Preparation of different formulae from quinoa and different sources dietary fiber to treat obesity in rats

Maha A. Hejazi

Faculty of Home Economics -King Abdul-Aziz Univ., Saudi Arabia.
E-mail: maha.hej@hotmail.com

Abstract: This study was carried to evaluate the quinoa and mixed with different sources from dietary as defatted soybean, carrot powder and resistance starch to give four formulae protects rats from diet induced obesity. Chemical composition, total dietary fractions, phenolic acid, flavonoids compounds and minerals content were determined in raw materials. The results showed that the quinoa mill and soybean had rich amount of protein, dietary fiber and antioxidants. Whereas carrot powder has the highest in sodium contained and also resistance starch give high amount for total dietary fiber fractions. The biological experimental showed that the rats group 1 fed on fat and basal diet as considerable obesity control and the fourth groups were fed on fat and basal diet substituted with 20% from different formulae (from formula number 1 to formula number 4) during four weeks (30 days). At the end of experimental the complete blood picture, total lipid profile, total cholesterol fractions, liver and kidney functions were determined in the fifth groups. The results showed that the increase in complete blood picture as hemoglobin, hematocrit, red blood cells and platelets in the rat groups fed on quinoa because it's contained a high valuable iron. Significant decreased in total cholesterol, cholesterol fractions (LDL and HDL), triglycerides and total lipid in rats fed on formula 1 contained 60% quinoa and different levels of dietary fiber mixture (15% from both of defatted soybean and carrot). When quinoa and different dietary fiber in the formulae increased the liver functions were decreasing. The kidney function as urea, creatinine and uric acid in rats fed on fat and basal diet the urea, creatinine and uric acid were the lowest from 42.0, 1.13 and 5.73 mg/dl in obesity rats group to 16.0, 0.5 and 2.46 mg/dl in rats group fed on 60% quinoa and different fiber (15% both of defatted soybean and carrot powder). From the results it could be concluded and recommended that the quinoa has an antiobesity activity and could be used as a nutritional supplement for the prevention and treatment of obesity and obesity-associated disorders.
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1. Introduction

Obesity, which is a major recognized risk factor for type-2 diabetes, is rapidly increasing in prevalence resulting in a "diabesity" epidemic. Diabesity represents one of the major public health problems in the 21st century. Some of the strategies that have shown to be effective in reducing type-2 diabetes incidence are exercise and a healthy diet. New drugs that have as a target the inhibition of the enzyme dipeptidyl dipeptidase IV (DPPIV) have been released. However some of these drugs have secondary effects; for that reason, the food industry is exploring the aspects related to the components present in food that promote a healthy life, such as the bioactive peptides encrypted in the proteins of several foods **Velarde-Salcedo et al. (2012)**.

The prevalence of overweight and obesity and their associated metabolic disorders are considered a major threat to the public's health. While several diet and exercise programs are available for weight loss and prevention of weight regain, progress is often slow and disappointing. Recently, natural bioactive phytochemicals present in foods have been discovered for their potential health benefit effects on the prevention of chronic disorders such as cancer, cardiovascular disease, inflammatory and metabolic diseases including obesity. Polyphenols are a class of naturally-occurring phytochemicals, of which some such as catechins, anthocynines, resveratrol and curcumin have been shown to modulate physiological and molecular pathways that are involved in energy metabolism, adiposity, and obesity. The potential *in vivo,* beneficial effects of these polyphenols on adiposity and obesity as complementary agents in the up-regulation of energy expenditure have emerged by investigating these compounds in cell cultures, animal models of obesity and in some human clinical and epidemiological studies **Ogden et al. (2006).**

Hyperlipidemia, being an important risk factor cardiovascular disease, is a serious public health problem in the world. It major role in the pathogenesis of atherosclerosis has been implicated by several clinical and epidemiological studies **(Jaffer et al., 2004).** Hyperlipidemia, also has an indirect role by stimulating the production of oxygen free radicals (OFRs) from polymer phonuclear leukocytes (PMNLs) and monocytes **(Prasad, 2005)**. Regarding

is treatment, now a day there is an increasing interest towered the potential health benefits of medical plants.

