بحث رقم (٨)

Effect of the supplementation with quinoa seeds on sensory properties of some oriental sweets and on the health status of rats

Dina H.EL Bushuty* Naglaa M. Shanshan* Ola T. Sahloul
*Home Economics Dept., Fac. of Specific Education,
Damietta Univ., Egypt.

ABSTRACT

The current research aims to study the effect of quinoa seeds (*Chenopodium quinoa*) cultivated in Egypt on sensory properties of some oriental sweets (Dumplings-locomades, Aish El Saraya , Asabeh Zainab, Sad El Hanak, Konafa) as well as its effect on the health status of rats. Quinoa seeds powder were introduced in the above mentioned oriental sweets at 20%, 30% and 40% substitutions, and the sensory properties of these products were evaluated through trained arbitrators. Also biochemical analysis and histopathological properties were investigated using forty male albino rats which were randomly divided into two main groups. The first main group (10 rats) was considered as control group fed on basal diet while the second main group (30 rats) consisted of three subgroups 10 rats eaches. Quinoa was introduced in their diet at level of substitution 20%, 30% and 40%, for 5 weeks.

Concerning the sensory evaluation it could be noticed that with the increase of the ratio of quinoa flour in oriental sweets the resulted aroma, taste , color , and overall acceptability scores decreased obviously. In this respect, results showed good acceptance for oriental sweets (Dumplings-locomades, Aish El Saraya , Asabeh Zainab, Sad El Hanak, Konafa) containing 20% quinoa whereas oriental sweets fortification by 40% quinoa gave the lowest scores.

Moreover the biochemical analysis results showed that groups fed on 20% , 30% and 40% quinoa displayed a decrease in body weight gain. The decrease was significant when comparing between control group C (rats fed on basal diet) and rat group fed on basal diet supplemented with 20% quinoa. Concerning organs' weights there was significant decrease ($P<0.05$) in liver and kidney weights between control group (C) and groups feeding on quinoa at levels 20% and 30% (Q1,Q2). Also there was a significant decrease ($P<0.05$) in heart and spleen weight between control group (C) and rats feeding on 30% quinoa (Q2).However, there were no significant differences between control group (C) and other groups fed on quinoa at different levels 20%,30% and 40% (Q1,Q2,Q3) in glutathione peroxidase (GPx) and chloramphenicol acetyltransferase (CAT) enzymes activities. Concerning malate dehydrogenase (MDH) enzyme's activity there was significant decrease ($P<0.05$) when comparing between control group (C) and rats group fed on 20% quinoa (Q1). On the other hand,

there were significant increase (P<0.05) when comparing between control group (C) and rat groups fed on 30% and 40% quinoa (Q2,Q3).

Results also declared that there were no significant differences (P<0.05) between control group (C) and groups fed on quinoa at level 20%,30% and 40% (Q1,Q2,Q3) in hemoglobin (HB) , red blood cells (R.B.C.s) , packed red cell volume PCV (HCT) and platelets (PLT). Concerning albumin level a significant increase (p<0.05) was observed between control group (C) and rat groups fed on basal diet supplemented with 20% and 40% quinoa (Q1,Q3). Concerning calcium there was significant decrease (p<0.05) between control group (C) and rat groups fed on quinoa at 30% (Q2) whereas , the differences between control group(C) and other groups were not significant.

According to histopathological studies´ results declared that with the increase of the ratio of quinoa in rats´ diet the results lead to bad effects on liver and some histopathological changes in kidney.

The study recommends that more studies should be conducted on the seeds of quinoa cultivated in Egypt to ensure the safety of its use and to find out the causes of the effects that appeared on both liver and kidney before the general use by humans in fortification of food.

Keywords: quinoa – sensory evaluation-oxidation enzymes – Histopathological –rats

INTRODUCTION

Quinoa (Chenopodium quinoa) is a crop grown for its edible highly nutritious seeds identified as an important crop to improve world food security **(David *et al,* 2017).**

The seeds possess on extraordinary nutritional value; which has been cultivated for the last 5,000-7,000 years in the Andean region of Bolivia and Peru. 2013 was declared by the United Nations as the International Year of Quinoa as recognition of its great potential **(Bastidas *et al,* 2016).**

According to **Sanchez (2012)** quinoa, is technically not a grain; but in reality a seed. This is why it is sometimes called “pseudo-grain” or “pseudo cereal.” While real cereals are botanically classified as grasses, pseudo cereals are considered to be broad leaf plants (non-grasses). Seeds are generally better sources of high-quality protein than true cereal grains, such as wheat and rice **.**It can be found in the form of

chips , seeds , and flour, in addition to products such as noodles and energy bars, the seeds can be cooked in hot water prior to consumption **(Internacional,2003)** .The main component in quinoa is carbohydrates, which consisted of 67% to 74% of the dry matter. Starch makes about 52−60% .It contains from 2% to 10% fat.

Quinoa and soya oils show similar fatty acid compositions. It was found that quinoa is a rich source of essential fatty acids such as linolenic acid (18:2n-6: 52%). Lipids isolated from quinoa seed and seed fractions have been marked by lipid classes and fatty acid composition **(Chamorro, 2003).**Quinoa seeds have eminent nutritional properties, based on not only on the protein content but also on its high amino acid balance. Beyond their nutritional function, quinoa seeds strengthen compounds like phenolic acids promoting health properties **(James, 2009).**

The seeds of quinoa are a good substitute in gluten free diets because most people get lots of their vitamins B needs from baked goods. It contains between 14 and 18% protein, with characteristics similar to milk protein. It is also a source of calcium, magnesium, zinc and iron **(Penarrieta *et al*., 2008).**

These seeds contain significant amounts of phytochemicals such as flavonoids, phenolic acids, squalene, phytosterol, saponins, fat-soluble vitamins, fatty acids, trace elements and some compounds which can influence biochemical parameters in organisms **(Gorinstein *et al*., 2007 and Paśko *et al*.,2008)**.Quinoa seeds contain antihypertensive, antioxidant and cancer preventive peptides. There is evidence that quinoa has some hypoglycemic effect however, the antidiabetic potential and the effect of quinoa proteins on body weight have not been well characterized **(Velarde-Salcedo *et al*.,2012).**

Saponins and phytic acid are the basic disadvantageous factors in quinoa. Other inhibitors, trypsin inhibitor and tannins, are found in low levels **(Chamorro ,2003).**The crop is newly introduced to Egypt and needs comprehensive studies to improve its cultural practice and adapting suitable varieties and strengthening harvesting and post harvesting processes and manufacture of the crop **(Shams,2011)**.

