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Improvement of noodles using pomegranate peel and gelatinization rice to lowering cholesterol and glycemic rats

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ABSTRACT

This study was carried out to determine the technological and nutritional viability of the use of pomegranate peel, as a by-product, in the development of noodles. Chemical and technological characteristics of noodles substituting 10, 20 and 30% of rice flour and pre-gelatinized rice flour by pomegranate peel powder were evaluated. The product with highest proportion of the residue-derived powder increased considerably its nutritional value, when compared with noodles prepared only with rice flour. Thus, the pasta added of pomegranate peel powder is a more beneficial food not only for the gluten intolerant individuals, but for anyone concerned about a healthy diet. At the end of biological experimental period the lipid parameters and blood sugar were determined in all groups fed on basal diet substitute with 20% from noodles formulae fortified with 10, 20 and 30% pomegranate peel powder and the resultant showed that when increased pomegranate peel powder in noodles formulae period the lipid parameters and blood sugar. From the obvious results it can be concluded that the pomegranate peel contains important amounts of minerals content, vitamins, polyphenols as natural antioxidants and high amount of nutrition values. Rice had contained fat, protein and carbohydrates and provide substantial amount of B vitamins; thiamin, niacin and riboflavin finely, rice is very high digestibility value. Moreover, it can be recommended that the noodles from rice and pomegranate peel lowering cholesterol and blood sugar.

Keywords: pomegranate peel, rice flour and pre-gelatinized rice flour, chemical and technological characteristics, lowering cholesterol and blood sugar.

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INTRODUCTION

Noodles are foods with high acceptability worldwide because they are part of the diet of many populations and are relatively inexpensive and easy of preparation[1]. This may be also considered as a functional food because of their low content of fat and sodium [2]. There are in the market, suitable foods for celiac people that among other ingredients contain corn starch, potato starch, tapioca starch and rice flour. In the particular case of making noodles, there are experiences where have been used in very acceptable form, raw materials as defatted corn germ and beans to replace durum wheat semolina [3]. In general the use of starches, gums and hydrocolloids are the most suitable means to make the gluten replacement in products for celiac people [4,5,6].

Noodles are classified into different types on the basis of raw material, processing methods, salt composition, size of noodle strand and form of noodles in the marketplace. Wheat noodles, rice noodles, starch noodles, mung-bean starch noodles and buckwheat noodles are few examples of noodle types which are available in the market nowadays. Noodles are classified into hand-made standard or flat noodles (teuchiudon or teuchihiramen) and thin hand-made noodles (tenobe so-men) based on manufacturing involved. Additionally, these are also classified on the basis of form of product in the marketplace i.e. instant noodles, boiled noodles (yude-men), dried noodles, (kanmen), steamed noodles (mushi-men), frozen boiled noodles, instant cup noodles, and machine made noodles [7].

Rice noodles are the most consumed form of rice product next to cooked rice grain in Asia [8]. Noodles may either be served by frying and mixing with vegetables and meats or served as a soup noodle by boiling in a broth. Rice protein lack gluten; hence lack the functionality of continuous visco-elastic dough. Rice flour is therefore pre-gelatinized in order to act as binder for the remaining flour. The extent of pre-gelatinization plays a vital role in providing desirable texture to the noodle strands. The level of gelatinization is maintained adequately to develop the desired binding power during the process of extrusion; though too much gelatinization may create handling problems [8]. Rice noodles are commonly prepared by two main methods; sheeting of dough to develop flat noodles and extruding to develop vermicelli. The raw materials for rice based noodles are usually evaluated by determining their functionalities; processes involved and desired end product [7].

Rice is also a good raw material to design formulations without gluten, is thought that this cereal provides 20% of dietary energy supply of the world. Not only is a rich source of energy but also is a good source of vitamin B such as thiamine, riboflavin and niacin. Besides, in consideration of the amino acid profile, while it has a high content of glutamic and aspartic acid it also has a low content of lysine which is a limiting amino acid [9]. Noodles prepared from flours of rice varieties different were acceptable but they showed large variation in texture quality [10].

