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EFFECT OF DIETARY POTATO CHIPS ON BODY WEIGHT, LIVER AND KIDNEY FUNCTION IN RATS

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ABSTRACT

The chemical composition of potato chips from the local Egyptian market (El. Jauhara., Crunhy, Chipsy, Crispy and Lion), beside the chemical properties of their oils, as well as their dietary effect on body weight, some serum constituent, liver and kidney function of rats were studied.

Results showed that all potato chips had almost the same content of total lipids (34.96- 36.14%), total protein (5.99 – 6-68%), total carbohydrates (41.68 – 42. 43%) and total ash (3.77- 4.0 %).

Infrared technique showed that all the studied commercial potato chips oils contain a small amount of trans fatty acids.

Feeding two diet with 60% commercial potato chips (A or B) to rats resulted in a significant reduction of body weight and body gain compared with rats received basal diet or received 60% home potato chips.

The same commercial potato chips (A or B) diet caused a significant increase of serum amino transferase (Alanine transferase ALT and asparate transferase AST), alkaline phosphatase (ALP), creatinine, urea, total lipids and cholesterol of rats when compared with those fed basal diet or with rats received 60% home potato chips.

INTRODUCTION

There is growing needs for through and a reliable information on the nutrient composition of all human foods specially which so called fast foods. The relationship of dietary lipids to normal human health and to heart disease, obesity and cancer has been the subject of much research and public concern, (Richard 1974 and Slover *et al.*, 1980).

In Egypt we need detailed information on the amount of fat, specific fatty acids composition including trans unsaturated and polyunsaturated fatty acids, cholesterol and plant sterols in foods as eaten.

Cornelius, (1989) mentioned that liver enzymes alanine trans aminase (ALT) and asparatate trans aminase (AST) of blood serum are used in diagnosis of liver disorder. The striking increase in serum alkaline phosphatase activity in hepatobiliary disorders is due to a unique over production of hepatic alkaline phosphatase iso-enzyme.

There are some parameters used to evaluate renal functions, such as non protein nitrogen substances (NPN); which include urea, creatinine and uric acid. (Coles, 1986).

The present work was undertaken to comparative study on the chemical composition of some potato chips as well as their nutrition effects on body weight, chemical constituent of blood, and liver and kidney functions of rats.

MATERIALS AND METHODS

Sixty albino rats (of average weight 135-149 g) were divided into six groups, ten rats per each were employed in this experiment. All groups were feed with normal diet for two weeks for acclimation. The diet includes protein, minerals, vitamins, energy resources and other beneficial dietary constituents as recommended by the National Research Council, (1995). The first group was given a diet without potato chips (control). The second group received diet containing 60% home potato chips. The third and fifth groups received diet containing 95% potato chips used under a commercial name in the Egyptian market and donated to by the letters (A) or (B) without any other ingredient except vitamin and salt. The fourth and sixth groups received diet containing 60 % of potato chips (A) or (B), to evaluate their effect on rats. The ingredients in groups 2, 4 and 6 were decreased from the control one by their amount in the added potato chips diets. Table (1) show the composition of the experimental diets in the six groups. The clinical manifestation and the effect of dietary potato chips on growth were recorded as recommended by Prakash and Arora (1998). At the end of the 8th week, rats were slaughtered to follow up the changes that might take place in liver, kidney, spleen and testis weight. Serum was isolated for biochemical analysis.

Type and sources of potato chips under investigation: -

- Chipsy and Crunchy :produced by Chipsy for Food Industries Co. Egypt.
- Crispy :Produced by International Natural Food Co. Egypt.
- Lion: Produced by Senyorita group for Food Industries.
- El-Jawhara :Produced by El-Jawhara Co. for International Industries.
- Rats were supplied by the Farm of General Organization of Serum & Vaccine (Abasia Farm, Egypt).

Chemical composition of potato chips:

Crude protein ,*total lipids* ,*ash*, *total carbohydrates*, *acid value*, *iodine value*, *peroxide value* and *unsaponifiable matter* *% were determined* according to the methods described in AOAC (1990).

Table (1): Composition of experimental diets.

Ingredient	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6
Casin	15	9	-	9	-	9
Sucrose	20	12	-	12	-	12
Corn starch	40	14	-	14	-	14
Sunflower oil	20	-	-	-	-	-
Home potato chips	-	60	-	-	-	-
Potato chips (A)	-	-	95	60	-	-
Potato chips (B)	-	-	-	-	95	60
Vitamine mixture*	1	1	1	1	1	1
Salt mixture	4	4	4	4	4	4

- Ingredient (mg/kg diet) :

Thiamin (10), riboflavin (10), pyridoxine (10), pantothenate (30), inositol (500), niacin (50), biotin (0.2), vitamin B_{12} (20), folic acid (2), vitamin A palmitate (500.000 I.U./g), ergocalciferol (500.000 I.U./g) and vitamin E acetate (500 I.U./g).