The literature does not report data declaring the effect of quinoa on the biochemical profile of animals. Therefore, the aim of this research was to investigate the effect of quinoa on sensory properties of some oriental sweets, as well as its effect on the biochemical parameters and histopatological studies on rats.

MATERIALS AND METHODS

Materials:

1-Quinoa seeds

Quinoa seeds (Chipaya cv.) grown in Egypt in 2016 season was used through the experiments, brought from a farm in south Egypt and kept at 3– 4°C until used.

Quinoa seeds

2-Chemicals and Kits

Vitamins, minerals, cellulose, choline chloride and diagnostic kits were purchased from El-Gomhoria Co., Sherief Street , Cairo, Egypt.

Methods:

Seeds were soaked for 12 hour in distilled water containing sodium carbonate and sodium polyphosphate **(Dolan *et al.*, 2006).** The initial soak temperature was 77 ^{0}C and samples were then allowed to get room temperature at 25 ^{o}C**.** The seeds were washed many times with hot water to remove saponins till there was no more foam in the washing water and they were then dried at 50 ^{o}C. The quinoa seeds were ground to fine powder in an electric stainless steel mill using a laboratorial disc mill.

Preparing of oriental sweets

Oriental sweets (Dumplings-locomades, Aish El Saraya, and Konafa) were prepared according to **Saba (1995)**, while Asabeh Zainab and Sad El Hanak were prepared according to **EL -Kammah (1987)**. Table (1) shows the composition of the oriental sweets.

Table (1) composition of the oriental sweets

Dumplings-locomades			
Quinoa 0%	**Quinoa 20%**	**Quinoa 30%**	**Quinoa 40%**
Wheat flour:240g Quinoa flour:0g Yeast :10g Water to knead Oil for reddening Sugar syrup	Wheat flour:192g Quinoa flour:48g Yeast :10g Water to knead Oil for reddening Sugar syrup	Wheat flour:168g Quinoa flour:72g Yeast :10g Water to knead Oil for reddening Sugar syrup	Wheat flour:144g Quinoa flour:96g Yeast :10g Water to knead Oil for reddening Sugar syrup
Aish El Saraya			
Quinoa 0%	**Quinoa 20%**	**Quinoa 30%**	**Quinoa 40%**
Wheat flour:480g Quinoa flour:0g Yeast: 10g Water to knead Sugar syrup	Wheat flour:384g Quinoa flour:96g Yeast: 10g Water to knead Sugar syrup	Wheat flour:336g Quinoa flour:144g Yeast: 10g Water to knead Sugar syrup	Wheat flour:288g Quinoa flour:192g Yeast: 10g Water to knead Sugar syrup
Asabeh Zainab			
Quinoa 0%	**Quinoa 20%**	**Quinoa 30%**	**Quinoa 40%**
Wheat flour:185g Samit flour:65g Quinoa flour:0g Margarine:65g Yeast:5g Water to knead Oil for reddening Sugar syrup	Wheat flour:150g Samit flour:50g Quinoa flour:50g Margarine: 65g Yeast: 5g Water to knead Oil for reddening Sugar syrup	Wheat flour:130g Samit flour:45g Quinoa flour:75g Margarine: 65g Yeast: 5g Water to knead Oil for reddening Sugar syrup	Wheat flour:110g Samit flour:40g Quinoa flour:100g Margarine: 65g Yeast: 5g Water to knead Oil for reddening Sugar syrup
Sad El Hanak			
Quinoa 0%	**Quinoa 20%**	**Quinoa 30%**	**Quinoa 40%**
Wheat flour : 60g Quinoa flour:0g Sugar: 90 g Margarine::15g Water to knead	Wheat flour : 48g Quinoa flour:12g Sugar: 90 g Margarine::15g Water to knead	Wheat flour : 42g Quinoa flour:18g Sugar: 90 g Margarine::15g Water to knead	Wheat flour : 36g Quinoa flour:24g Sugar: 90 g Margarine::15g Water to knead
Konafa			
Quinoa 0%	**Quinoa 20%**	**Quinoa 30%**	**Quinoa 40%**
Konafa:500g Quinoa flour:0g Margarine: 150g Sugar syrup	Konafa:400g Quinoa flour:100g Margarine: 150g Sugar syrup	Konafa:350g Quinoa flour:150g Margarine: 150g Sugar syrup	Konafa:300g Quinoa flour:200g Margarine: 150g Sugar syrup

Sensory properties

Sensory properties of the oriental sweets were evaluated by 10 trained panelists.

Experimental animals

Forty male albino rats (Sprague Dawley strain) weighing about 166.00 $\pm$ 3.78g were obtained from a farm in Helwan .All rats were fed on basal diet for one week, afterwards the rats were divided into two main groups. The first main group (10 rats) was fed only on the basal diet (control group C) according to **Reeves *et al.*, (1993)**The second

main group (30 rats) were divided into 3 subgroups which were fed for 5 weeks as follows:

Group2:10 rats were fed basal diet containing 20% quinoa (Q1)

Group 3:10 rats were fed basal diet containing 30% quinoa(Q2)

Group 4:10 rats were fed basal diet containing 40% quinoa(Q3)

The composition of the different experimental diets is illustrated in table (2)

Table(2):Composition of the different experimental diets

Ingredients	Group C	Groups supplemented with quinoa		
		Q1	Q2	Q3
Protein(casein)	10%	10%	10%	10%
Corn oil	10%	10%	10%	10%
Mineral mixture	4%	4%	4%	4%
Vitamin mixture	1%	1%	1%	1%
Cellulose	5%	5%	5%	5%
Choline chloride	0.2%	0.2%	0.2%	0.2%
Methionine	0.3%	0.3%	0.3%	0.3%
Quinoa	-	20	30	40
Corn starch	69.5%	49.5	39.5	29.5

Blood sampling

At the end of the experimental period (5weeks) rats were fasted over night before sacrificing .Blood was collected and centrifuged (3000rpm) and the serum was separated for analysis .Serum was carefully aspirated transferred into clean cuvet tubes and stored frozen at -20°C for analysis. Body weight gain was calculated by the following formula:

BWG (g) =Final weight (g) -Initial weight (g)

Biochemical analysis

For each group analyses included the following:

Determination of oxidation enzymes

Catalase activity(CAT) was determined according to **Aebi (1984)**,whereas Glutathione peroxidase (GPX) activity was determined according to **Weiss *et al.*, (1980)** .The determination of lipid peroxidation (MDH) was done according to **Satoh(1978)** .