Rice flour is obtained from fine milling of rice kernels. Rice flour may be made from either brown rice or white rice [11]. It is energetic and basic food consumed on a regular basis and has a very high digestibility value. Rice flour comprised of about 0.4–0.8% fat, 7% protein and 78% carbohydrates [12] and provide substantial amount of B vitamins; thiamin, niacin and riboflavin [13].

The proximate analysis of rice flour i.e. moisture, protein, ash, crude fiber, fat, amylose and amylopectin concentrations varies significantly due to the variation in genetic makeup, environmental factors and milling process [14,15,16]. A broad range of rice varieties are cultivated in the world that shows compositional variation among them. Noodles prepared from various rice varieties shows variation in quality characteristics [14]. It was reported that the moisture, ash, protein and fat concentration of dried rice noodles varied from 5.00-8.20%, 0.24–1.51%, 7.2–10.47% and 0.36–1.14%, respectively, [16,17,18]. Han et al. [19] found that the protein concentration was ranged from 6.92% to 8.65% in various rice varieties. While, the amylose concentration of rice varieties ranged from 10.13% to 32.07%. Juliano et al. [20] classified rice as low amylose (10-20%), intermediate (20- 25%) and high amylose concentration (> 25%). Varietal differences were found in case of ash, lipid and starch concentrations, which might also be attributed to the processing such as milling [19].

These compositional differences influence the functional, thermal, cooking, eating and pasting properties of final noodles [21]. Starch is the main component of rice flour and has significant impact on the

overall quality of noodle [22] as gluten is absent in rice noodles; the pasting, thermal and physicochemical properties of the starches would be responsible for providing a quality noodle [23].

In addition to their nutritional value, pomegranate peels were used since ancient times as anti-thelmintic, anti-tracheobronchitis, for healing wounds, ulcers, bruises, stomatitis, diarrhea, vaginitis, and against excessive bleeding [24]. In recent years, more medicinal values of pomegranate peel have been investigated such as abortifacient, analgesic, antiameobic, antibacterial, anticonvulsant, antifungal, antimalarial, anti-mutagenic, antiviral, antispasmodic, diuretic, hypoglycemic, hypothermic, and antioxidant activities [25]. The major class of pomegranate phytochemicals is the polyphenols that are predominant in the fruit and includes flavonoids (flavonols, flavanols, and anthocyanins), condensed tannins (pro-anthocyanidins) and hydrolysable tannins (HTs) (ellagi-tannins and gallo-tannins) [26]. These tannins are highly susceptible to both enzymatic and non-enzymatic hydrolysis. The hydrolysis products include glucose and ellagic acid or gallic acid. Additional phytochemicals present in pomegranate peel include organic and phenolic acids, sterols and triterpenoids, and alkaloids [27]. The ellagi-tannins present in the pomegranate peel accounts for approximately 92% of the total antioxidant activity of pomegranate fruit [28]. Therefore, the health benefits of pomegranate peel are accredited for the pharmacological activities exhibited by bioactive photochemical like polyphenols.

The objective of this study was to prepare noodles added of rice flour; pre-gelatinized rice flour and pomegranate peel powder and evaluate its technological and nutritional viability.

MATERIALS AND METHODS

Materials:

Fresh pomegranate fruit (Punicagranatum) and rice (Oryze sativa L.) high amylose were obtained from local market in Taif Kingdom of Saudi Arabia. Rice was milled and passes through a 60-80 mesh screen to give rice flour.

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

Methods:

Preparation of pomegranate peels:

Pomegranate fruits were washed by distilled water then peeled and their edible portions (seeds) were carefully separated. The peels were air dried in a ventilated oven at 40°C for 48 h and ground to a fine powder and passed through a mesh sieve.

Preparation of rice and pre-gelatinization rice flour:

Rice flour was prepared by using wet milling method [29]. Polished rice grains were steeped in tap water for 4 hours, before milling. Rice flour cake was separated from slurry by centrifugation, and then it was dried in tray dryer at 45±5oC. Flour was milled 2 times by electric miller and passed through 100-mesh sieve.

