ISSN 1110-0419

Annals Of Agric. Sc., Moshtohor,
Vol. 45(4): 1445-1456, (2007).

BIOLOGICAL STUDIES ON FERMENTED SALTED BOURI FISH "FESEEKH"

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ABSTRACT

Consumption of high sodium food like salted bouri fish " feseekh" is a primary cause of hypertension as well as a contributor to many other diseases such as cardiovascular, renal abnormalities and stroke mortality. Therefore, reduction and / or substitution of sodium with potassium in salted bouri fish (mugil cephalus) " feseekh" are important with retaining their optimum properties of normal salt content. In the present work, fresh mullet fish was used in processing of "feseekh", fish samples were treated with,)100% NaCl), (90% NaCl + 10% KCl), (80% NaCl + 20% KCl), (70% NaCl + 30% KCl), (60% NaCl + 40% KCl) and (50% NaCl + 50% KCl). All treatments fish samples were stored at room temperature (25°C ±5) until curing and maturing for 45 day. After maturing, "feseekh" treatments were added to diet of adult male albino rats for 45 days. Serum bio-chemically analysis for total cholesterol (TC), triglycerides (TG), (HDL and LDL – cholesterol), total protein, uric acid, createnine, alanine and aspartate amino transferase (ALT and AST), Glucose, sodium, potassium, phosphorus and calcium were determined. Also, sensory evaluation of fish samples "feseekh " and testing the significance between the samples were investigated. The results indicated that reduced sodium feseekh had significant effect on the lipid profile in serum of rats. Replacement of NaCl by 30 and 40% KCl (groups 4, 5) showed the best results, where the total cholesterol was decreased by 10.51 and 10.54% compared to group 1 (100% NaCl). As well as LDL-cholesterol was decreased by 18.7 and 21.69% in groups 4, 5, respectively. Group 5 (40% KCl) showed also significant decreasing in total lipid and triglycerides by 9.6 and 10.6%, respectively. On the other hand group 4 (30% KCl) had the highest scores given by the panelists followed group 5, it could be recommended to produce this product on a commercial scale.

INTRODUCTION

Preservation with salt was important in the development of the fishing industry. In some areas of the world (i.e. Africa, Asia and Latin America), salting is one of the oldest techniques for preserving fish, it is still in use nowadays even in the developed countries, because of economic reasons to satisfy consumer's habits (Awad and Abd El-Aal, 1994). In Egypt, "Feseekh" is the traditional name of fermented salted bouri fish (Mugil cephalus). The effect of fermenting and salting processes on gross chemical composition was studied, The lipid content decrease from 12.6 to 11.2% in small fish and from 7.5 to 6.5% in large fish accompanied by an increase in peroxide value and production of free fatty acids (El-Sebaiy and Metwalli, 1989). The

average consumption or the total daily intake of sodium is estimated to range from 3900 to 4700 mg sodium (10-12g salt) per person per day, and this intake level is 20-25 times greater than the minimum & adult requirement (200 mg of sodium or 0.5 g of salt) which is needed to maintain physiological balance (Sebranek, *et al.*,1983). Sodium intakes of 1100-3300 mg/day and potassium intakes of 1865-5625 mg/day are considered safe and adequate for adults (FNB, 1980). Many researchers reported that replacement of NaCl with other chloride salts may not be totally desirable for flavour, only potassium chloride appears to offer the best alternative for replacing NaCl because it is currently generally recognized as safe (GRAS) for use in processed foods (Terrell, 1983). Moghazy, (2002) reported that reduction and/or substitution of sodium in processed foods, specially meat products are important but with retaining their optimum properties with normal salt content. Abundant evidences indicated that high sodium intake was usually related to high blood pressure. Recent expert committees in the United States such as the National High Blood Pressure Education Program and the American Heart Association recommended limiting daily sodium intake in adults to not more than 100 mmol Na, or 6g salt, as reported by Pearson, *et al.* (2000) and Whelton, *et al.* (2002). In the United kingdom, the Scientific Advisory Committee on Nutrition (2003) concluded that reducing the average salt intake of the population is likely to decrease the burden of the high blood pressure and improve public health as well as recommended a reduction in the population mean daily intake from the current average of 150 mmol Na (9g salt) to 100 mmol Na (6 g salt). He, *et al.* (1999) reported that 61% increase in cardiovascular disease mortality in over weight persons and 39% increase in all- cause mortality associated with 100 mmol higher sodium intake.

