
Protein	24.5	11.64	12.85	14.28	16.52	17.94	19.11
Lipids	5.8	2.14	1.53	2.14	2.84	3.41	4.12
Ash	2.68	0.95	1.12	1.50	1.81	2.50	2.81
Crude fiber	11.0	1.52	2.45	3.58	4.67	5.82	6.79
T. C	56.02	83.75	82.05	78.50	74.16	70.33	67.17
TDF	16.15	3.70	5.56	7.12	8.85	10.12	11.86
SDF	4.50	1.20	1.74	2.29	2.94	3.32	3.90
ISDF	11.65	2.50	3.82	4.83	5.91	6.80	7.96

T. C Total carbohydrates TDF total dietary fiber SDF Soluble dietary fiber ISDF Insoluble dietary fiber

Physical properties of noodle and its formulae:

Cooking qualities:

The cooking time and cooking loss of dried noodles supplemented with broccoli powder are shown in Table (2). The degree of cooking can be observed either by eye or image analysis (Sozer *et al*., 2007). In the present study, it was determined by the disappearance of the core of the noodle strand during cooking. The optimum cooking times of all noodle samples ranged from 13.0 to 15.5 min. The cooking loss is the amount of dry matter in the cooking water of optimally cooked noodles. An increase in the cooking loss with noodles containing broccoli powder may have been due to weakening of the protein network by the presence of broccoli powder. This may allow more solids to be leached out from the noodles into the cooking water (Rayas-Duarte *et al*., 1996). These results are in the agreement with Ovando- Martinez *et al*. (2009) who reported that partial or complete substitution of durum wheat semolina with fiber material can result in negative changes to pasta quality, including increased cooking loss.

Table 2: Cooking time (min) and cooking loss of noodles supplemented with broccoli powder (%).

Formulae	Cooking time (min)	Cooking loss* (%)
Control	13.0	9.35±0.12d
10%	13.5	9.84±0.06d
20%	14.0	10.42±0.09c
30%	14.5	11.05±0.00b
40%	15.0	11.49±0.02b
50%	15.5	12.00±0.08a

*Cooking loss values are shown as mean ± SD; n = 5.
Different superscript letters in a column indicate significant differences ($P \leq 0.05$).

Changes in color for dried and cooking noodle and its formulae:

Color is a key quality trait because of the visual impact at the point of sale. It provides some indication of the quality of the starting materials and, in some cases, the age of the product. Asian customers prefer bright yellow, alkaline noodles that retain a stable color for 24–48 h after preparation and consider red or dull grey noodles as undesirable (Asenstorfer *et al*., 2006). Factors controlling color stability, which include alkaline formulation, flour refinement and enzymatic browning associated with polyphenol oxidase, have been extensively investigated (Hatcher *et al*., 2008). Color characteristics of raw sheet and optimally cooked noodles supplemented with broccoli powder are shown in Table (3). The results indicated that as the amount broccoli powder increased, the appearance of the raw sheet and the cooked noodles supplemented with broccoli powder grew darker. The darkness of the both raw sheet and the cooked noodles supplemented with broccoli powder is a product of the Maillard reaction between reducing sugars and proteins (Mohamed *et al*., 2010). The redness (a*) and yellowness (b*) values were also significantly different between all samples. The redness values significantly increased relative to the broccoli powder content, while the yellowness values significantly decreased.

Table 3: Color characteristics of raw sheet noodles and cooking noodles supplemented with broccoli powder.

Formulae	Dried noodles			Cooking noodles		
	L	a	b	L	a	b
Control	83.52□0.70a	-1.44□0.14d	20.73□0.45a	74.49□0.48a	-2.10□0.17e	19.86□0.85a
10%	76.65□1.68b	0.24□0.11c	19.38□0.76b	61.81□1.32b	2.25□0.61d	17.53□0.61b
20%	72.07□0.60c	1.31□0.10b	18.73□0.22c	53.02□0.56c	3.86□0.23b	14.02□0.38c
30%	71.01□0.52cd	2.23□0.19a	18.40□0.22cd	48.01□0.37d	3.19□0.31c	13.62□0.45c
40%	70.39□1.23de	2.25□0.26a	18.10□0.08de	47.38□1.09d	3.88□0.25b	13.79□0.19c
50%	69.02□1.18e	2.28□0.18a	17.67□0.46e	45.67□1.17e	4.68□0.41a	11.60□0.39d

Values are shown as mean ± SD; n = 3.
Different superscript letters in a column indicate significant differences ($P \leq 0.05$).