Pre-gelatinization rice flour (pre-gel flour) was prepared by passing rice flour solution containing 40% solid through drum dryer of which the conditions were set at 20 lb/inch2 of steam pressure, 0.25 rpm of drum speed and 0.01 inch of drum dryer gap. Then rice flour flakes were dried by using tray dryer at 45±5oC. Pre-gel flour was milled 2 times by electric miller and passed through 100-mesh sieve. Samples were kept in polyethylene bag

Preparation of noodle formulae:

Formulae noodles containing three concentrations of pomegranate peel powder (10, 15 and 30%) were prepared from rice flour and gelatinized rice flour. The noodles were prepared according to Garcia et al. [30] and stored in high density polyethylene bags until analyzes. Table (1) shows the formulae used in the preparation of noodles as control and its formulae by adding pomegranate peel powder.

Chemical analysis of noodles and their formulae:

Protein content, ash, crude fiber, lipids content and total carbohydrates were determined in noodles and their formulae according to AOAC [31]and also, amylose was determined using the method outlined by Juliano [32]. Total dietary fiber was determined of noodles formulae according to the methods described by Prosky [33]. Also, soluble and insoluble dietary fiber was determined with Lee and Prosky [34].

Table (1). Formulae of noodles with different concentrations of pomegranate peel powder.

Ingredient / g	Noodles rice formulae with pomegranate peel powder %			
	Control	10	20	30
Rice flour	500	425	400	350
Pre-gelatinized rice flour	165	148.5	132	115.5
Pomegranate powder	--	66.5	133	199.5
Water	275	275	275	275
Egg powder	60	60	60	60

The total phenolic compounds in the pomegranate peel powder and noodles formulae were determined by the Folin- Ciocalteau method El-falleh et al. [35]. The absorbance was measured at 750 nm using a spectrophotometer (Beckman, DU 7400 USA). The total phenolic compounds content in the pomegranate peel powder and noodles formulae were calculated and expressed as gallic acid equivalent per g dry weight (mg GAE/g DW).

Cooking noodle qualities and their formulae:

The cooking tests (cooking time, weight gain, volume increase and loss of soluble solids into the cooking water) were applied only on noodles and their formulae. All analyzes were performed in triplicate according to Chillo et al. [36].

Sensory evaluation of noodles and their formulae:

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. [37].

Biological experiments for noodles formulae:

Male albino rats Sprague Dawley strain (30 animals) weighing 170-180g. Animals were housed in individual cages with screen bottoms and fed on basal diet for one week. It consisted of casein 10%, corn oil 10%, cellulose 5%, salt mixture 4%, vitamin mixture 1% and corn starch 70% according to AOAC [31].

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 (30 days) and considered as negative control. The second main group (24 rats) was fasted over night and injected with streptozootocin (dissolved in 0.1M citric acid buffer and adjusted at pH 4.5) into the leg muscle (5mg /100g body weight) to induce diabetic and hypercholesterolemia rats according to Madar [38]. After 48 hr. of injection the second main group was divided into four sub groups (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, third and fourth subgroups (6 rats for each) were fed on basal diet substituted with 20% noodles had contained 10, 20 and 30% pomegranate powder. 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°C until their analyses. Serum glucose, total lipids, total cholesterol and triglycerides were determined according to Tietz [39], knight et al. [40], Allain et al. [41] and Fossati and Prencipe [42], respectively. High and low density lipoprotein- cholesterol in serum was determined according to Burstein [43] and Fruchart [44].

Statistically analysis:

The data obtained in the present study was analyzed by ANOVA. For all analyses, when a significant difference ($p \leq 0.05$) was detected in some variable, the data means test was applied to evaluate the difference between the samples. The results were analyzed with the aid of the software SAS System for Windows SAS [45].

RESULTS AND DISCUSSION

Chemical composition of noodles supplemented with pomegranate powder

Chemical compositions (g/100g) of pomegranate peel powder and noodles formulae are shown in Table (2). Results showed that significant increases were found in protein, fat and total carbohydrate contents for noodles control 7.85, 3.24 and 84.68%, respectively compared with pomegranate peel powder 0.76, 0.59 and 73.61% respectively. On the contrary, significant increases were found in ash, crude fiber and total dietary fiber contents for pomegranate peel powder 5.50, 19.54 and 56.23%, respectively compared with noodles control.