Khaw and Barrett – Connor (1987) concluded that within the range found in a free- living population, even modest entirely feasible differences in sodium intake were associated with blood pressure differences of clinical and public health relevance, their findings reinforce current recommendations to lower sodium intake in the general population. Human observation and animal experimentation suggested that increase of potassium intake may protect against stroke. Epidemiological studies reported a negative association of dietary potassium intake and stroke mortality, (Ascherio *et al.*, 1998).

The current US dietary guideline for sodium is a limit of 2.4 g/d or 6g NaCl/d. this amount of sodium was excess of any physiological need and is likely an essential though not by itself sufficient primary cause of hypertension as well as a contributor to many other cardiovascular and renal abnormalities. The evidence incriminating the current excessive consumption of sodium derives from epidemiologic, experimental, and interventional data, most of which support a threshold of $\approx$ 100 mmol/d for the harmful effects of sodium to be expressed. Although the current recommendation may not be low enough to go below that threshold, it is an appropriate and attainable goal for now, (Kaplan, 2000). The current US dietary guideline for sodium for the general public is no more than 2.4 g/d, equivalent to 110 mmol Na/d or 6.0 g NaCl. This is approximately two – thirds of the average dietary sodium intake of US adults, so that an overall average reduction of 40-60 mmol/d is being recommended, (Kumanyika, *et al.*, 1993).

One recent review concluded that interventions to reduce dietary sodium had trivial effects and do not support the need for public health action, (Hooper *et al.*, 2002). The UK, Scientific Advisory Committee on Nutririon (2003) recommended reduction average salt intake in Britain from 9 g to 6 g/d. A daily intake of 100 mmol Na (6 g/d) is clearly feasible and achievable, because ≈ 40% of the current, free-living population cohort already appeared to have dietary sodium intake within this range. The aim of this study to production of reduced sodium feseekh for cardiovascular disease and estimated the optimum properties by substitution of sodium with potassium chloride.

MATERIALS AND METHODS

Salting of bouri fish and substitution of Na^+ with K^+

Fresh mullet bouri fish (mugil cephalus) samples were obtained from local market in Qalyoubia and used in processing of "fessekh" in the laboratory experiments, (Meat and Fish Tech. Res. Dept., Agric. Res. Cent.)."Fessekh" was manufactured by the common method applied in the local market, whereas, the fish washed in tap water several times then treated with 0.03% ascorbic acid and left till partial swelling (48 hrs) at room temperature gills of fish were treated with salt. The fish samples were packed in exchanged layers with coarse salt in suitable plastic vessels provided that the first layer at the bottom of vessel and the final layer on the surface of fish were dry salt. A heavy weight was placed on the surface to avoid the floating of fish then, the vessels were closed and left for curing and maturing (45 days) of fish to become suitable for consuming. All samples were salted with a ratio of (1salt: 2 fish). Samples were divided to six groups according to substitution of sodium with potassium, as follow:

Group 1: (100%NaCl).
Group 2: (90%NaCl+10%KCl).
Group 3: (80%NaCl+20%KCl).
Group 4: (70% NaCl+30% KCl).
Group 5: (60% NaCl+40% KCl).
Group 6: (50% NaCl+50% KCl).

Animals and diets:

Adults male Sprague- Dawley albino rats (average weight 140 g) were obtained from Biology Unit in Food Tech. Res. Inst., and used in this study. All rats fed on basal diet for 7 days (adaptation period), it was consisted of protein 10%, cellulose 5%, cotton seed oil 10%, salt mixture 4%, vitamin mixture 1% and corn starch 70% according to (Lan-peter and Pearson, 1971). After that, the rats were divided into seven groups (5 rats/each) and fed on the prepared diets for 45 days as shown in Table(1). Biological evaluation of the different diets was carried out by estimated body weight gain according to (Chapman *et al.*, 1959). Blood samples were collected before and after treatments from orbital venous plexuses into a centrifuge tube and the serum was separated and stored at - 18°C till analysis.