Determination of Complete blood picture

Complete blood picture like hemoglobin (HB) and platelets (PLT) were measured using a whole blood sample according to **Dacie and Lewis (1984)** respectively. While red blood cells (R.B.C.s) and white

blood cells (W.B.C.s) were measured according to the method described by **Riley (1960)**.

Determination of albumin

Serum albumin was determined as recommended by **Maguire and Price** (**1986).**

Determination of calcium

Serum calcium was estimated according to the method described by **Baginsk *et al* (1973).**

Histopathological analysis

The tissues of liver and kidney were fixed in 100% formalin and embedded in paraffin wax. Sections of 4-5 microns thickness were made using rotary microtome and were stained with haematoxylin-eosin. Histological observations were made under light microscope **(Carleton, 1979)**.

Statistical Analysis

Statistical analysis was performed by using computer of statistical package for social science (SPSS version 11.0). The results are presented as means $\pm$SD and means $\pm$SE. One way analysis of variance (ANOVA) was used to test the differences between groups **(SPSS, 1999)**.

RESULTS AND DISCUSSION

Sensory evaluation

Effect of treatments on the sensory properties of the prepared oriental sweets supplemented with different levels of quinoa 20%,30% and 40% are presented in table (3).Results showed the mean values for aroma, taste , color, overall acceptability and total evaluation for the samples. It could be noticed that with the increase of the ratio of quinoa flour scores for aroma, taste, color, and overall acceptability decreased. On the other hand , results showed good acceptance for oriental sweets (Dumplings-locomades, Aish El Saraya , Asabeh Zainab, Sad El Hanak, Konafa) supplemented with 20% quinoa concerning aroma, taste, color and overall acceptability while oriental sweets supplemented with 40% quinoa showed lower results for aroma, taste , color and overall acceptability.

Table (3) Sensory evaluation for treatments

Dumplings-locomades				
Properties / Treatments	Aroma (20 scores)	Taste (40 scores)	Color (20 Scores)	Overall Acceptability (20 Scores)
Quinoa 0%	19.73± 0.39	39.86±0.33	19.88±0.02	19.96±0.05
Quinoa 20%	19.40±0.22	37.20±0.66	18.90± 0.23	18.40±0.30
Quinoa 30%	18.00±0.21	34.70±0.30	17.50±0.22	17.00±0.25
Quinoa 40%	16.20±0.24	31.40±0.47	15.80± 0.41	15.10±0.23
Aish El Saraya				
Properties / Treatments	Aroma (20 scores)	Taste (40 scores)	Color (20 scores)	Overall Acceptability (20 Scores)
Quinoa 0%	19.88±0.03	39.92±0.02	19.88±0.02	19.94±0.01
Quinoa 20%	19.00±0.33	38.40±0.33	19.40±0.26	18.40±0.30
Quinoa 30%	16.70±0.39	35.50±0.26	18.10±0.27	17.30±0.21
Quinoa 40%	16.50±0.40	31.30±0.44	15.20±0.32	15.80±0.24
Asabeh Zainab				
Properties / Treatments	Aroma (20 scores)	Taste (40 scores)	Color (20 scores)	Overall Acceptability (20 Scores)
Quinoa 0%	19.94±0.01	39.96±0.05	19.94±0.01	19.88±0.03
Quinoa 20%	19.82±0.02	39.20±0.13	19.40±0.16	19.20±0.13
Quinoa 30%	19.66±0.01	37.60±0.26	18.40±0.16	17.40±0.16
Quinoa 40%	18.90±0.17	30.60±0.26	17.40±0.16	14.40±0.16
Sad El Hanak				
Properties / Treatments	Aroma (20 scores)	Taste (40 scores)	Color (20 scores)	Overall Acceptability (20 Scores)
Quinoa 0%	19.86±0.02	39.96±0.05	19.84±0.03	19.96±0.01
Quinoa 20%	18.20±0.38	39.60±0.16	18.00±0.00	19.20±0.13
Quinoa 30%	17.60±0.45	37.80±0.24	17.20±0.32	17.80±0.24
Quinoa 40%	15.60±0.65	21.00±0.78	12.40±0.77	11.00±0.29
Konafa				
Properties / Treatments	Aroma (20 scores)	Taste (40 scores)	Color (20 scores)	Overall Acceptability (20 Scores)
Quinoa 0%	19.82±0.13	39.78±0.12	19.92±0.07	19.78±0.04
Quinoa 20%	18.20±0.78	35.20±0.78	19.00±0.66	16.00±1.49
Quinoa 30%	17.20±0.78	25.80±0.84	17.20±0.78	13.20±1.22
Quinoa 40%	13.60±1.07	15.40±1.07	12.80±0.78	7.00±1.15

Values are expressed as means ± SE

Effect of Quinoa on initial body weight, final body weight and body weight gain (BWG) of the experimental rat groups:

From the results in table (4) it could be noticed that there was significant decrease ($P<0.05$) in body weight gain in rat group which was fed basal diet supplemented with 20% quinoa (Q1) compared to control group C. On the other hand there was no significant decrease ($P<0.05$) in rat groups fed basal diet supplemented with 30% and 40% (Q2,Q3) quinoa compared to control group C .

In this concept **Carlson *et al.*, (2012)** reported that quinoa contains amounts of saponins which can be connected to the decrease in weight gain. This association was replicated in rats, mice and chickens and was checked using a range of different dietary concentrations of quinoa. However it could not be applied in piglet studies because of expectations that the concentration of saponins in the diet was too low to cause a significant change in weight gain.