Organoleptically characteristics of noodle and its formulae:

Average of sensory properties score for noodles and its formulae at different amounts of broccoli powder are recorded in Table (4). From the results, it could be seen that the sensory evaluation, panelists gave lower overall acceptability scores for the formulae with high broccoli powder percentage in the formulation. Noodle formula with 10% broccoli powder had the highest score in terms of overall acceptability followed by noodle formula with 20 and 30 % has high scores in overall acceptability.

From the obviously results, it could be concluded that, the broccoli powder was successfully incorporated into noodles formulation. Broccoli powder addition is increased protein, total dietary fiber and total lipids in the noodle formulae. Moreover, color of the formulae was affected adversely by the addition of broccoli powder. Noodles formulae prepared with 10, 20 and 30% broccoli powder were most like by the taste panelists.

Table 4: Effect of broccoli powder on the sensory evaluation of noodles.

Formulae	Taste 20	Flavor 20	Texture 15	Color 15	Mouth-fell 15	Appearance 15	Overall acceptability 100
Control	18.84^{a} ±0.63	19.88^{a} ±0.69	14.89^{a} ±0.321	13.82^{a} ±0.11	14.32^{a} ±0.37	14.20^{a} ±0.69	95.95
10%	17.94^{ab} ±0.44	18.00^{b} ±0.54	14.39^{a} ±0.32	13.74^{a} ±0.33	14.12^{a} ±0.83	14.27^{a} ±0.69	92.46
20%	17.60^{ab} ±0.06	18.05^{b} ±0.98	13.38^{b} ±0.95	12.96^{b} ±0.99	13.82^{b} ±0.22	13.75^{b} ±0.77	89.56
30%	17.00^{ab} ±1.08	17.83^{b} ±0.89	12.95^{bc} ±0.97	12.69^{b} ±0.78	13.17^{bc} ±0.23	13.27^{b} ±0.74	86.91
40%	16.05^{b} ±0.76	16.62^{c} ±0.99	12.76^{c} ±0.48	12.54^{b} ±0.79	12.71^{c} ±0.642	12.27^{c} ±0.658	82.95
50%	16.10^{b} ±0.76	16.00^{c} ±0.79	12.35^{c} ±0.93	11.89^{c} ±0.64	11.52^{d} ±0.93	12.40^{c} ±0.63	80.26

Effect of noodles from broccoli powder on initial body weight, gain body weight, gain body weight and feed efficiency ratio in the hyperglycemic rats:

Initial body weight, gain body weight, total food intake and feed efficiency ratio in the experimental hyperglycemic rats which were fed on noodles made from 10 and 20, 30, 40 and 50% broccoli powder and the results are reported in Table (5).

At the end of experiment (4 weeks), the results illustrated that the gain in body weight at the end of experimental period for the negative control fed on basal diet was increased 37.0 g, while the hyperglycemic positive control fed on basal diet was increased 20.2 g. Feeding on basal diet supplemented with 20% noodles made from broccoli powder 10, 20, 30, 40 and 50% had slightly decreased in body weight gain 15.24, 12.0, 10.0, 6.5 and 4.1 g, respectively than negative control (37.0 g).

The values of food intake for negative control was 462.7 g and hyperglycemic rats positive control was 498.6 g. Whereas, the rats group 1, 2, 3, 4 and 5, the food intake were nearly values 460.85, 450.0, 440.44, 410.62 and 400.20 g, respectively for four weeks.

The calculate data of feed efficiency ratio (FER), it can be observed that the value of feed efficiency ratio of basal diet was 7.99%, which was depressed to 4.05% for hyperglycemic rats control positive. The FER values of rats group 1, 2, 3, 4 and 5 were 3.31, 2.67, 2.27, 1.58 and 1.02%, respectively.