Biochemical analysis:

Total cholesterol, triglycerides, HDL-cholesterol, total protein, total lipids, glucose, aspartate amino transferase (AST) & alanine amino transferase (ALT), uric

acid and creatinine were determined by kits according to methods of Richmond (1973), Jacobs and Vandenmark (1960), Gordon (1977), Watanabe *et al.* (1986), Zollner and Kirsch (1962), Slein (1974), Reitman and Frankel (1957), Berham and Trinder (1972) and Prenciple and Tanganelli (1982) LDL-cholesterol was estimated according Hatch and lees (1968). Calcium (Ca^{+}), potassium (K^{+}), phosphor (Ph^{+}) and sodium (Na^{+}) were measured colorimetrically at wavelength (570 nm) according to method of Raysarkar and Chauhan (1967).

Table (1): Composition of the tested diets (g/100g).

Diets / Group	% Protein		% Oil b		% Mineral mix. c	% Vit. mix. C	% Cellulose	% starch
	Casein	Feseekh (g) a	Oil added	Oil in feseekh				
Control (basal diet)	10	-	10	-	4	1	5	70
1- (100% NaCl)	-	43.48	7.56	2.44	4	1	5	36.52
2- (90 % NaCl + 10% KCl)	-	43.48	6.90	3.10	4	1	5	36.52
3- (80% NaCl + 20% KCl))	-	43.48	7.40	2.60	4	1	5	36.52
4- (70% NaCl + 30% KCl)	-	43.48	7.25	2.75	4	1	5	36.52
5- (60% NaCl + 40% KCl))	-	43.48	8.03	1.97	4	1	5	36.52
6- (50% NaCl + 50% KCl)	-	43.48	7.40	2.60	4	1	5	36.52

(a) feseekh weight in gram contained 10% protein
(b) oil added+ oil from feseekh = 10%
(c) Composition of vitamins and minerals mixture (A.O.A.C. 1990).

Chemical composition:

Moisture, crude protein (Total Nitrogen x 6,25) crude fat, and ash contents were determined according to (AOAC,1995). Thiobarbituric acid value (T.B.A) and salt content were determined as mentioned by Pearson (1970).

Microbiological methods:

- Nutrient agar media incubated at 37°C for 24-48 hrs was used for determination of total aerobic plate count (TPC) (Difco, 1970).
- Nutrient agar media containing 10% sodium chloride incubated at 37°C for 3 days was used for determination of halophilic bacteria count (HPC) (Difco, 1970).

Sensory Evaluation:

Fermented salted bouri fish " feseekh " of different treatments were evaluated for their compactness, after curing and maturating (45 days). Feseekh was evaluated for color, odor, texture, taste and overall acceptability according to the method described by (Allam,1977).

Statistical analysis:

The results were statistically analyzed according to (Kurtz, 1983).

RESULTS AND DISCUSSION

Chemical Composition and Microbiological:

Data in Table (2) show the % moisture, protein, fat, Ash, salt and thiobarbituric acid (TBA, as mg malonaldehyde/kg sample) as well as total aerobic plate count (T.P.C.) and halophilic bacteria count (H.P.C.) (cfu / g) of fresh and fermented salted bouri fish " feseekh ". It could be observed that there are changes of fat, protein, salt, T.B.A, T.P.C and H.P.C. between all sample either control or treatments, this may be due to the effect of salt added and storage period during fermentation of fish. Any way, in compression with fresh fish, due to the different treatments, it could be observed that moisture and total plate count (T.P.C.) were decreased while, fat, protein, ash, salt, T.B.A. and H.P.C. were increased. This clearly indicated the effect of different treatments used to replace NaCl with KCL when compared with fresh fish.

Table (2): Chemical composition, chemical & microbial quality of fresh and fermented salted bouri fish, (feseekh), (on wet weight).