Table(4): Effect of quinoa on initial body weight ,final body weight and body weight gain(BWG) of the experimental rat groups

Groups	Initial body weight (g)	Final body weight (g)	BWG (g)
C	166.00 ± 3.94^{a}	207.40 ± 4.03^{a}	41.40 ± 1.95^{a}
Q_1	166.00 ± 3.94^{a}	200.80 ± 1.03^{b}	34.80 ± 3.08^{b}
Q_2	166.00 ± 3.94^{a}	205.20 ± 3.73^{a}	39.20 ± 3.64^{a}
Q_3	166.00 ± 3.94^{a}	206.20 ± 5.18^{a}	40.20 ± 1.68^{a}

Values are expressed as means ± SD for 10 rats in each group , C=(control group) , Q_1= (rats fed 20% quinoa), $Q_{2=}$(rats fed 30% quinoa), $Q_{3=}$ (rats fed 40% quinoa), Different letters on same column represent statistically significant(P<0.05) difference between means.

Effect of quinoa on weights of internal organs of the experimental rat groups:

The results given in table (5) showed that there was significant decrease (P<0.05) in liver and kidney weights between control group C and groups fed on quinoa at levels 20% and 30% (Q1,Q2), whereas there were no significant differences (P<0.05) between control group C and rats which received 40% quinoa (Q3) in liver and kidney weights. On the other hand, there was a significant decrease (P<0.05) in heart weigh between control group C and rats which received 30% quinoa (Q2). There was no significant difference (P<0.05) in heart weight between control group C and rats received 20% and 40% quinoa (Q1,Q3) . Furthermore there was a significant decrease (P<0.05) in spleen weight between control group C and rats which received quinoa at 30% (Q2).

Table (5): Effect of quinoa on weights of internal organs of the experimental rat groups.

Groups	Liver Weight (g)	Kidney Weight (g)	Heart Weight (g)	Spleen Weight (g)
C	6.32 ± 0.10^{a}	2.00 ± 0.06^{a}	0.88± 0.04^{a}	1.22 ± 0.04^{a}
Q_1	6.12 ± 0.19^{b}	1.82 ± 0.07^{b}	0.82 ± 0.07^{ab}	1.30 ± 0.06^{a}
Q_2	6.12 ± 0.24^{b}	1.82 ± 0.07b	0.78 ± 0.7^{b}	1.02 ± 0.15^{b}
Q_3	6.30 ± 0.24^{ab}	2.00 ± 0.09^{a}	0.84 ± 0.08^{ab}	1.30 ± 0.06^{a}

Values are expressed as means ± SD for 10 rats in each group, C= (control group) , Q_1= (rats fed 20% quinoa), $Q_{2=}$(rats fed 30% quinoa), $Q_{3=}$ (rats fed 40% quinoa), Different letters on same column represent statistically significant (P<0.05) difference between means.

Effect of quinoa on antioxidant enzymes (GPx , CAT, MDH) of the experimental rat groups:

From the results in table (6) it could be concluded that there were no significant increases between control group (C) and other groups fed on quinoa at different levels 30% and 40% (Q2,Q3) in GPx (Glutathione peroxidase) and CAT (Chloramphenicol acetyltransferase) enzymes activities concerning MDH (Malate Dehydrogenase) enzyme there was a significant decrease ($P<0.05$) between control group (C) and rat group fed on 20% quinoa(Q1). On the other hand, when comparing there was a significant increase ($P<0.05$) between control group (C) and rat groups fed on 30% and 40% quinoa(Q2,Q3) .

In this respect quinoa is known to have compounds with strong antioxidant activity, like flavonoids and phenolic acids but the presence of these compounds was not assessed. The phytochemical composition of quinoa is known to vary due to genetic and environmental factors **(Tang *et al.*,2015)** .According to **Paśko *et al.*, (2010b)**the antioxidant properties of quinoa were most notably during periods of oxidative stress. Plasma lipid peroxidation was decreased whereas the expression of antioxidant compounds like glutathione peroxidase and catalase were elevated in several organs.

Table(6): Effect of quinoa on antioxidant enzymes (GPx, CAT, MDH) activities of the experimental rat groups

Groups	GPx (U/L)	CAT(U/L)	MDH(U/L)
C	191.60 ± 5.10^{a}	39.20 ± 2.14^{a}	201.60 ± 5.10^{c}
Q_1	189.00 ± 13.08^{a}	38.60 ± 2.17^{a}	174.00 ± 10.74^{d}
Q_2	192.00 ± 14.37^{a}	40.80 ± 2.69^{a}	211.00 ± 12.20^{b}
Q_3	195.00 ± 19.43^{a}	41.20 ± 4.07^{a}	221.00 ± 8.43^{a}

Values are expressed as means ± SD for 10 rats in each group , C=(control group) , Q_1= (rats fed 20% quinoa), $Q_{2=}$(rats fed 30% quinoa), $Q_{3=}$ (rats fed 40% quinoa), Different letters on same column represent statistically significant($P<0.05$) difference between means.

Effect of quinoa on complete blood count of the experimental rat groups:

Results presented in table (7) demonstrate the effect of quinoa on complete blood count of the experimental rat groups .Results declared that there are no significant differences($P<0.05$) between control group C and groups that received quinoa at levels of 20%,30% and 40% (Q1,Q2,Q3) in hemoglobin (HB), red blood cells (R.B.C.s), packed red

cell volume PCV(HCT) and platelets (PLT). There was a significant decrease ($P<0.05$) in white blood cells between control group C and the group that received 20% quinoa (Q1). On the other hand there was a significant increase between control group C and the group that received 40% quinoa at levels.

Phytic acid which affects iron absorption can be found in quinoa seeds in the external layers beside the endosperm. According to reports the mean value of phytic acid concentration was 1.18 g/100 g in five varieties of quinoa **(Chamorro ,2003)**.In this concern there are several antinutritional substances which have been found in quinoa such as saponins, phytic acid, tannins and protease inhibitors; which can have a bad effect on metabolic reactions **(Improta and Kellems, 2001 and Rosero1 *et al*., 2013).** The present results are not similar with those reported by **Hejazi, (2016)** who reported that the increase in hemoglobin, hematocrit, red blood cells and platelets in the rat groups fed on quinoa was because it contained a high valuable iron.