Quinoa (Chenopodium quinoa Willd) is usually referred to as a pseudo-cereal since it is not a member of the Gramineae family, but it produces seeds that can be milled in to flour and used as a cereal crop. It is an annual dicotyledonous plant usually standing 0.5-2.0 m high with large panicles of 1.8-2.2 mm long seeds produced at the end of the stem. The seed is usually pale yellow, but it may vary from almost white through pink, orange or red to brown and black. The embryo can hold 60% of the seed weight and it forms a ring around the endosperm that loosens when the seed is cooked **National Research Council (1989).** Unlike most grains; quinoa (Chenopodium quinoa Willd.) contains a complete protein. It is high in essential amino acids and fatty acids and it's a good source of vitamin C, E and several of the B vitamins (**Jancurova et al., 2009**). This makes it especially good as a grain substitute in gluten free diets as most people get the majority of their B vitamins from baked goods. Quinoa contains between14 and 18% protein, with characteristics similar to milk protein. Quinoa is also a source of calcium, magnesium, zinc and iron **(Penarrieta et al., 2008)**. The quinoa seed was characterized by an excellent nutrient profile. Besides being important energy sources due to their starch content, quinoa provide good-quality protein, dietary fiber and lipids rich in unsaturated fats (**Penarrieta et al., 2008 and Alvarez – Jubete et al., 2009a).** Moreover, they contain adequate levels of important micronutrients, such as minerals and vitamins and significant amounts of other bioactive components, such as saponins, phytosterols, squalene, fagopyritols and polyphenols. (**Alvarez-Jubete et al., 2009b and Alvarez-Jubete et al., 2010a).**

Carrot (Daucus carota L.) is a good source of natural antioxidants, especially carotenoids and phenolic compounds (**Prakash et al. 2004** and **Zhang and Hamauzu, 2004)**. After processing, carrot residues, e.g. peels, pumice, are usually discarded or used as animal feed. However, carrot by-products still contain high contents of beneficial substances, especially bioactive compounds with antioxidant activities **(Zhang and Hamauzu, 2004).**

Soybean (Glycine max) has distinct nutritional values because of its high protein, vitamin, and mineral compositions that offer healthy advantages **(Obatolu et al., 2006).** Health and medicinal benefits associated with soy protein include reduced blood cholesterol level **(Anderson et al., 1995),** protection against cardiovascular disease, and reduced risk of certain cancers (prostate and breast) in humans **(Messina and Barnes, 1991 and Peterson and Barnes, 1991, 1993).**

In the last decade, the use of amaranth and quinoa has broadened not only in the common diet **(Berti et al., 2005).** These pseudocereals seeds have high nutritional and functional values which are associated with the quality and quantity of their proteins, fats and antioxidant potential **(Gorinstein et al., 2002; 2007 and Pas´ko et al., 2007).** A new way in nutrition, in recent years, is the consumption of sprouts – the atypical vegetable, which have received attention as functional foods, because of their nutritive value including amino acid, fiber, trace elements and vitamins as well as flavonoids, and phenolic acids **(Pas´ko et al., 2008).**

The objective of the present study has been carried out to evaluate the different formulae made from quinoa and different sources dietary fiber as soybean, carrot powder and resistance starch to treat obesity in rats. The different formulae have rich contain protein, polyphenol, minerals, dietary fiber and total carbohydrates. The different formulae were used for feed the rats groups to treatment of obesity and prevent of benefit health.

2. Materials and Methods

Materials:

Yellow quinoa (Chenopodium quinoa), was imported from the Republic of Bolivia. Soybean (Glycine max) and carrot (Daucus carota, L) were obtained from local market at the west zone, Saudi Arabia.

Yellow carrot was cleaned and washed with tap water, peeled and cut into slices. The slices material were soaked in boiled water for 5 min. and dried in an electric oven at 40 -50^{o}C for 24 hr as described by **Park (1987).** All seeds and dried carrot were milled in a Laboratory Mill Junior to give a fine power. The soybean powder was extracted oil using n-hexane (40-60) at room temperature for 48 h. The extracts were filtrated and soybean defatted was dried at 50±5^{o}C in an electric oven according to **AOAC (2005).** The obtained powder were packed in poly ethylene bags and stored in a refrigerator until uses.

Methods:

Preparation of resistant starch:

Resistant starch was prepared according to the method described by **Po-Ying et al. (1994).** Corn starch weighted 200 g. into a beaker one liter and mixed with distilled water 700 ml. of suspension was autoclaved at 125°C for 1 hr. After autoclaving, the sample was cooled to room temperature and stored in a refrigerator over-night at 4°C. a product (resistant starch) was determined according to the method described by **Sambucetti and Zuleta (1996)**. A product (resistant starch) containing approximately 30% resistant starch was obtained.