Item / Treatments	Moisture	% Protein	% Fat	% Ash	% Salt	T.B.A mg\kg sample	T.P.C Cfu/g	H.P.C Cfu/g
Fresh fish	73.23	19.41	4.67	1.52	0.43	0.43	$2.5x10^3$	-
1- (100% NaCl)	53.21	21.61	5.62	15.63	14.22	2.46	$2.6x10^4$	$4 x 10^3$
2- (90 % NaCl + 10% KCl)	52.67	23.30	6.94	14.83	9.62	1.63	$2.2 x 10^4$	$5.1 x 10^3$
3- (80% NaCl + 20% KCl))	50.41	22.71	5.98	15.86	8.56	1.77	$9.7 x 10^4$	$6.6 x 10^3$
4- (70% NaCl + 30% KCl)	51.36	22.61	6.32	16.67	9.79	1.56	$9.9 x 10^4$	$7.3 x 10^3$
5- (60% NaCl + 40% KCl))	51.93	23.20	5.52	12.98	10.72	1.81	$3 x 10^5$	$7.4 x 10^3$
6- (50% NaCl + 50% KCl)	52.61	24.61	6.47	16.61	10.41	1.13	$6 x 10^4$	$3.8 x 10^4$

Sensory evaluation:

Data in Table (3) show the sensory evaluation of fermented salted bouri fish " feseekh " samples as affected by reducing of sodium in various percentages. It could be observed that of treatment 4 (30% KCL) and treatment 5 (40% KCL) had the highest scores given by the panelists compared with treatment 1 (100% NaCL). Replacement of 50% NaCl with 50% KCl in treatment 6 affected the taste and odor. This might be due to the bitter taste of KCL used at high level, as until 40 % KCl, it appeared to offer the best alternative for replacing NaCl particularly in the light of fact that KCl is currently generally recognized as safe (GRAS) (Moghazy, 2002) and (Terrell, 1983).

Biological studies:

1-Body weight gain(g):

Data in Table (4) show the body weight of rats fed on (feseekh). It could be observed that non-significant differences between all groups at the beginning of experiment (zero time). While, by the end of feeding period (45 days), the results

indicated that all groups of rats (except group 5) fed either on high or low sodium feseekh had higher body weight compared to control (basal diet). Concerning the gain body weight, the descending arrangement of groups was as follows: group 1, 2, 3, 4, and 6 followed by group 5. Also, from the results of statistical analysis, it was clearly that the highest body weight gain was recorded for group 1 (100 % NaCL) accordingly had the highest significant difference compared to the other treatments. This may be due to great increase of sodium intake in body tissues of rats during feeding periods. That's because higher sodium levels may be help for holding or retain fluid in body tissues and lead to shortness of breath and swelling of tissues. Also, consequently increasing of body weight, as well as, increment of sodium in blood might be result kidney diseases, hypertension and cardiovascular diseases.

Table (3): Sensory evaluation of fermented salted bouri fish (feseekh).

Characters / Treatments	Color (10)	Taste (20)	Texture (10)	Odor (10)	Overall acceptability (10)
1- (100% NaCl)	6.50^{b}	13.10^{b}	7.10^{a}	6.07^{b}	6.51^{b}
2- (90 % NaCl + 10% KCl)	6.70^{ab}	13.50^{ab}	6.55^{a}	6.45^{ab}	6.64^{ab}
3- (80% NaCl + 20% KCl))	6.45^{b}	13.70^{ab}	6.75^{a}	6.80^{ab}	6.87^{ab}
4- (70% NaCl + 30% KCl)	7.40^{ab}	15.60^{a}	6.95^{a}	7.30^{a}	7.35^{a}
5- (60% NaCl + 40% KCl))	7.65^{a}	14.10^{ab}	7.00^{a}	6.95^{ab}	7.01^{ab}
6- (50% NaCl + 50% KCl)	6.50^{b}	12.10^{b}	6.05^{a}	5.80^{b}	6.09^{b}
LSD at 5 %	1.02	2.13	1.12	1.23	0.84

Table (4): Body weight of rats fed on (feseekh).