Serum total lipids were determined according to the method mentioned by Christopher *et al.* (1970). *Serum cholesterol* by Flegg (1973). *Blood urea by* Patton and Crauch (1977). *Serum creatinine by* Siest *et al.* (1985). *Serum alanine (ALT) and aspartate (AST) aminotransferases* activities by White (1970). *Serum alkaline phosphatase (ALP)* activity by Bessey *et.al.* (1964).

The fatty acids were isolated and treated with diazomethane to prepare their methyl ester as reported by Vogel (1975). The fatty acid methyl ester were analyzed using a Pye Unicum series 304 GC, with flame ionization detector under the following condition: column PEGA 10%, nitrogen 30 ml / min., injector temperature 250°C, detector temperature 300 Column temperature 140°C for 4 min., rate 10°C/ min., final temperature 180°C for 25 min.. Peake area and space the percentage of each separated ester were calculated by an integrator, Helott pakard model 3390 A.

Spectrophotometric analysis was carried out using Pye Unicam spectrophotometer SP 6-550.

Infrared absorption spectra were determined using FT-IR 1650 (Perkin Elmer) spectrophotometer.

Statistical analysis, was performed using the methods of Snedecor and Cochran (1967).

RESULTS AND DISCUSSION

a) The chemical composition of different potato chips: -

The chemical composition and the major chemical properties of the potato chips oils which considered as a good criterion for keeping quality and nutritive value of these potato chips oils are shown in Table (2). Data show that

the differences between total ash, crude protein, total carbohydrates, crude fiber and total lipids contents for the different types of potato chips under investigation are very small.

The acid value in general did not show a significant variation in all the studied potato chips oils. It ranged from 0.56 to 0.89, this slight increase in the acid value was mostly due to the slight oxidation of aldhydes and ketones which formed during frying process, leading to the formation of mono and dicarboxylic short chain organic acids (Wishner and Keeney 1965).

The unsaponifiable matter content of the investigated market potato chips oils significantly decreased than its content in home potato chips oil. This decrease might be due to the destruction of tocopherol and sterol contents under condition of deep fat frying (Yuki and Ishikawa 1976).

The low peroxide value obtained for home potato chips oil (5.93 meq/ kg oil) indicated that very little oxidation had occurred in the potato chips material. On the contrary high peroxide values (26.37- 37.21 meq/kg oil) were obtained for oils extracted from the market potato chips (El-Jawhara, Crunchy, Chipsy, Crispy and Lion). However, this increase in the peroxide value might be regarded to the technological processes which have a direct effect on diminishing the amount of the natural antioxidant found in the frying oils. Also the high amount of unsaturated fatty acids in the oil before processing might accelerate their ability towards oxidation.

Fatty acid composition of oils extracted from potato chips are presented in Table (3). The obtained data revealed that oleic acid with one double bond resembles the highest amount of unsaturated fatty acids which is not an essential fatty acids and amounted to 58.56 % in total fatty acid of oil extracted from Crunchy, while linoleic acid amounted only to 6.59 %. Oil extracted from home potato chips characterized by high amount of linoleic acid (46.45 %) while oils extracted from El–Jawhara, Chipsy, Crispy And Lion caricaturized by high amount of palmitic acid ranged from 47.7 % to 51.40%.

Infrared spectroscopic analysis was used to identify the trans isomer fatty acid in potato chips oils. An absorption band with maximum at 970 Cm^{-1} arising from a C-H deformation of trans double bond, is exhibited in the spectra of all compounds containing and isolated trans – group. This band is not observed in the spectra of the corresponding cis and saturated compounds. The trans fatty acids are present in all commercial samples under investigation. Fig (1) showed a slight amount of trans fatty acids in all potato chips oils. It could be concluded in this aspect that the unsaturated fatty acids which are found naturally in the cis configuration might be isomerized to the trans configuration during the process of frying, i.e. the high temperature promotes isomerization from the naturally occurring cis to trans isomers.