Determination the chemical analysis of raw materials.

Proximate analysis including crude protein, crude lipids, ash, crude fibers and total carbohydrates were determined in the yellow quinoa mill, defatted soybean, carrot powder and resistance starch according to the methods of **AOAC (2005)**. Minerals content (K, Na, Ca, P, Cu, Fe and Mn) were determined in the yellow quinoa mill, defatted soybean, carrot powder and resistance starch using the Flam Photometer apparatus (Galienkamp, FGA330, England) and Perkin Elmer atomic absorption spectrophotometer (model 80, England) as described in **AOAC (2005).** Total dietary fiber (TDF), soluble and insoluble dietary fibers were determined in the yellow quinoa, defatted soybean, carrot powder and resistance starch according to the method described by **Prosky et al. (1984) Lee and Prosky (1995).**

Extract antioxidants from dried raw materials powder.

Air dried yellow quinoa mill, defatted soybean, carrot powder and resistance starch were finely powdered as previously described and extracted with petroleum ether (40-60^{o}C) to remove fats and resinous materials. The residues were exhaustively separately extracted with 500 ml of methanol (70%). The extract was filtrated through Whatman no., 1 filter papers and the filtrates were evaporated to dryness under reduced pressure on a rotary evaporator (RE 300/MS) at 40^{o}C.

Determination of total phenolic content

The total phenol content of the extracts was determined using the method reported by **Xu and Chang (2007)**. A sample of methanolic extract (0.2 ml) was mixed with 1 ml of Folin– Ciocalteau reagent (ten folds dilution). The mixture was allowed to stand for 5 min at room temperature before adding 0.80 ml of 20% Na2CO3 and then mixed gently. The reaction mixture was incubated for 40 min and the absorbance measured at 760 nm in spectrophotometer. The total phenolic content was calculated using gallic acid as standard.

Determination of total flavonoid content

The total flavonoid content was measured using the Aluminium chloride colorimetric method modified from the procedure reported by **Woisky and Salatino (1998).** Two ml of the extract was mixed with 100µl of 10 percent AlCl3, 100µl of 1 mol per liter potassium acetate and 2.8 ml water and allowed to incubate at room temperature for 30 min. Thereafter, the absorbance of the reaction mixture was subsequently measured at 415 nm.

Preparation of different formulae:

Yellow quinoa mill, resistance starch, defatted soybean and carrot powder were used to prepare different formulae at different levels. The ingredients used to treatment obesity on rats are given in Table (1)**.**

Table (1): The ingredients used to treatment obesity on rats:

Formulae number	Quinoa mill	Defatted soybean	Carrot powder	Resistance starch
1	60	15	15	10
2	50	20	20	10
3	40	25	25	10
4	30	30	30	10

Nutritional experimental.

Male albino rats (30 rats) weight 45-55 g brought from House Experimental Animal, Center of King Fahd for Researches, University King Abdul-Aziz, Jada City, Saudi Arabia were housed in individual cages with screen bottoms and fed on fat and basal diet for eight days. This basal diet consisted of corn starch 70 %, casein 15 %, corn oil 5%, salts mixture 4 %, vitamin mixture 1 % and cellulose 5 % according to **AOAC (2005)**. After feeding on high fat (30.0 mg fat/day/kg body weight for each rat according to **Anne-Sophie et al., 2011**) and basal diet rats were divided into five groups (6 rats for each). The first group was fed for period experimental on fat and basal diet considered as control. The groups from the second to fifth groups were fed on fat and basal diet substituted with 20% from different formulae (from formula number 1 to formula number 4) during four weeks (30 days). 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.

Complete blood picture as hemoglobin (Hb), hematocrite (Ht) and platelets were determined using a whole blood sample and the method described by **Dacie and Lewis (1984)** respectively. Red blood cells (RBCs) and white blood cells (WBCs) were measured as recommended by **Riley (1960)**.

Triglycerides, total lipids, total cholesterol, HDL and (LDL) were determined according to the method of **Fossati and Principe (1982), Zollner and Kirsch (1962), Allain et al. (1974)**, **Lopes-Virella et al. (1977) and Steinberg (1981),** respectively.