Groups	Body weight gain (g)		
	Initial	Final	Gain
Control (basal diet)	140.00^{cd}	152.67^{c}	12.67^{c}
1- (100% NaCl)	141.70^{cd}	189.70^{a}	48.00^{a}
2- (90 % NaCl + 10% KCl)	145.70^{c}	176.00^{ab}	30.33^{b}
3- (80% NaCl + 20% KCl))	141.70^{cd}	170.00^{b}	28.33^{b}
4- (70% NaCl + 30% KCl)	140.30^{cd}	168.00^{b}	27.67^{b}
5- (60% NaCl + 40% KCl))	140.00^{cd}	130.70^{d}	-9.33^{d}
6- (50% NaCl + 50% KCl)	139.70^{cd}	168.00^{b}	28.33^{b}
L.S.D at 5 %	14.33		8.68

2-Cholesterol and triglycerides:

Data in Table (5) showed that total cholesterol and triglycerides were recorded 73.33 – 75.40 mg / dl and 78.67 – 81.33 mg /dl, respectively for all treatments either group or control. It was clearly that no significant differences among all treatments (groups and control) at the beginning of experiment. On the other hand, the end of feeding period (45 days) there were significant and non-significant differences among all treatments either for total cholesterol or triglycerides. But any way, it was clearly that with decreasing of sodium and increasing of potassium K in the feseekh diet, the total cholesterol decreased in serum of rats until 40 % KCL (group 5) when compared to group 1 (100% NaCl). This may be due to the decrease of sodium and increase of potassium in the serum of rats where that potassium (K) may be improve and reduce the blood pressure via reducing the total cholesterol. On

the other hand, there were no significant differences among all groups in triglycerides at zero time, but after 45 days triglycerides had significant decrease in group 2, 3 and 5. While group 4 and group 6 had non-significant change in triglycerides. Generally replacement of NaCl by 30 and 40 % KCL (groups 4,5) show decreased in total cholesterol by 10.51 and 10.54 % compared to group 1 (100% NaCl) This may be due to reducing NaCl of samples and increasing dietary potassium. Moreover, fish oil contains eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) which suppressed the activity of enzymes related to fatty acids synthesis and suggested that the reduces synthesis of fatty acids in the liver decreased the secretion of triglycerides into the blood stream (Wong, *et al.*, 1984).

Table (5): Total cholesterol and triglycerides in serum of rats fed on (feseekh).

Groups	Total cholesterol (mg/dl)		Triglycerides (mg/dl)	
	Initial	Final	Initial	Final
Control (basal diet)	74.00^{d}	79.00^{d}	81.00^{ab}	80.32^{ab}
1- (100% NaCl)	75.30^{d}	98.00^{b}	80.30^{ab}	84.70^{a}
2- (90 % NaCl + 10% KCl)	73.33^{d}	92.30^{bc}	80.33^{ab}	74.67^{b}
3- (80% NaCl + 20% KCl))	75.35^{d}	89.33^{c}	80.43^{ab}	75.67^{b}
4- (70% NaCl + 30% KCl)	74.32^{d}	87.70^{c}	81.33^{ab}	83.30^{a}
5- (60% NaCl + 40% KCl))	75.31^{d}	87.67^{c}	80.35^{ab}	75.70^{b}
6- (50% NaCl + 50% KCl)	75.40^{d}	107.00^{a}	78.67^{ab}	78.67^{ab}
LSD at 5 %	8.15		6.18	

3- Total lipid, high and low density lipoprotein (HDL and LDL):

Data in Table (6) show the total lipids, HDL and LDL- cholesterol in serum of rats fed on (feseekh). It could be noticed that, there were no significant differences between all groups at the beginning either for total lipids, HDL and LDL. After feeding of rats on high & low sodium feseekh for (45days) significant increase was observed in total lipid between all groups compared to control (basal diet). Concerning group 1 (100% NaCL) and other groups (low sodium) group 5 recorded the lowest value in total lipid (9.6 %). The same trend of total lipids was recorded for the HDL and LDL where the group 5 showed the best result of HDL (highest content in serum of rats) and LDL (lowest content in serum of rats). Generally, group 5 that represented diet contained 40% KCL was the best treatment according to the results obtained where caused reduction in total lipids and LDL by 9.6 and 21.7% compared with group 1 (100% NaCl).This, may be due to potassium enhanced assembly for circulating HDL through promoted lipoprotein lipase activity. In addition, potassium helps in regulate blood pressure and maintain a regular heart beat.