These results showed that significant decreases gradually in protein, fat and total carbohydrates were found in different concentrate formulae may be caused the pomegranate peel powder lower in protein, fat and total carbohydrates than noodles rice control. On the other hand, significant increased ash content, crude fiber and total dietary fiber by increasing pomegranate peel powder were observed in the rice noodles formulae at the levels of 10, 20 and 30% pomegranate peel powder, respectively compared with control noodles. On the contrary, significant decreases of carbohydrate content were observed by increasing in pomegranate peel powder at levels 10, 20 and 30% to reach 82.95, 80.70 and 78.70% compared with control noodles. Moreover, the in the same table observed that the control noodles had contained high amylose (28.09%) and also, the amylose was decreased when pomegranate peel powder increased at levels 10, 20 and 30% formulae noodles to reach 26.54, 24.36 and 23.18%, respectively. These decrease may be caused the rice had the highest amylose whereas the amylose was not detected in pomegranate peel powder.

Rice flour is one of the most appropriate cereal flours for consumers with Celiac disease since there is no gluten in [10]. Due to lack of gluten, the quality of rice noodles depends mostly on starch properties [10], which serve as the structural network of the noodle products. Li and Luh [46] found that rice varieties with high amylose, low gelatinization temperature and hard gel consistency were suited to make noodles.

Total phenolic acids was determined in pomegranate peel powder and rice noodles formulae and the resultant illustrated that the total phenolic was 58.63 mg GAE/g DW in pomegranate peel powder and also not detected total phenolic in noodles control. Whereas, the formulae rice noodles were increased in total phenolic when pomegranate peel powder increased to reach 6.32, 14.35 and 22.15 mg GAE/g DW, these caused the pomegranate peel powder had the highest in total phenolic as natural antioxidant.

Pomegranate peels are exploited in traditional medicine because of their strong astringency, making them a popular remedy throughout the world. In the form of an aqueous decoction (boiling the hulls in water for 10-40 min), it was used for dysentery and diarrhea and also for stomatitis. It can be drunk and used as a mouthwash, douche or enema [47]. The phytochemistry of pomegranate has also been widely studied by some researchers and this fruit is found to be a rich source of polyphenolic compounds [48]. Both flavonoids and tannins are more abundant in the peels [49]. Peels of pomegranate contain a wide variety of phytochemical compounds like gallotannins, ellagic acid, gallic acid, punicalins, punicalagins, as it was previously stated by some researchers [50].

Cooking tests of noodles supplemented with pomegranate powder:

In Table (3) are the results of the characterization of the noodles after the cooking tests which include cooking time, weight gain, volume increase and loss of soluble solids in water, important parameters for assessing the overall quality. The values of weight gain of the noodles showed significant differences (p > 0.05). Thus, considering that weight gain is a parameter of quality that is directly related to the yield of the pasta after cooking, it is considered as appropriate the value of approximately 2 times the original weight (200%) [51]. The increase volume of the pasta, differentiated among treatments at 5% (p <0.05), and the standard sample showed the largest volume. This difference is explained by Menegassi, and Leonel [52],who mentioned that the volume increase depends on the cooking time and the format of the noodles, as well as the content and quality of proteins, which hydrate and absorb water during the mixing of the dough.

The sample with addition of 10% of pomegranate peel showed the shortest cooking time, and this result is of great importance nowadays, when consumers have sought foods of faster preparation. Ferreira et al. [53] found times higher when evaluating the cooking time macarrões prepared with the mixed flour sorghum, rice and potatoes. Noodles containing pomegranate peel had lost from 7.2% (10%) to 8.533% (30%) of soluble solids in water and the standard sample, which contains only rice flour and pre-gelatinized rice flour, had lost only 5.967. The greatest solid loss was due to the residual pomegranate peel incorporated in the first three samples. Garib [54] studied pasta made with 75% of wheat flour, 15% of pre-gelatinized corn flour, 10% soy flour, and reported loss of soluble solids of 9.33%.