Liver function as Alanine (ALT) and Aspartate (AST) transaminoferase were determined according to

the method described by **Reitman and Frankel (1957).**

Kideny function as uric acid, creatinine and urea were estimated according to the method described by **Barham and Trider (1972)**, **Bartles et al. (1972) and Fawcett and Soctt (1960),** respectively**.**

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).**

3. Results and Discussion

Chemical analysis and polyphenolics of raw materials:

Chemical composition and polyphenolics (phenolic acid and flavonoids compounds) of quinoa mill, defatted soybean, carrot power, and resistance starch were determined and the results are reported in Table (2). From the results, it could be noticed that the defatted soybean had contained the highest content of protein (51.60%) and crude fiber (10.71) and also, the lowest content of total carbohydrates (25.45%), respectively. Whereas, carrot power characterized by the higher content of crude fiber (9.85%) followed by quinoa mill (8.38%) respectively. Meanwhile, resistance starch had the highest content of total carbohydrates (98.30%) and the lowest content of other components.

Total dietary fiber fractions as soluble and in soluble dietary fiber were determined in raw materials and the resultant showed that the resistance starch had the highest in total dietary fiber and its fractions (39.56, 13.19 and 26.39%) followed by defatted soybean was 25.39, 8.73 and 16.66% and quinoa mill had contained 15.99, 3.85 and 12.14%, respectively. Whilst, carrot powder had the lowest amounted for total dietary fiber and its fractions.

Legumes, such as soybeans, kidney beans, lentils and chickpeas, contain many important nutrients and photochemical; and are present in most Chinese daily diets as good sources of protein, generous amounts of dietary fiber, starch, lipids and minerals. Many researchers have shown the relationship between legume consumption and health benefits, such as, protection from cardiovascular disease, breast cancer, colon cancer, other cancers and diabetes **(Mathers, 2002).**

Quinoa is potential sources of food due to their high quality of proteins **Grobelnik et al. (2009).** The amount of high-protein possessing an attractive amino acid balance for human nutrition because of it high levels of lysine and methionine represents a compromise between nutritional improvement and achievement of satisfactory sensory and functional properties of the product. The main problem in the use of quinoa as components, replacing wheat in the blends, arises from the fact that these pseudocereals do not contain gluten, and thus the addition into leavened and pasta products are limited **Gross et al. (1989).**

Phenolic acid and flavonoids compounds as pigment and antioxidants were determined of quinoa mill, defatted soybean, carrot power, and resistance starch and the results are reported in the same Table (2). The resultants illustrated that the quinoa mill hah the highest contained amounts from phenolic acid and flavonoids compounds (328 and 197 mg/100g) followed by defatted soybean was 110.0 and 81.4 mg/100g and carrot powder had amounted 62.21 and 34.54 mg/100g, respectively. Meanwhile, resistance starch had not detected from phenolic acid and flavonoids compounds.

Polyphenolic compounds have an important role in stabilizing lipid oxidation and are associated with antioxidant activity **(Yen et al., 1993).** The phenolic compounds may contribute directly to antioxidative action **(Duh et al., 1999).** Total flavonoid, phenolic, and antioxidant contents have been assessed by spectrometry among several quinoa varieties, indicating that differences in phytochemical content may be due to genotypic or environmental factors **(Gomez-Caravaca et al., 2011).**

Table (2) Chemical analysis of raw materials g/100g dry weigh.

Chemical analysis	Quinoa	Defatted soybean	Carrot powder	Resistance starch
Protein	16.47	51.60	7.04	0.50
Ash	5.52	6.93	4.59	0.72
Lipids	6.85	5.22	0.97	0.13
Crude fiber	8.38	10.71	9.85	0.35
TC	62.78	25.54	77.55	98.30
TDF	15.99	25.39	5.21	39.56
TSDF	3.85	8.73	1.74	13.19
TIDF	12.14	16.66	3.47	26.39
*T. Phenolic	328	110.0	62.21	-
**T. Flavonoids	197	81.4	34.54	-

TC: Total carbohydrates; TDF: Total dietary fiber TSDF: Total soluble dietary fiber; TIDF: Total insoluble dietary fiber;
*Total phenolic as mg gallic acid equivalent/100g; **Total flavonoids as mg queractin equivalent/100g

Minerals content of raw materials:

Table (3) showed that the mineral content of quinoa, defatted soybean, carrot powder and resistance starch were determined and the resultant reported that the quinoa mill had higher amounts from potassium, calcium, copper, iron and manganese (926.7, 248.7, 5.10, 13.2 and10 mg/100g) than defatted soybean and carrot powder. Defatted soybean had the highest phosphorus contained of 685.0 mg/100g and also carrot powder had the highest sodium contained of 69.0 mg/100g. Meanwhile, the resistance starch has not detected for minerals content. These results agreement with **Vega-Galvez et al. (2010)** who reported that the quinoa has higher total mineral (ash) content (3.4%) than rice (0.5%), wheat (1.8%), and other cereals **(Bhargava et al., 2006).** The micronutrients calcium (275 to 1487 mg/kg), copper (2 to 51 mg/kg), iron (14 to 168 mg/kg), magnesium (260 to 5020 mg/kg), phosphorus (1400 to 5300 mg/kg), potassium (75 to 12000 mg/kg), and zinc (28 to 48 mg/kg) are present in sufficient quantities in quinoa to maintain a balanced human diet**.** Variations in mineral content are influenced by environmental conditions during plant growth and seed set, especially in soil mineral availability **Alvarez-Jubete et al. (2009a).**

Furthermore, taken into consideration that potassium depresses while sodium enhances blood pressure, thus, high amount could be an important factor in presentation of hypertension **Yoshimura et al. (1991).** Calcium and phosphorous are associated with each other for development and proper functioning of bone, teeth and muscles **Turan et al. (2003).** Iron deficiency according to World Health Organization (WHO) affect about 3.7 billion people out of which 2 billion people are anemic **Meng et al. (2005).**

According to the **National Academy of Sciences (2004)** the magnesium, manganese, copper, and iron present in 100 g of quinoa mill cover the daily needs of infants and adults, while the phosphorus and zinc content in 100 g is sufficient for children, but covers 40–60% of the daily needs of adults. The potassium content can contribute between 18% and 22% of infant and adult requirements, while the calcium content can contribute 10% of the requirements.

Calcium, magnesium and iron are minerals that are deficient in gluten-free products and in the gluten free-diet. The inclusion of these pseudocereals, which are a good source of these and other important minerals, can assist to reduce this deficiency **Alvarez-Jubete (2010b).** In general, the content of calcium in quinoa can contribute 10 % of the infant and adult requirements **Abugoch (2009).**

Table (3) Minerals content of raw materials mg/100g dry weigh.

Minerals content	Quinoa	Defatted soybean	Carrot powder	Resistance starch
Potassium	926.7	360.0	320.0	-
Sodium	67.50	25.04	69.0	-
Calcium	248.7	220.0	133.0	-
Phosphorus	383.7	685.0	235.0	-
Copper	5.10	2.30	2.10	-
Iron	13.2	11.0	3.00	-
Manganese	10.0	2.80	1.80	-

Changes in body and daily food intake:

At the end of biological experimental the results present in Table (4) showed that the group 1 rats as considerable control fed on fat and basal diet was the highest weight in final body weight (49.41%) may be obesity and daily food intake (7.54 g). Whereas the rats group 2 fed on formula 1 which contained 60% quinoa mill had the lowest weight in final body weight 22.35% and daily food intake 5.21g followed by rats groups 3. 4 and 5 were fed on 50, 40 and 30% quinoa mill the changes in body weight were increased by decreasing quinoa in diet (23.64, 24.95 and 25.47%, respectively). The decrease weight in final body weight rats fed on quinoa compared with group 1 obesity rats as control may be caused the increase in fiber intake in the quinoa mill, defatted soybean and resistance starch.

According to animal feeding experiments, quinoa protein also has high digestibility. Among raw quinoa proteins, 91.6% is absorbable. Heat treatment (cooking) improves protein digestibility to 95.3% **(Ruales et al., 2002).** Quinoa's high bioavailability is partially due to its relatively low content of trypsin inhibitors (1.36 to 5.04 TIU/mg) **(Vega-Galvez et al., 2010),** which reduce protein enzymatic digestion and absorption **(Valencia-Chamorro, 2003).** Records indicate a wide variety of medicinal uses of quinoa, from the treatment of wounds and fractures to the promotion of digestive health **(FAO 2011).**

Table (4): Means of initial, final and changes in body weight and daily food intake on rats fed on different formulae.