4- Total protein, uric acid and creatinine:

Results in Table (7) show the total protein, uric acid and creatinine in serum of rats feeding on fermented salted bouri fish feseekh. It could be noticed that, there were no significant differences between all groups concerning total protein, uric acid and creatinine at initial of excrement. At the end of experiment there significant increase in total protein for groups (4, 5 and 6) and significant increase in uric acid for groups (2, 3, 5 and 6). Group 5 (40% KCL) showed the highest increase in total

protein (11.40 %) and uric acid (23.10 %). While group 6 showed the high increase in creatinine (26.60%) compared to group 1 (100% NaCl)This, may be due to various of ratio of sodium and potassium in feseekh diet. Also, the high content of salt intake in the body tissues had especially effects on the kidneys.The kidneys are less able to rid the uric acid this due to increasing of total protein level in body.

Table (6): Total lipid, HDL and LDL-Cholesterol in serum of rats fed on (Feseekh).

Groups	Total lipids (mg/dl)		HDL (mg/dl)		LDL (mg/dl)	
	Initial	Final	Initial	Final	Initial	Final
Control (basal diet)	256.30^{a}	261.30^{a}	23.67^{bc}	24.00^{bc}	34.33^{d}	38.94^{d}
1- (100% NaCl)	255.00^{a}	317.30^{ab}	23.70^{bc}	31.00^{ab}	35.00^{d}	50.06^{b}
2- (90 % NaCl + 10% KCl)	254.30^{a}	301.31^{a}	24.00^{bc}	27.67^{bc}	35.34^{d}	49.67^{bc}
3- (80% NaCl + 20% KCl))	254.70^{a}	308.70^{bc}	23.67^{bc}	32.67^{ab}	35.00^{d}	41.67^{bcd}
4- (70% NaCl + 30% KCl)	256.00^{a}	319.70^{ab}	24.10^{bc}	30.33^{ab}	35.67^{d}	40.71^{cd}
5- (60% NaCl + 40% KCl))	254.70^{a}	286.70^{d}	23.67^{bc}	33.33^{a}	35.00^{d}	39.20^{d}
6- (50% NaCl + 50% KCl)	255.30^{a}	328.70^{a}	23.00^{bc}	30.33^{ab}	38.67^{d}	60.40^{a}
L.S.D at 5%	14.60		5.06		8.48	

Table (7): Total protein, uric acid and createnine in serum of rats fed on (Feseekh).

Groups	Total protein (mg/dl)		Uric acid (mg/dl)		Createnine (mg/dl)	
	Initial	Final	Initial	Final	Initial	Final
Control (basal diet)	6.93^{f}	7.10^{def}	1.76^{fg}	1.72^{f}	0.57^{a}	0.57^{a}
1- (100% NaCl)	6.90^{f}	7.33^{cde}	1.77^{fg}	1.90^{de}	0.56^{ab}	0.45^{d}
2- (90 % NaCl + 10% KCl)	6.90^{f}	7.37^{cd}	1.80^{fg}	2.11^{bc}	0.54^{ab}	0.52^{bc}
3- (80% NaCl + 20% KCl))	6.87^{f}	7.60^{bc}	1.77^{fg}	2.27^{ab}	0.56^{ab}	0.48^{cd}
4- (70% NaCl + 30% KCl)	6.80^{f}	7.90^{ab}	1.80^{fg}	1.99^{cd}	0.55^{ab}	0.48^{cd}
5- (60% NaCl + 40% KCl))	6.83^{f}	8.17^{a}	1.77±^{fg}	2.34^{a}	0.56^{ab}	0.55^{ab}
6- (50% NaCl + 50% KCl)	7.00^{f}	8.00^{a}	1.76^{fg}	2.16^{bc}	0.56^{ab}	0.57^{a}
L.S.D at 5%	0.37		0.18		0.05	

5- Aspartate amino transferase (AST); alanine amino transferase (ALT) and glucose:

Data in Table (8) show the aspartate amino transferase (AST); Alanine amino trafserase (ALT) and glucose in serum of rats fed on (feseekh). It could be noticed that at zero time, there were no significant differences between all groups concerning AST,ALT and glucose. By the end of feeding period there were no significant differences among some groups and significant differences among others. Of AST, there were significant different between the group 1 and basal diet (control) due to feeding of rats on feseekh 100 % NaCl (group 1). The highest increase in AST, ALT and glucose were recorded for rats fed on 50% NaCL + 50 % KCL (group 6), while the lowest decrease in AST was recorded for group 5 (40% KCL), compared with other groups. Also, rats feeding on (feseekh) (40 % KCL) group 5 had no significant differences of ALT contents in serum of rats compared with group1 and control (basal diet), this may be due to dietary potassium intake which may be prevent of free radical formation, increase of vascular smooth muscle and improve the liver function (Sacks, *et al.*, 1998)

Table (8): AST, ALT and glucose in serum of rats fed on (feseekh).

Groups	AST (U/L)		ALT (U/L)		Glucose (mg/dl)	
	Initial	Final	Initial	Final	Initial	Final
Control (basal diet)	47.67^{b}	45.00^{bc}	41.00^{bcd}	40.33^{bcd}	99.67^{abc}	100.30^{abc}
1- (100% NaCl)	46.67^{b}	40.00^{de}	40.67^{bcd}	37.00^{de}	95.67^{ef}	128.70^{ab}
2- (90 % NaCl + 10% KCl)	43.70^{bcd}	39.00^{de}	39.70^{bcd}	32.00^{f}	96.00^{def}	121.70^{ab}
3- (80% NaCl + 20% KCl))	46.65^{b}	47.83^{b}	40.67^{bcd}	35.00^{e}	95.67^{ef}	112.30^{abc}
4- (70% NaCl + 30% KCl)	46.00^{b}	47.00^{b}	40.00^{bcd}	43.33^{ab}	94.00^{f}	128.00^{abc}
5- (60% NaCl + 40% KCl))	46.70^{b}	38.67^{e}	40.67^{bcd}	38.67^{cde}	95.33^{ef}	129.70^{ab}
6- (50% NaCl + 50% KCl)	47.67^{b}	52.67^{a}	42.33^{bcd}	46.80^{a}	95.00^{f}	143.00^{a}
L.S.D at 5%	4.36		4.47		17.10	

6- Minerals content in serum of rats fed on flesh feseekh:

Data in Table (9) showed that calcium was increase by feeding the rats on all treatments of feseekh compared to basal diet group. While groups (4, 5 and 6) showed the high increase compared to group 1 (100 % NaCl). On the other hand sodium in serum was increased in group 1 (10.60 %) compared to basal diet group and showed decreasing in the other groups by decreasing of NaCl in feseekh treatments. While potassium had a reverse trend. phosphor may be effected by electrolytic balance between Na and K in the serum of rats. Generally, reduction and substitution of sodium until (40% KCl) provides the best in "Feseekh" because affected the public health benefits as regulate blood pressure, reduces total lipid and LDL cholesterol and increase HDL, (groups 4 and 5). Also, maintain a regular aspartate amino transferase (AST) and Alanine amino transferase (ALT). On the other hand, regular the triglycerides and electrolyte balance in (Na^{+} & k^{+}) into body among cells.

Table (9): Minerals content in serum of rats and fermented salted bouri fish in flash (feseekh).