Table (2): Chemical constituencies of noodle and its formulae on dry weight:

Chemical analysis	Pomegranate powder	Control noodle	Noodle formulae made from pomegranate powder		
			10%	20%	30%
Protein	0.76±0.076	7.85±1.35	7.57±1.25	7.34±1.46	7.17±0.97
Lipids	0.59±0.053	3.24±0.91	2.82±0.95	2.59±0.85	2.12±0.74
Ash	5.50±0.05	1.72±0.24	2.25±0.82	2.79±0.67	3.24±0.62
Crude fiber	19.54±0.16	2.51±0.15	4.41±0.97	6.58±1.24	8.77±1.23
T. C	73.61±2.25	84.68±4.35	82.95±5.32	80.70±4.39	78.70±3.64
TDF	56.23±3.32	2.85±0.38	6.27±0.43	9.37±1.81	12.28±2.78
SDF	13.56±2.84	0.92±0.01	1.32±0.12	1.76±0.27	2.89±0.82
ISDF	42.67±3.56	1.93±0.48	4.95±0.54	7.61±0.40	9.39±0.68
Amylose	---	28.09±1.38	26.54±1.24	24.36±2.04	23.18±2.86
T. P.	58.63±3.13	-----	6.32±0.18	14.35±1.64	22.15±2.14

T. C Total carbohydrates   TDF total dietary fiberSDF Soluble dietary fiber   ISDF Insoluble dietary fiber
T. P. Total phenolic calculated and expressed as mg gallic acid equivalent per g dry weight (mg GAE/g DW).

Table (3): Cooking tests of noodles supplemented with pomegranate powder.

Formulae	Weight gain (g)	Cooking time (min)	Loss of soluble solids (%)	Volume increase (%)
Control	8.611±0.948a	11.333±1.528 a	5.967±0.252 b	61.910±0.956 a
Formula1	8.804±0.003 a	6.667±0.577b	7.200±0.26ab	51.200±0.576 b
Formula 2	8.104±0.002 a	8.667±0.432 b	7.700±0.243ab	48.200±0.457 b
Formula 3	7.576±0.401 a	9.000 ±0.000ab	8.533±0.850 a	42.860±1.321c

Organoleptic properties of noodles and their formulae substituted with pomegranate powder:

Sensory evaluation is used to measure human responses to foods with different techniques to get important and useful information [55]. Sensory evaluation is defined as a scientific method for analyze, evoke, measure and interpret responses to products under controlled conditions with the help of sight, smell, touch,

taste and hearing. The tested samples are often labeled with random numbers and served in different orders for counterbalance of other judgments than the sensory experience.

Tables (4) showed that the organoleptic properties of noodles and their formulae substituted with pomegranate powder. The resultant from Table (4), it could be noticed that the noodles with pomegranate powder at level 10, 20 and 30%, respectively were acceptability (45.0, 40.0 and 37.5) and nearly control noodles (45.0%). These results showed that the addition of pomegranate powder was acceptability till 30% caused pomegranate powder is a good source for many nutrients such as natural antioxidants and total dietary fiber.

Biological investigation:

Effect of feeding noodles pomegranate powder on the initial body weight, gain body weight, total food intake and feed efficiency ratio in the experimental hypercholesterolemia and hyperglycemia rats:

Initial body weight, gain body weight, total food intake and feed efficiency ratio in the experimental hypercholesterolemia and hyperglycemia rats which were fed separately on 20% from different noodles formulae substituted with 10, 20 and 30% pomegranate powder and the results are reported in Table (5). The mean values of initial body weight of all groups after adaptation feeding on basal diet were ranged from 173.2 to 177.4 g.

Table (4): Organoleptic properties of sausage and their formulae substituted with pomegranate powder:

Formulae	Appearances (10)	Taste (10)	Color (10)	Texture (10)	Flavor (10)	Over all acceptability
Control	9.00 a ±0.12a	9.00a ±0.10	9.00 a ±0.11	9.00a ±0.11	9.00a ±0.12	45.0
Formula 1	9.00 a ±0.14	9.00a ±0.12	9.00a ±0.12	9.00a ±0.12	9.00 a ±0.12	45.0
Formula 2	8.00ab ±0.15	8.00ab ±0.16	8.00ab ±0.15	8.00ab ±0.14	8.00ab ±0.14	40.0
Formula 3	7.50b ±0.12	7.50b ±0.13	7.50b ±0.13	7.50b ±0.14	7.50b ±0.14	37.5

At the end of experimental period (4 weeks), the final body weight of negative control hypercholesterolemia rats was higher than the positive control. The hypercholesterolemia and hyperglycemia rats were fed on noodles formulae had lower in final body weight than those of the hypercholesterolemia and hyperglycemia rats' positive control.