Groups	Initial body weight	Final body weight	Changes in body weight		Daily food intake
			(g)	(%)	
Group 1	45.23 ±1.88	67.58 ±2.17	22.35	49.41	7.54 ±0.75
Group 2	50.27 ±1.25	61.51 ±2.45	11.24	22.35	5.21 ±0.42
Group 3	48.48 ±1.54	59.94 ±1.97	11.46	23.64	5.69 ±0.46
Group 4	47.65 ±1.37	59.54 ±2.26	11.89	24.95	6.14 ±0.52
Group 5	51.91 ±1.69	64.13 ±2.11	13.22	25.47	6.86 ±0.39

Group 1 considerable as control fed on fat and basal diet.
Groups 2, 3, 4 and 5 fed on substituted from 20% from fat and basal diet with formulae 1, 2, 3 and 4, respectively.

Effect of different diets on complete blood picture in the rats:

From the results in Table (5) it could be noticed that the complete blood picture as hemoglobin, hematocrit, red blood cells and platelets were decreased in rats obesity group 1 as control (11.8 g/dl, 35.3%, 5.45 m/cm and 519.3 cm, respectively). Meanwhile the rats fed in formula 1 in group 2 were the highest in the same parameters (13.8 g/dl, 41.4%, 8.04 m/cm and 988.3 cm, respectively) followed by rats in group 3 fed on formula 2 (13.2 g/dl, 39.5%, 7.22 m/cm and 794.5 cm, respectively), rats in group 4 fed on formula 3 (12.7 g/dl, 38.0%, 6.97 m/cm and 753.3 cm, respectively) and rats in group 5fed on formula 4 (12.6 g/dl, 37.5%, 6.542 m/cm and 676.3 cm, respectively). The results from white blood cells were the oppositely obviously parameters. The increase in hemoglobin, hematocrit, red blood cells and platelets in the rat groups fed on quinoa because it's contained a high valuable iron. These results are similar with those reported by **Velarde-Salcedo et al. (2012)** studied the identify and the ability of quinoa peptides to inhibit the enzyme dipeptidyl dipeptidase IV (DPPIV) activity and the effect of these peptides upon fat accumulation in mouse adipocyte cultures. Quinoa is a plant which contained antihypertensive, antioxidant and cancer preventive peptides. Also there is evidence that quinoa has some hypoglycemic action; however, the antidiabetic potential and the effect upon body weight of the seed proteins have not been well characterized.

Table (5): Effect of different formulae on complete blood picture in the rats.

Groups	Hemoglobin (g/dl)	Hematocrit (%)	Red blood cells(m/ cm)	White blood cells(cm)	Platelets (cm)
Group 1	11.8 ±1.03^{b}	35.3 ±3.17^{b}	5.45 ±0.43^{b}	10.4 ±1.05^{a}	519.3 ±27.3^{b}
Group 2	13.8 ±0.79^{a}	41.4 ±2.46^{a}	8.04 ±1.02^{a}	5.53 ±1.47^{b}	988.3 ±24.7^{a}
Group 3	13.2 ±0.87^{ab}	39.5 ±2.64^{ab}	7.22 ±0.53^{ab}	6.33 ±2.85^{ab}	794.5 ±35.42^{ab}
Group 4	12.7 ±0.8^{ab}	38.0 ±2.46^{ab}	6.97 ±0.30^{ab}	7.67 ±0.93^{b}	753.3 ±37.8^{ab}
Group 5	12.6 ±0.95^{ab}	37.5 ±2.54^{ab}	6.54 ±0.52^{ab}	8.21 ±1.01^{ab}	676.3 ±21.1^{ab}

Effect of different diets on lipid profile in the rats.

Total lipid, triglycerides and total cholesterol were determined in blood serum experimental rats fed on different formulae containing 60, 50, 40 and 30% quinoa mixture from defatted soybean, carrot powder and resistant starch. The obtained data are given in Table (6). Diets reach in dietary fiber, it could be noticed that there was significant decreased total cholesterol, cholesterol fractions (LDL and HDL), triglycerides and total lipid in rats fed on formula 1 contained 60% quinoa and different levels of dietary fiber mixture. These results mean when dietary fiber mixture increased in different formulae the total lipid parameter and total cholesterol pattern were decreased in rats fed on different formulae made from quinoa and different dietary fiber mixture. Similar results were obtained by **Cheng and Lai (2000)** who reported that serum cholesterol and triglyceride concentrations were clearly lower in rats fed diet containing amount of corn resistant starch. Also, **Flores et al. (2004)** mentioned that response in hamsters on serum lipidemic when fed on diets containing 2% cholesterol and different dietary fiber sources. Whilst**, Gorecka et al. (2002)** reported that the cholesterol was absorbed in the highest degree by fiber and the absorption of bile acid by fiber.