Table(7): Effect of quinoa on complete blood count of the experimental rat groups

Groups	HB (g/dl)	R.B.C.s (mil/cmm)	PCV(HCT) (%)	W.B.C.s (mil/cmm)	PLT (mil/cmm)
C	11.90 ± 0.24^{a}	$4.12\times 10^{6} \pm 0.10^{a}$	37.00 ± 0.66^{a}	11.06 ± 1.10^{b}	330.00 ± 20.81^{a}
Q_1	12.38 ± 1.22^{a}	$4.40\times 10^{6} \pm 0.52^{a}$	38.80 ± 4.07^{a}	8.78 ± 1.11^{c}	355.00 ± 38.72^{a}
Q_2	11.68 ± 1.56^{a}	$4.16\times 10^{6} \pm 0.50^{a}$	37.00 ± 4.61^{a}	10.22 ± 0.91^{bc}	336.00 ± 44.89^{a}
Q_3	11.08 ± 2.18^{a}	$4.02\times 10^{6} \pm 0.52^{a}$	35.20 ± 6.51^{a}	12.68 ± 2.83^{a}	332.00 ± 30.29^{a}

Values are expressed as means ± SD for 10 rats in each group , C=(control group) , Q_1= (rats fed 20% quinoa), $Q_{2=}$(rats fed 30% quinoa), $Q_{3=}$ (rats fed quinoa 40%). Different letters on same column represent statistically significant ($P<0.05$) difference between means.

Effect of quinoa on albumin of the experimental rat groups:

Data presented in table (8) declared the effect of quinoa on albumin of the experimental rat groups .There was a significant increase($p<0.05$) in albumin level when comparing between control group (C) and rat groups which were fed on basal diet supplemented with 20% and 40% quinoa (Q1,Q3) whereas there were no significant differences between control group (C) and rat group fed on basal diet supplemented with 30% quinoa (Q2).This data was confirmed by **Paśko *et al.,(*2010a)** who declared that the convergence in the level of

albumin in groups of rats was because of the higher amount of protein in the diet of rat groups.

Table(8): Effect of quinoa on albumin of the experimental rat groups

Groups	Albumin(g/dl)
C	3.80 ± 0.13^{b}
Q_1	4.08 ± 0.12^{a}
Q_2	3.68 ± 0.18^{b}
Q_3	4.00 ± 0.14^{a}

Values are expressed as means $\pm$ SD for 10 rats in each group , C=(control group) , Q_1= (rats fed 20% quinoa), $Q_{2=}$(rats fed 30% quinoa), $Q_{3=}$ (rats fed 40% quinoa),Different letters on same column represent statistically significant(P<0.05) difference between means.

Effect of quinoa on calcium level of the experimental rat groups:

Results in table (9) showed that there were no significant differences ($p<0.05$) between control group(C) and rat groups fed on quinoa at 20% and 40% ratios (Q1, Q3) concerning calcium levels. whereas, there was significant decrease ($p<0.05$) between control group(C) and rat group which was fed on 30% quinoa (Q2) .

Eisa *et al.*,(2014) declared that quinoa cultivated under high saline soil conditions in Egypt , demonstrated some changes in some minerals levels .

Unfortunately, there is also many antinutritional substances were found in quinoa, such like saponins, phytic acid, tannins and protease inhibitors; which can have a negative effect on metabolic reactions **Improta and Kellems(2001) and Rosero1 *et al.*,(2013).**On the other hand **,**quinoa contains oxalates which is a toxic substances. A large dose of oxalate intake plays a role in secondary hyper oxaluria, a main risk factor for calcium oxalate stone formation. A high dietary oxalate intake affects mineral and trace element absorption in humans and may lead to calcium oxalate stone formation due to the ability of oxalate to form insoluble complexes with divalent cations in the gastrointestinal tract **(Siener *et al.*, 2006).**

Table(9): Effect of quinoa on calcium level of the experimental rat groups

Groups	Calcium (mg/dl)
C	7.00 ± 0.06^{a}
Q_1	6.90 ± 0.21^{ab}
Q_2	6.78 ± 0.22^{b}
Q_3	6.98 ± 0.23^{a}

Values are expressed as means ± SD for 10 rats in each group , C=(control group) , Q_1= (rats fed 20% quinoa), $Q_{2=}$(rats fed 30% quinoa), $Q_{3=}$ (rats fed 4 0 % quinoa), Different letters on same column represent statistically significant(P<0.05) difference between means.

Histopathological Results:

Histopathological examination of liver:

Microscopically, liver of rats from control group(C) revealed the normal histological structure of hepatic lobule (Fig. 1). However, liver of rats from Q1group (rats fed on 20% quinoa) showed slight cytoplasmic vacuolization of hepatocytes and congestion of hepatic sinusoids(Figs 2). Liver of rat from Q2 group (rats fed on 30% quinoa) showed congestion of central vein and hepatic sinusoids (Fig. 3a), focal hepatic necrosis associated with inflammatory cells infiltration (Figs.3b). Liver of rats from Q3 group (rats fed on 40% quinoa) showed slight activation of Kupffer cells (Figs. 4a), slight vacuolation of some hepatocytes, slight congestion of hepatic sinusoids (Fig. 4b) and portal infiltration with inflammatory cells .

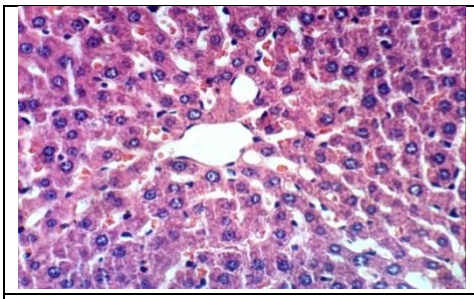

Fig. (1): Liver of rat from group c (control group) showing the normal histological structure of hepatic lobule (H & E X 400).