Element / Groups	Serum of rats								Flash feseekh	
	Ca (mg /dl)		Na (mg /dl)		K (mg /dl)		Ph (mg /dl)		Na(mg /100g	K(mg /100g
	Initial	Final	Initial	Final	Initial	Final	Initial	Final	After 45 days	
Control (basal diet)	10.57^{f}	10.63^{f}	125.70^{cd}	124.70^{cd}	4.73^{b}	4.57^{bc}	3.77^{a}	3.66^{ab}	–	–
1- (100% NaCl)	10..53^{f}	11.10^{bcd}	125.00^{cd}	138.00^{a}	4.73^{b}	4.13^{d}	3.70^{a}	3.60^{bc}	2404.32	229.38
2- (90 % NaCl + 10% KCl)	10.57^{f}	11.33^{ab}	123.70^{d}	137.00^{a}	4.70^{b}	4.30^{cd}	3.63^{ab}	3.43^{d}	1677.32	963.53
3- (80% NaCl + 20% KCl))	10.50^{f}	11.30^{abc}	125.00^{cd}	134.30^{ab}	4.70^{b}	4.77^{b}	3.70^{a}	3.43^{d}	1561.24	955.29
4- (70% NaCl + 30% KCl)	10.70^{f}	11.40^{a}	123.00^{d}	130.30^{bc}	4.67^{b}	4.50^{bc}	3.63^{ab}	3.23^{e}	1411.28	1321.02
5- (60% NaCl + 40% KCl))	10.60^{f}	11.47^{a}	125.00^{cd}	126.00^{cd}	4.60^{bc}	551^{a}	3.70^{a}	3.46^{cd}	1284.59	1459.19
6- (50% NaCl + 50% KCl)	10.71^{ef}	11.40^{a}	126.70^{cd}	122.70^{d}	4.67^{b}	5.61^{a}	3.67^{a}	3.40^{d}	1314.64	1495.16
L.S.D at 5 %	0.25		6.13		0.31		0.17			

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دراسات بيولوجية على سمك البوري المملح والمتخمر {الفسيخ}

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معهد بحوث تكنولوجيا الأغذية مركز البحوث الزراعية.

من المؤكد أن الاستهلاك الزائد من الأغذية المرتفعة في نسبة الصوديوم ربما يكون من الأسباب الأساسية لإصابة الإنسان بمرض ارتفاع ضغط الدم وبالتالي الإصابة بأمراض القلب وتصلب الشرايين وأيضا حدوث السكتة الدماغية.

ولذلك من المهم خفض نسبة الصوديوم أو استبداله بالبوتاسيوم في منتجات الأسماك وخاصة المرتفعة في نسبة الملح مثل الفسيخ ، مع مراعاة المحافظة على الخواص التكنولوجية والحسية للمنتج النهائي وفي هذه الدراسة تم استخدام سمك البوري في إنتاج الفسيخ منخفض الصوديوم عن طريقة استبداله بالبوتاسيوم وذلك على النحو التالي: - ٩٠٪ كلوريد صوديوم + ١٠٪ كلوريد بوتاسيوم ،٨٠٪ كلوريد صوديوم + ٢٠٪ كلوريد بوتاسيوم ،٧٠٪ كلوريد صوديوم + ٣٠٪ كلوريد بوتاسيوم ، ٦٠٪ كلوريد صوديوم + ٤٠٪ كلوريد بوتاسيوم و ٥٠٪ كلوريد صوديوم + ٥٠٪ كلوريد بوتاسيوم. مع استخدام التمليح الطبيعي ١٠٠٪ كلوريد صوديوم (عينة الكنترول) للمقارنة بجميع المعاملات السابقة ثم تم التخزين على درجة حرارة ٢٥° م ± ٥° م لمدة ٤٥ يوم وذلك لإتمام عملية التسوية والإنضاج للفسيخ بعد ذلك تم إضافة الفسيخ المعامل إلى عليقة الفئران والتغذية لمدة ٤٥ يوم.

تم إجراء بعد التحاليل البيوكيمائية على سيرم الفئران في بداية ونهاية التجربة وكذلك تم إجراء تقييم حسي للمعاملات السابقة ، وقد اظهرت النتائج المتحصل عليها أن إستخدام ٤٠٪ كلوريد بوتاسيوم كنسبة إستبدال لكلوريد الصوديوم أدى إلى خفض معنوي في الكوليسترول الكلي بنسبة ١٠,٥٤٪ بالمقارنة بمجموعة الكنترول (١٠٠٪ كلوريد صوديوم)، بالإضافة إلى ذلك فإن الليبوبروتينات منخفضة الكثافة قد انخفضت بنسبة ١٨,٧ ، ٢١,٦٩٪ في كل من المجموعتين الرابعة والخامسة { ٣٠ ، ٤٠٪ كلوريد بوتاسيوم } على التوالي. وقد أظهرت المجموعة الخامسة أيضا انخفاض معنوي في مستوى الليبيدات الكلية والجلسريدات الثلاثية في سيرم الفئران بنسبة ٩,٦ و ١٠,٦٪ على التوالي.