The gain body weight, food intake and feed efficiency ratio were decreased in rats group 2, 3 and 4 respectively, may be due to the hyperglycemic rats groups fed on broccoli had contained rich amounts from protein, total lipids and dietary fiber. These constituents are contained of protein and dietary fibers are more peripheral and not limited to nutrient absorption, these resulted in a significantly greater reduction of weigh, food intake and feed efficiency ratio.

Weickert and Pfeiffer (2008) found that an increased intake of cereal fiber significantly improved whole body glucose disposal resulting in an 8% improvement of insulin sensitivity. This suggests that the mechanisms behind insoluble fiber are more peripheral and not limited to nutrient absorption. First, an accelerated secretion of glucose-dependent insulin tropic polypeptide (GIP) was observed directly after the ingestion of an insoluble fiber in healthy women**.** GIP is an in cretin hormone which stimulates postprandial insulin release. Second, insoluble fiber can result in a reduced appetite and food intake**.** Third, short chain fatty acids, via fermentation, have been shown to reduce postprandial glucose response**.**

Table 5: Initial body weight, gain body weight, gain body weight and feed efficiency ratio in the experimental hyperglycemic rats:

Groups	Initial body weight (g)	Gain body weight (g)	Total food intake (g)	Feed efficiency ratio
Control -ve	170.5^{b} ±7.63	37.0^{a} ±1.22	462.7^{b} ±26.01	7.99^{a} ±0.24
Control +ve	170.26^{ab} ± 7.95	20.2^{b} ±3.84	498.6^{a} ± 28.28	4.05^{b} ±0.20
Group 1	175.5^{a} ±8.656	15.24^{ab} ±2.49	460.85^{b} ±30.80	3.31^{b} ±0.14
Group 2	171.75^{ab} ±7.82	12.0^{ab} ±0.71	450.0^{ab} ±31.21	2.67^{ab} ±0.14
Group 3	176.76^{a} 8.64±	10.0^{ab} ±1.22	440.44^{ab} ±31.14	2.27^{ab} ±0.11
Group 4	177.26^{a} ±9.07	6.5^{c} ±1.66	410.62^{c} ±31.29	1.58^{c} ±0.11
Group 5	178.20^{a} ±8.16	4.1^{c} ±1.42	400.20^{a} ±29.45	1.02^{c} ±0.09

Control negative group normal rats fed on basal diet.
Control positive group diabetic rats fed on basal die.
Group 1 diabetic rats fed on basal diet substitute with 20% noodles made from 10% broccoli powder.
Group 2 diabetic rats fed on basal diet substitute with 20% noodles made from 20% broccoli powder.
Group 3 diabetic rats fed on basal diet substitute with 20% noodles made from 30% broccoli powder.
Group 4 diabetic rats fed on basal diet substitute with 20% noodles made from 40% broccoli powder.
Group 5 diabetic rats fed on basal diet substitute with 20% noodles made from 50% broccoli powder

Effect of feeding noodles from broccoli powder on total cholesterol, HDL and LDL in hyperglycemic rats:

The present data in Table (6) showed that the determination of total cholesterol, high density lipoprotein (HDL) and low density lipoprotein (LDL) in rats fed on basal diet substitute with 20% from noodle made from 10, 20, 30, 40 and 50% broccoli powder. From the results in Table (6), it could be observed that the total cholesterol in control positive was the highest amounted (394.9 mg/dl) than other group due to the positive control hyperglycemic rats fed on basal diet during the experimental period. Moreover, the results illustrated that the hyperglycemic rats fed on noodle made from 40 and 50% broccoli powder, the total cholesterol had the lowest (205.3 and 190.5 mg/dl) contained and nearly the negative healthy control 184.7 mg/dl fed on basal diet. These lowering results may be caused the noodle made from 40 and 50% broccoli powder which highly amounts of soluble and insoluble dietary fibers.

High density lipoprotein (HDL) was opposite results to low density lipoprotein (LDL) and the results are reported in the same Table. The results illustrated that the LDL in positive control was the highest amounted 110.8 mg/dl and the control negative was the lowest amounted 29.5 mg/dl as well as the rats group fed on 50% broccoli was 30.4 mg/dl followed by 40% was 33.5 mg/dl and 30% broccoli powder was 35.1 mg/dl.