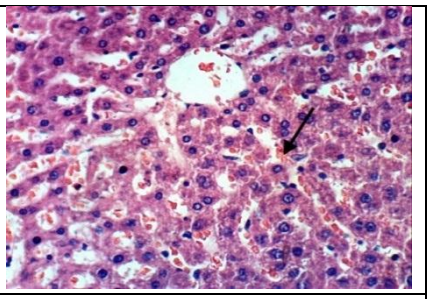

Fig. (2): Liver of rat from Q1group (rats fed on 20% quinoa) showing slight cytoplasmic vacuolization of hepatocytes and congestion of hepatic sinusoids (H & E X 400)

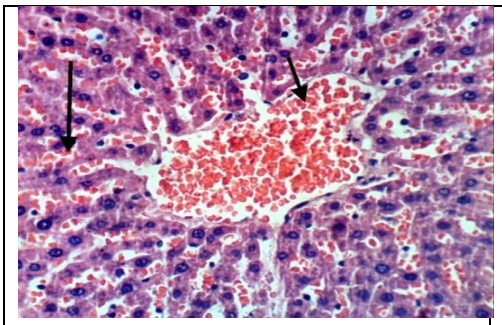

Fig. (3 a): Liver of rat from Q2 group (rats fed on 30% quinoa) showing congestion of central vein and hepatic sinusoids (H & E X 400)

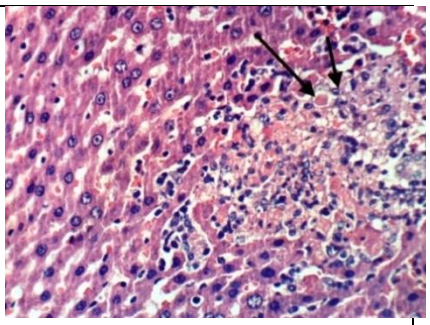

Fig.(3b): Liver of rat from Q2 group (rats fed on 30% quinoa) showing focal hepatic necrosis associated with inflammatory cells infiltration as well as apoptosis of hepatocytes (H & E X 400).

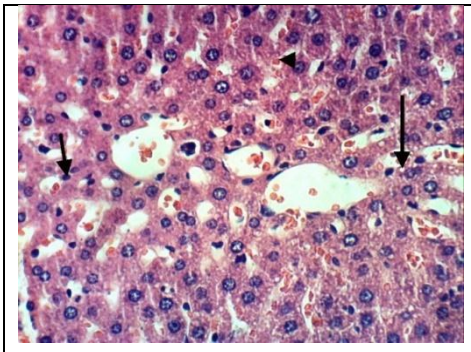

Fig. (4a): Liver of rat from Q3 group (rats fed on 40% quinoa) showing slight activation of Kupffer cells, slight vacuolation of some hepatocytes and slight congestion of hepatic sinusoids(H & E X 400).

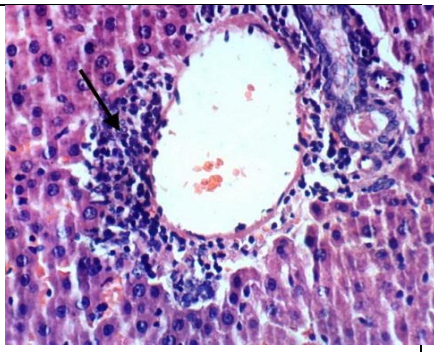

Fig. (4b): Liver of rat fromQ3 group (rats fed on 40% quinoa) showing portal infiltration with inflammatory cells (H & E X 400).

Histopathological examination of kidneys:

Microscopically, kidneys of rats from group C (control group) revealed the normal histological structure of renal parenchyma (Figs. 5). Moreover, kidneys of rats from Q1 group (rats fed on 20% quinoa) showed no histopathological changes (Figs. 6). Kidneys of rats from Q2group (rats fed on 30% quinoa) revealed no histopathological changes except slight vacuolation of glomerular tufts in some examined sections (Fig. 7). Some sections from Q3 group (rats fed on 40% quinoa) revealed focal necrosis of renal tubules associated with inflammatory cells infiltration (Figs. 8).

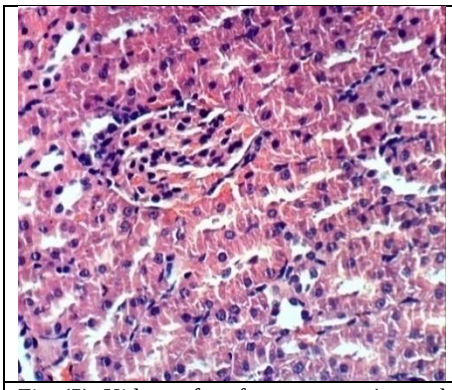

Fig. (5): Kidney of rat from group c (control group) showing the normal histological structure of renal parenchyma (H & E X 400).

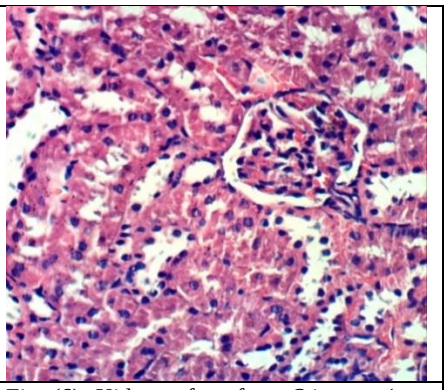

Fig. (6): Kidney of rat from Q1group (rats fed on 20% Quinoa) showing no histopathological changes(H & E X 400).

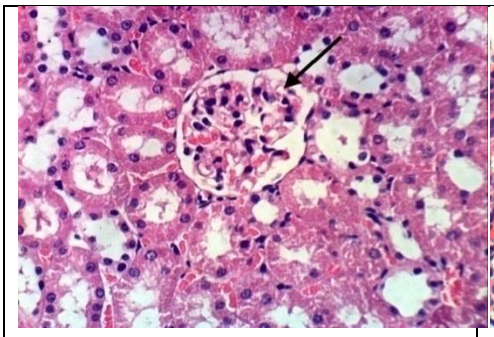

Fig. (7): Kidney of rat from Q2 group (rats fed on 30% Quinoa) showing slight vacuolation of glomerular tuft (H & E X 400).

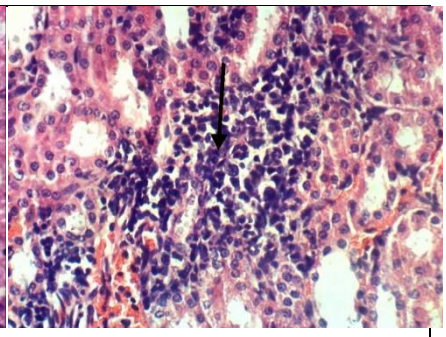

Fig. (8): Kidney of rat from Q3 group (rats fed on 40% Quinoa) showing focal necrosis of renal tubules associated with inflammatory cells infiltration (H & E X 400).