The obtained results illustrated that the gain in body weight at the end of experimental period for the negative control fed on basal diet was increased to 146.6 g, while the hypercholesterolemia and hyperglycemia positive control was 46.0 g. Feeding on basal diet separately on 20% from different noodles formulae substituted with 10, 20 and 30% pomegranate powder had lowered in body weight gain 90.3, 81.8 and 70.5 g respectively than negative control (146.6 g).

Concerning food intake, the results indicated that rats fed on basal diet and different noodles formulae are reported in the same table. The values of food intake for negative control were 560 g and 530g for hypercholesterolemia and hyperglycemia rats as positive control. Whereas, the rats group 1, 2 and 3 fed on different noodles formulae, the food intake were nearly values 490, 470 and 420 g, respectively for four weeks

The calculate data of feed efficiency ratio (FER) for rats fed on basal diet and different noodles formulae summarized in the same table. From the results, it can be observed that the value of feed efficiency ratio of basal diet was 26.17%, which was depressed to 8.68% for hypercholesterolemia and hyperglycemia control positive. The FER values of rats group 1, 2 and 3 were 18.43, 17.40 and 16.78 %, respectively fed on different noodles formulae substituted fat with 10, 20 and 30% pomegranate powder.

The gain body weight, food intake and feed efficiency ratio were decreased in rats group 1, 2 and 3 respectively, may be due to the groups fed on noodles formulae substituted with 10, 20 and 30% pomegranate powder had contained rich amounts from natural antioxidants, the results are significantly greater reduction of weigh, food intake and feed efficiency ratio.

Serum triglycerides, total lipids, cholesterol profile and blood sugar of the experimental hypercholesterolemia and hyperglycemia rats:

At the end of biological experimental period the total lipid, triglyceride cholesterol profile and blood sugar were determined in all groups fed on basal diet substitute with 20% from noodles formulae substituted with 10, 20 and 30% pomegranate peel powder and the results are reported in Table (6). From the resultant, it could be noticed that the total lipid and triglyceride were increased in control positive (1.42g/dl and 245.7 mg/dl) than control negative was 0.65g/dl and 112.3 mg/ dl, respectively. Moreover, the results illustrated that the hypercholesterolemia and hyperglycemia rats fed on noodles made from 30% pomegranate powder; the total lipid and triglyceride were nearly control negative and it was amounted 0.68 g/dl and 115.1 mg/dl. The hypercholesterolemia and hyperglycemia rats fed on noodles made from 10% pomegranate powder was increased in total lipid and triglyceride 0.97g/dl and 170.5 mg/dl than other group fed on noodles different formulae. These results showed that all groups were fed on pomegranate powder during experimental period; the total lipid and triglyceride were decreased at the end of experimental due to the pomegranate powder had contained high natural antioxidants amount and total dietary fiber that increases degradation of cholesterol to fecal bile acids.

Table (5): Initial body weight, gain body weight, and feed efficiency ratio in experimental hypercholesterolemia rats.

Groups	Initial body weight (g)	Gain body weight (g)	Total food intake (g)	Feed efficiency ratio
Control negative	175.0 ± 2.70a	146.6 ± 2.70a	560.0 ±6.24a	26.17 ±0.05a
Control positive	173.2 ± 2.58a	46.0 ± 2.44a	530.0 ±6.25a	8.68 ±0.04c
Group 1	176.2 ±2.34a	90.3 ±1.95ab	490.0 ±5.43b	18.43 ±0.04ab
Group 2	173.8 ± 3.49a	81.8 ± 5.10b	470.0 ± 5.36b	17.40 ±0.08ab
Group 3	177.4 ±3.95a	70.5 ±4.54c	420.0 ±5.17b	16.78 ±0.05b