However, more recent studies found interesting data illustrating that for every 10 g of additional fiber added to a diet the mortality risk of CHD decreased by 17–35% **Streppel et al. (2008).** Risk factors for CHD include hypercholesterolemia, hypertension, obesity and diabetes type two. It is speculated that the control and treatment of these risk factors underlie the mechanisms behind DF and CHD prevention. First, soluble fibers have been shown to increase the rate of bile excretion therefore reducing serum total and LDL cholesterol **Story et al. (1997).** Second, short chain fatty acid production, specifically propionate, has been shown to inhibit cholesterol synthesis **Amaral et al. (1992).** Third, dietary fiber demonstrates the ability to regulate energy intake thus enhancing weight loss or maintenance of a healthier body weight. Fourth, either through glycemic control or reduced energy intake, dietary fiber has been shown to lower the risk for diabetes type two. Fifth, DF has been shown to decrease pro-inflammatory cytokines such as interleukin-18 which may have an effect on plaque stability **Esposito et al. (2003).** Sixth, increasing DF intake has been show to decrease circulating levels of C-Reactive protein (CRP), a marker of inflammation and a predictor for CHD **Ma et al. (2006).**

De Carvalho et al. (2014) showed possible benefits of quinoa intake against oxidative stress. They evaluated the effects of 25 grams of daily consumption of quinoa during 4 weeks on oxidative stress markers, total cholesterol and fractions of cholesterol in a group of postmenopausal women, and they found a reduction of total cholesterol and LDL-cholesterol. It is known that high LDL-cholesterol concentrations are related to an elevated cardiovascular risk **Nishikura et al. (2014).** Since quinoa intake can regulate cholesterol concentrations, as shown by **De Carvalho et al. (2014).**

Table (6): Effect of different formulae on lipid profile in the rats.

Groups	Total lipids (mg/dl)	Triglycerides (mg/dl)	Total cholesterol (mg/dl)	HDL (mg/dl)	LDL (mg/dl)
Group 1	142.54±3.17^{a}	245.7±12.79^{a}	196.3±6.5^{a}	47.3±1.72^{d}	131.7±20.2^{a}
Group 2	65.21±1.03^{c}	112.3±9.1^{ab}	86.3±1.7^{c}	73.7±2.0^{a}	25.0±2.56^{c}
Group 3	73.72± 1.06^{ab}	118.7±9.07^{ab}	110.3± 3.5^{b}	65.0±3.0^{ab}	60.3± 2.03^{b}
Group 4	78.41±1.13^{ab}	131.0±10.0^{b}	127.0±4.0^{ab}	61.0±5.3^{ab}	79.67±3.0^{ab}
Group 5	80.45±2.01^{b}	145.0±11.27^{c}	132.0±6.28^{ab}	55.32±3.49^{ab}	87.34±4.0^{ab}

Effect of different diets on liver function in the rats:

Table (7) showed the mean values of serum AST and serum ALT as a factor affecting liver function. The fat and basal diet (obesity control) showed sAST value 69.15 µ / L. and the rats feeding on 60, 50, 40 and 30% quinoa mill and different dietary fiber sources mixture, resulted was significant decreased in s. AST by about 0.61, 0.52, 42 and 0.26 fold. Also, the serum ALT activity on rats feeding on 60, 50, 40 and 30% quinoa mill and different dietary fiber sources mixture, the results showed that significant increased in obesity control than other groups fed on different formulae when increased quinoa the s. AST were decreasing. The decrease in serum ALT and AST in rats fed on quinoa mill and different dietary fiber sources mixture, may be caused quinoa had rich contained in polyphenols and defatted soybean had high amounted at isoflavons. These components may be able to be act antioxidant. **Zhu et al. (2001)** have isolated six flavonol glycosides from quinoa mill these compounds exhibited antioxidant capacity, suggesting that quinoa mill can serve as a good source of free radical scavenging agents. These authors found antioxidant values expressed as total radical-trapping antioxidative potential (TRAP), ferric ion-reducing antioxidant power (FRAP), cupric-reducing antioxidant capacity (CUPRAC), and nitric oxide (NO). The TRAP value for quinoa was 251 nM mL _1 in acetone extract and 1.686 nM mL−1 in water extract, the FRAP value was 2.3 mM trolox equivalent g−1, a CUPRAC value of 5 mM trolox equivalent g−1; and 32% of NO.