Meanwhile, the hyperglycemic rats fed on basal diet substitute with 20% from noodle made from 10% broccoli powder; the LDL was 50.1 mg/dl.

High density lipoprotein (HDL) was determined in all groups and the best group from the results was the rats fed on noodle made from 50% broccoli powder 88.2 mg/dl followed by 40% was 84.2 mg/dl and 30% broccoli powder was 80.3 mg/dl, respectively. These results showed that the risk ratio was occurred the obviously results from total cholesterol, LDL and HDL.

Table 6: Total cholesterol, HDL and LDL -cholesterol (mg / dl) and risk ratio of the experimental hyperglycemic rats:

Groups	Total cholesterol	LDL	HDL	Risk ratio
Control -ve	184.7^{c} ±12.35	29.5^{c} ±4.54	67.6^{b} ±6.19	2.73^{c} ±0.77
Control +ve	394.9^{a} ±14.21	110.8^{a} ±2.76	45.3^{c} ±9.20	8.72^{a} ±0.98
Group 1	265.3^{b} ±15.43	50.1^{b} ±2.76	65.1^{b} ±10.0	4.07^{b} ±0.62
Group 2	220.7^{ab} ±14.73	38.4^{ab} ±2.88	72.0^{a} ±9.29	3.07^{b} ±0.60
Group 3	214.9^{ab} ±14.21	35.1^{ab} ±2.76	80.3^{a} ±9.20	2.68^{c} ±0.52
Group 4	205.3^{c} ±13.32	33.5^{ab} ±3.43	84.2^{a} ±7.71	2.44^{c} ±0.53
Group 5	190.5^{c} ±11.41	30.4^{c} ±2.35	88.2^{a} ±5.45	2.15^{c} ±0.28

Effect of feeding noodles from broccoli powder on total lipids, triglycerides and blood glucose level in hyperglycemic rats:

At the end of experimental period (4 weeks) the total lipids, triglycerides and blood glucose level were determined in all groups and the results are reported in Table (7). From the results in Table (7), it could be noticed that the total lipids, triglyceride and blood glucose level were increased in control positive (1.64g/dl, 252.5 mg/dl and 255.24 mg/dl) than control negative was 0.89 g/dl, 144.1 mg/ dl and 104.0 mg/ dl, respectively. Moreover, the results illustrated that the hyperglycemic rats were decreased gradually in total lipids, triglycerides and blood glucose level by increasing broccoli powder in noodles formulae.

These results showed that the total lipids, triglycerides and blood glucose level were decreased at the end of experimental due to the broccoli powder had contained high fiber amount that increases the reduction of cholesterol is possibly a sum of several effects; the most accepted one is due to decreased absorption of bile acids that causes a removal of steroids from the body by fecal excretion resulting in increased catabolism of cholesterol, an increase in the secretion of bile acids, a decrease in lipoprotein cholesterol secretion, and a reduction in the total body pool of cholesterol, total lipids and triglycerides Malkki *et al*. (2001).

Conclusion:

From the obviously results it could be conclusion that the broccoli is considered a low- glucose food which helps to normalize blood sugar and added the broccoli powder had contained highly amounts of protein and total dietary fiber. Thus, these broccoli powders have the potential to be used as food natural fortification of instant noodles to high nutritional value.

Table 7: Serum triglycerides, total lipid and blood glucose level of the experimental hyperglycemic rats:

Groups	Total lipids g/dl	Triglycerides mg/dl	Glucose mg/dl
Control -ve	0.89^{ab} ±0.26	144.1^{c} ±19.63	104.00^{d} ±8.04
Control +ve	1.64^{a} ±21.68	252.5^{a} ±17.65	255.24^{a} ±15.36
Group 1	1.45^{b} ±0.13	178.2^{b} ±11.75	172.34^{b} ±11.25
Group 2	1.20^{c} ±0.15	165.4^{b} ±13.33	145.75^{c} ±1143
Group 3	1.06^{c} ±0.21	152.5^{b} ±17.65	133.25^{c} ±10.87
Group 4	0.95^{ab} ±0.14	149.8^{c} ±12.82	120.25^{c} ±11.65
Group 5	0.90^{ab} ±0.11	145.9^{c} ±14.12	110.00^{d} ±10.51

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