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% pomegranate peel powder.
Group 2 diabetic rats fed on basal diet substitute with 20% noodles made from 20% pomegranate peel powder.
Group 3 diabetic rats fed on basal diet substitute with 20% noodles made from 30% pomegranate peel powder

From the results in the same table, it could be observed that the total cholesterol in control positive was the highest amounted (297.3 mg/dl) than other group due to the positive control fed on basal diet during the experimental period. Moreover, the results illustrated that the hypercholesterolemia and hyperglycemia rats fed on noodles made from 30% pomegranate powder, the total cholesterol had the lowest (200.0 mg/dl) contained and nearly the negative healthy control 187.3 mg/dl fed on basal diet. These lowering results may be caused the noodles made from 30% pomegranate powder which highly amounts from natural antioxidants and total dietary fiber. The hypercholesterolemia and hyperglycemia rats fed on noodles contained of 20% pomegranate powder had lowered cholesterol 227.0 mg/dl followed by hypercholesterolemia rats fed on noodles prepared from 10% pomegranate powder was 240.6 mg/dl. Moreover, the results illustrated that the

LDL in positive control was the highest amounted 131.7 mg/dl and the control negative was the lowest amounted 25.0 mg/dl as well as the rats group fed on 30% noodles pomegranate powder was 30.7 mg/dl followed by 20% was 40.6 mg/dl and10% was 44.3 mg/dl, respectively. High density lipoprotein (HDL) was determined in all groups and the best group from the results was the rats fed on sausage made from 30% pomegranate powder was 80.0 mg/dl followed by 20% was 74.0 mg/dl and 10% was 67.5 mg/dl, respectively.

Whereas, the blood glucose from the obviously results, It could be noticed that the positive control was the highest amounted 169.3 mg/dl followed by rats fed on basal diet substitute with 20% from noodles made from10% pomegranate powder was 130.1mg/dl. Whilst, the groups fed on basal diet substitute with 20% from noodles made from 20 and 30% pomegranate powder were decreased 125.3 and 110.7 mg/dl, respectively, than control positive and nearly to control negative 115.3 mg/dl. The obtained results are in agreement with Parsaeyan [56] found that the mechanism of the observed hypo-triglycerides effect may be due to decreased fatty acid synthesis, increased lipolytic activity by inhibition of hormone-sensitive tissue lipases or suppression of lipogenic enzymes, Activation of LCAT and tissues lipases.

Pomegranate fruit parts have bioactive compounds which prevent low-density lipoprotein oxidation, prostate cancer, platelet aggregation and various cardiovascular diseases [57]. Ozkal and Dinc [49] reported the presence of tannins, anthocyanins and flavonoids in pomegranate rind. Pomegranate peel is a rich source of tannins and other phenolic compounds [58]. The noodles industry can use fruit by-products as a potential source of phenolics as they have immense nutraceutical value and can be used to produce functional noodles products of commercial interest.

Table (6): Serum lipids parameters and blood sugar (after 4 weeks) of the experimental hypercholesterolemia rats:

Groups	Total lipids (g/dl)	Triglycerides (mg/dl)	Total cholesterol (mg/dl)	HDL (mg/dl)	LDL (mg/dl)	Blood sugar (mg/dl)
Control negative	0.65 ±0.03c	112.3 ±6.1c	187.3 ±1.1c	83.7 ±4.0a	25.0 ±5.56c	115.3 ±5.7c
Control positive	1.42 ±0.17a	245.7 ±27.9a	297.3 ±6.5a	47.3 ±7.2d	131.7 ±20.2a	169.3 ±3.8a
Group 1	0.97 ±1.02ab	170.5 ±10.5ab	240.6 ±4.1b	67.5 ±3.1b	44.3 ±9.8b	130.1 ±2.3b
Group 2	0.78 ±0.13b	141.0 ±30.0b	227.0 ±7.0ab	74.0 ±5.3ab	40.6 ±10.0ab	125.3 ±1.2ab
Group 3	0.68 ±0.19c	115.1 ±7.5c	200.0 ±6.3c	80.0 ±4.2a	30.7 ±6.34c	110.7 2.8c±

CONCLUSIONS

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

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