Table (7): Effect of different formulae on liver function in the rats.

Groups	s. ALT (µ/L)	s. AST (µ/L)
Group 1	69.15 ±2.4^{a}	50.0 ±2.4^{a}
Group 2	26.6 ±2.6^{ab}	21.6 ±1.5^{ab}
Group 3	33.0 ±2.2^{ab}	25.0 ±2.0^{ab}
Group 4	40.0 ±2.6^{b}	34.0 ±2.6^{b}
Group 5	51.4±3.8^{c}	39.4±2.4^{b}

Effect of different diets on kidney function in the rats.

Table (8) showed that the results from liver function as urea, creatinine and uric acid `at the end of biological experimental in all groups fed on different formulae. From the resultant it could be noticed that the urea, creatinine and uric acid rats fed on fat and basal diet the urea, creatinine and uric acid were the lowest from 42.0, 1.13 and 5.73 mg/dl in obesity rats group to 16.0, 0.5 and 2.46 mg/dl in rats group fed on 60% quinoa and different fiber (15% both of defatted soybean and carrot powder). Whereas, the rats fed on50% quinoa mill and different fiber (20% both of defatted soybean and carrot powder) was decreased in urea, creatinine and uric acid 32.0, 0.67 and 3.13 mg/dl followed by rats fed on 40% quinoa mill and different fiber (20% both of defatted soybean and carrot powder) and 30% both of them quinoa mill, defatted soybean and carrot powder. These results showed that all groups were fed on quinoa and different sources from dietary fiber during experimental period; the urea, creatinine and uric acid were decreased at the end of experimental due to the quinoa and different sources from dietary fiber had contained high fiber amount and antioxidant have been suggested to have a role in protection against diseases **(Thompson, 1994**). These include simple phenolic acids, lignans, and the flavonoids.

The current investigation showed a significant increase in the level of creatinine, uric acid and urea in the obesity control. This result is consistent with other studies demonstrated a relationship between kidney disease and increased cholesterol in the diet **Schaeffner et al. (2003).**

These results agree with **(Paloma et at. 2012)** as the intake of phenolic compounds is associated with many beneficial effects, it is also necessary to consider the dose for humans, because it is possible to reduce α-amylase activity by consuming food or medicinal herbs rich in polyphenols with strong α-amylase activity, if it takes in consideration that this source of polyphenols possess different kinds of this compounds in variable concentration. Therefore, more available evidences are necessary about the safety of using natural α-amylase inhibitor. Also, agree with **(Yasser et al. 2010)** this reduced of activity lipase enzymes may be due to role poly phenols in the plants, this is a result decreased inflammation of the pancreas and thus lower to normal level lipase enzyme of the rats.

Table (8): Effect of different formulae on kidney function in the rats

Groups	Urea (mg/dl)	Creatinine (mg/dl)	Uric acid (mg/dl)
Group 1	42.0 ±1.0^{a}	1.13 ±0.2^{a}	5.73 ±0.61^{a}
Group 2	16.0 ±4.4^{c}	0.5 ±0.1^{c}	2.46 ±0.25^{c}
Group 3	23.0 ±2.6^{ab}	0.67 ±0.1^{ab}	3.13 ±0.35^{ab}
Group 4	30.0 ±5.3^{b}	0.75 ± 0.1^{ab}	3.80 ±0.43^{ab}
Group 5	35.0±3.1^{b}	0.82±0.2^{b}	4.53±0.37^{b}

Quinoa is a 'pseudo-grain' because it has a similar nutrient profile to cereal grains and eaten in the same way. It stands out though because, not only does it contain more protein than other grains, the protein is also better quality than occurs in other plant foods. It also contains all of the essential amino acids we need for good health, plus plenty of iron, which is important for babies, so including iron-rich foods is essential.

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