Finally, it could be concluded that the histopathological studies in rats fed on diets containing quinoa declared very bad effects on liver and some histopathological changes in kidney especially at 40% ratio.

REFERENCE

Aebi,H.(1984) : Catalase in vitro. Method Enzyme, 105 :121-126

Baginsk, E.S.; Marie, S.S. ; Clark, W.L. and Zak, B. (1973): Direct micro determination of serum calcium. Clinica Chemica Acta, 46(1): 46-54.

Bastidas,G.; Rizzolo ,D.; Massanés,R. and Gomis, R. (2016): Quinoa (Chenopodium quinoa Willd), from Nutritional Value to Potential Health Benefits: An Integrative Review. J Nutr Food Sci. , 6:3

Carleton, H.(1979): Histological Techniques,4th Edition, London, Oxford University press, New York, USA.

Carlson, D.; Fernandez, J.A.; Poulsen ,H.D.; Nielsen, B. and Jacobsen ,S.E. (2012): Effects of quinoa hull meal on piglet performance and intestinal epithelial physiology. J Anim Physiol Anim Nutr .,96(2):198-205

Chamorro,V. (2003): Quinoa In Caballero B. Encyclopedia of Food Science and Nutrition, 8: 4895–4902.

Dacie, J. V. and Lewis, S. M. (1984): Practical hematology. Churchill Living Stone, London and New York.

David E. Jarvis.;Yung Shwen Ho.;Damien J. Lightfoot.;Sandra M. Schmöckel.;Bo Li,,Theo J. A. Borm.;Hajime Ohyanagi.;Katsuhiko Mineta.;Craig T. Michell.;Noha Saber.; Najeh M. Kharbatia.;Ryan R. Rupper.;Aaron R. Sharp.;Nadine Dally.;Berin A. Boughton.;YongH.Woo.;GeGao.;ElioG.W.M.Schijlen.;XiujieGuo.; AfaqueA.Momin.;SóniaNegrão.;SalimAlBabili.;ChristophGehring. ;Ute Roessner. And Christian Jung (2017): The genome of Chenopodium quinoa, nature, 10.1038/nature21370.

Dolan, K.D.; Siddiq, M.; Harte J.B. and Uebersax, M.A. (2006): Use of the shear press for process development of sugar-coated beans. J Food Process Preserv ,30: 449-457.

Eisa,S. ; Abdel-Ati, A. ; Ebrahim,M. ; Eid,M. ; Abd El-Samad,E. ; Hussin,S.;El-Bordeny,N.;Ali,S.andElNaggar,A.(2014): Chenopodium quinoa as a New Non-Traditional Crop in Egypt. Tropentag, Czech Republic

EL -Kammah., Khadija, A. (1987): The art of making sweets. Clotte Beck, Al-Nasr Press, p. 135-,156.

Gorinstein. S.; Vargas ,O.J.M; Jaramillo, N.O.; Salas, I.A.; Ayala ,A.L;Toledo, F.; Katrich ,E. and Trakhtenberg ,S. (2007): Thetotal polyphenols and the antioxidant potentials of some selectedcereals and pseudocereals. Eur Food Res Technol.,225:321–328

Hejazi, Maha .A .(2016): Preparation of different formulae from quinoa and different sources dietary fiber to treat obesity in rats. Nature and Science.,14(2)

Internacional (2003):"La Quinua: Alimento y Cultivo Promisoriodel Siglo XXI", 2003, Santa Fé de Bogotá, Colômbia. Proceedings.FAO.

Improta, F. and Kellems, R. O. (2001): Comparison of raw, washed and polished quinoa (Chenopodium quinoa Willd.) to wheat, sorghum or maize based diets on growth and survival of broiler chicks. Livest Res. Rural Dev., 13: 33 – 38.

James, A. L.E. (2009): Quinoa (Chenopodium quinoa Willd.): Composition, chemistry, nutritional, and functional properties. Advances in Food and Nutrition Research, 58: 1-31.

Maguire, G.A. and Price C.P. (1986):bromcresolpurpule method for serum albumin gives falsely low values in patients with renal insufficiency .Chin Chim Actal.,155:83-87

Paśko, P.; Sajewicz, M.; Gorinstein, S. and Zachwieja, Z. (2008): Analysis Of selected phenolic acids and flavonoids in Amaranthuscruentus and Chenopodium quinoa seeds and sprouts by HPLC. Acta Chromomatogr, 20:661–672

Paśko, P.;Barton, H.; Zagrodzki, P.; Izewska, A.; Krosniak, M.; Gawlik, M.; Gawlik, M. and Gorinstein, S. (2010a): Effect of diet supplemented with quinoa seeds on oxidative status in plasma and selected tissues of high fructose-fed rats. Plant Foods Hum Nutr., 65(2):146-151

Paśko,P.;Zagrodzki,P.;Bartoń,H.;Chłopicka,J.andGorinstein,S.(2010b): Effect of Quinoa Seeds (Chenopodium quinoa) in Diet on some

Biochemical Parameters and Essential Elements in Blood of High Fructose-Fed Rats. Plant Foods Hum Nutr., 65:333–338

Penarrieta, J. M.; Alvarado, J. A.; Akesson, B. and Bergenstahl, B. (2008): Total antioxidant capacity and content of flavonoid and other phenolic compounds in canihua (Chenopodium pallidicaule); An Andean pseudocereal. Molec. Nutr. Food Res., 52:708-717

Reeves, P.G.; Nielsen, F.H.; Fahey, G.C. and AIN, J.R. (1993): purified diets for laboratory rodents: final report of the American Institute of Nutrition ad hoc writing committee on the reformulation of the AIN-76A rodent diet. J Nutr, 123:1939–1951.

Riley, V. (1960): Adaptation of orbital bleeding technique to rapid serial blood studies. Proc. Soc. Exp. Biol. Med., 109: 751-754.

Rosero1,O.,M.;Marounek,N.;Břeňová,S. and Lukešova,D.(2013): Phytase activity and comparison of chemical composition, phytic acid P content of four varieties of quinoa grain (Chenopodium quinoa Willd).Acta Agronómica., 62 (1): 13 - 20.

Saba, Nargis, H .(1995): Cooking , Science and Art. Dar EL-Maaref, Cairo, p 613,774, 766.

Sanchez, Katherine ,A.(2012): Observations regarding consumption of Peruvian native grains (Quinoa, Amaranth and Kaniwa) weight status and perceptions of potential risk factors, warning signs and symptoms of type2 diabetes among Peruvian adults :a case study. Thesis submitted to the Faculty of the Graduate School of the University of Maryland, College Park, in partial fulfillment of the requirements for the degree of Master of Science.

Satoh,K(1978) : Serum lipid peroxide in cerebrovascular disorders determined by a new colorimetric method .Clinica Chimica Acta 90: 37-43.

Siener, R.; Honow, R.; Seidler, A.;Voss ,S. and Hesse , A. (2006): Oxalate contents of species of Polygonaceae, Amaranthaceae and Chenopodiaceae families. Food Chemistry, 98: 220–224.

Shams,A(2011): Combat Degradation in Rain Fed Areas by IntroducingNew Drought Tolerant Crops in Egypt. International Journal of Water Resources and Arid Environments, 1(5): 318-325

SPSS (1999): SPSS-PC for the IBM PC/XT computer. version11.0 SPSS Inc., U.S.A.

Tang, Y.; Li, X.; Zhang, B.; Chen, P.X.; Liu, R. and Tsao, R. (2015): Characterisation of phenolics, betanins and antioxidant activities in seeds of three Chenopodium quinoa Willd. genotypes. Food Chem .,166:380-388

Velarde-Salcedo, A. J.; De Mejía, A. P. B. and De la Rosa, E. G. (2012). In Vitro Evaluation of the Antidiabetic and Antiadipogenic Potential of Amaranth Protein Hydrolysates. Hispanic Foods: Chemistry and Bioactive Compounds, Chapter 12, pp 189–198.

Weiss, C.; Marker H.S. and Lehrer, G.M. (1980) : Sensitive fluorometricassaysfor glutathione peroxidase andreductase. Anal Biochem.,106:512-516

تأثير التدعيم ببذور الكينوا علي الخواص الحسية لبعض الحلويات الشرقية والحالة الصحية للفئران

*د/دينا حامد البشوتى*د/نجلاء مسعد شنشن*د/علا طلعت سحلول

*قسم الاقتصاد المنزلي – كلية التربية النوعية – جامعة دمياط – مصر

الملخص

يهدف البحث الحالي إلى دراسة إدخال مطحون بذور الكينوا المنزرعة في مصر في بعض الحلوى الشرقية (لقمة القاضي ، عيش السرايا ،أصابع زينب ، سد الحنك ، والكنافة)، و كذلك دراسة تأثيره على الحالة الصحية لفئران التجارب. حيث تم إدخال مطحون بذور الكينوا في الحلوى الشرقية السابق ذكرها بنسبة ٢٠%، ٣٠% و٤٠% استبدال ، و تم تحكيم الخواص الحسية لتلك المنتجات من خلال محكمين مدربين ٠كما تم دراسة الخواص البيولوجية و الهستوباثولوجية لفئران التجارب من خلال ٤٠ فأر من ذكور الألبينو تم تقسيمها إلي مجموعتين رئيستين ، المجموعة الرئيسية الأولي (الضابطة) وعددها ١٠ فئران و المجموعة الرئيسية الثانية وعددها ٣٠ فأر والتي تم تقسيمها إلي ثلاث مجموعات متساوية العدد حيث تم إدخال مطحون بذور الكينوا في غذائها بنسب ٢٠% ، ٣٠% و ٤٠% استبدال علي التوالي لمدة ٥ أسابيع. وأظهرت نتائج التقييم الحسي للمنتجات وجود درجة تقبل عالية للمنتجات المضاف إليها مطحون بذور الكينوا بنسبة ٢٠% استبدال، ودرجة تقبل منخفضة للمنتجات المضاف إليها مطحون بذور الكينوا بنسبة ٤٠% استبدال. هذا وعند مستوي معنوية ٠,٠٥ و بالمقارنة بالمجموعة الضابطة أظهرت نتائج الدراسة حدوث انخفاض معنوي في الوزن الذي اكتسبته مجموعة الفئران الثانية (٢٠% كينوا) ، كما وجد انخفاض معنوي في أوزان كل من الكبد والكلي في مجموعتي الفئران الثانية والثالثة (٢٠%، و٣٠% كينوا) ، ووجد انخفاض معنوي في أوزان كل من القلب والطحال في المجموعة الثالثة (٣٠% كينوا)، كما ظهر ارتفاع غير معنوي في كل من نشاط إنزيمات CAT و GPx في مجموعتي الفئران الثالثة والرابعة (٣٠%، و٤٠% كينوا) ، و زيادة معنوية في نشاط إنزيم MDH في مجموعتي الفئران الثالثة والرابعة (

٣٠% ، و ٤٠% كينوا) ، بينما لم تظهر أي فروق معنوية في الهيموجلوبين وكرات الدم الحمراء والصفائح الدموية في مجموعات الفئران(٢٠% ، ٣٠% و٤٠% كينوا)، وبالنسبة لكرات الدم البيضاء فقد حدث لها انخفاض معنوي في مجموعة الفئران الثانية (٢٠% كينوا)، بينما حدث لها زيادة معنوية في مجموعة الفئران الرابعة (٤٠% كينوا) كما أظهرت النتائج أيضاً وجود زيادة معنوية في مستوى الألبيومين في مجموعتي الفئران الثانية والرابعة (٢٠%و٤٠% كينوا) ، وانخفاضاً معنوياً في مستوي الكالسيوم في مجموعة الفئران الثالثة (٣٠% كينوا) ٠هذا ولقد اتضح من خلال الفحص الهستوباثولوجى وجود تأثيرات ضارة لبذور الكينوا علي خلايا الكبد تزداد بزيادة نسبة البذور المضافة للغذاء ، كما وجدت بعض التغيرات الهستوباثولوجية على الكلى مما جعل الدراسة توصي بضرورة عمل المزيد من الدراسات علي بذور الكينوا المنزرعة في مصر لتأكد من أمان استخدامها و لمعرفة أسباب التأثيرات التي ظهرت علي كل من الكبد والكلي وذلك قبل تعميم استخدامها من قبل البشر.

الكلمات المفتاحية: الكينوا– التقييم الحسي –إنزيمات الأكسدة– الألبيومين –الكالسيوم – الفحص الهستوباثولوجى – فئران التجارب.