Table (2): Chemical composition of potato chips and chemical properties of their oils

Commercial names of Potato chips	Chemical composition percentageof potato chips				Chemical properties of oil extracted from potato chips oils				
	Total ash	Crude protein	Total carbo-hydrates	Crude fiber	Total lipids	Acid value	Iodine value	Peroxide value	Unsapon-ifiable matter
El-Jauhara	3.77 ±0.03	6.68 ±0.077	41.96 ±3.466	11.51 ±0.321	36.08 ±1.106	0.89 ±0.0004	97.06 ±4.49	36.38 ±3.457	0.83 ±0.002
Crunchy	3.94 ±0.005	6.58 ±0.153	42.38 ±2.194	12.14 ±0.123	34.96 ±5.082	0.66 ±0.0007	107.47 ±1.014	33.91 ±2.849	0.63 ±0.003
Chipsy	4.0 ±0.006	6.01 ±0.044	41.68 ±5.298	12.09 ±0.114	36.14 ±2.284	0.77 ±0.0002	99.40 ±1.67	26.37 ±4.358	0.72 ±0.0001
Crispy	3.94 ±0.006	5.99 ±0.115	42.43 ±0.658	11.92 ±0.750	35.66 ±1.981	0.83 ±0.0005	93.61 ±1.633	35.62 ±4.360	0.58 ±0.0001
Lion	3.99 ±0.035	6.16 ±0.057	41.93 ±2.894	11.96 ±2.140	35.96 ±1.141	0.91 ±0.0001	94.09 ±0.249	37.21 ±4.341	0.58 ±0.0007
Home Potato chips	3.99 ±0.121	6.17 ±0.257	42.33 ±1.707	11.78 ±0.107	35.64 ±1.777	0.56 ±0.0006	112.09 ±1.591	5.93 ±0.197	1.14 ±0.011
L.S.D.	0.19	0.67	3.96	1.50	1.91	0.10	2.49	5.05	0.08

Table (3): Fatty acids composition of oils extracted from potato chips.

Commercial names of Potato chips	Fatty acid percentage									
	$C_{12:0}$	$C_{14:0}$	$C_{16:0}$	$C_{12:1}$	$C_{18:0}$	$C_{18:1}$	$C_{18:2}$	$C_{18:3}$	$C_{20:0}$	$C_{22:1}$
El-Jauhara	0.50 ±0.001	1.80 ±0.01	51.40 ±2.05	0.24 ±0.0005	4.35 ±0.145	29.33 ±1.037	9.53 ±0.31	0.03 ±0.0004	0.24 ±0.0018	n.d
Crunchy	0.42 ±0.0004	1.35 ±0.0035	26.63 ±0.383	0.21 ±0.0004	4.02 ±0.0150	58.56 ±1.823	6.59 ±0.411	0.23 ±0.0001	0.37 ±0.0004	2.10 ±0.04
Chipsy	0.51 ±0.0016	1.71 ±0.0007	47.70 ±4.094	0.30 ±0.0001	4.50 ±0.0961	29.63 ±0.423	14.45 ±2.819	0.37 ±0.0004	0.26 ±0.0002	n.d
Crispy	0.28 ±0.0002	1.66 ±0.103	50.67 ±4.015	0.27 ±0.001	4.80 ±0.049	30.65 ±0.893	10.90 ±0.990	0.36 ±0.002	0.16 ±0.0002	n.d
Lion	0.30 ±0.001	1.04 ±0.252	49.59 ±1.635	0.18 ±0.001	4.25 ±0.061	33.46 ±2.725	10.80 ±0.250	0.25 ±0.003	0.11 ±0.0001	n.d
Home Potato chips	0.23 ±0.001	0.65 ±0.021	10.44 ±0.55	0.30 ±0.001	4.51 ±0.203	35.96 ±1.835	46.45 ±1.629	0.09 ±0.0001	0.13 ±0.0005	n.d
L.S.D.	0.06	0.22	2.65	0.1	0.57	1.92	1.39	0.05	0.01	0.15

a) El-Jawhara b) Crunchy c) Chipsy
d) Crispy e) Lion f) Home potato chips

Fig (1): IR spectra of potato chips oils :

b) The effect of different potato chips on rats growth and different organs weight: -

Mean values of body weight and body weight gain of rats illustrates by Figures (2 and 3) revealed that, the decrease in body weights of rats received 95% potato chips A or B were differed from the corresponding values of rats received home potato chips by about 25.8% and 31.18% respectively, whereas the corresponding decreases in the rats received 60% potato chips A or B were as low as 15.59% and 16.0% relative to rats received home potato chips at the end of experimental period. Also body weight gain in groups 3, 4, 5 and 6 reached about –2.00, +3.80, -2.00 and ± 4.17 compared to the rats received home potato chips 14.1 at the end of the experimental period. The decrease in body weight and body weight gain of rats might be attributed to the disorder effect of potato chips A or B. Also, Fig. (4) showed significant variation between different organs weight (liver, kidney, spleen, and testis) in the third and fifth groups when compared with the first group (control) or with the second one (rats received home potato chips).

c) The effect of different potato chips diet on some blood serum parameters:

Estimation of results of some biochemical parameters in serum of the rats dieted treated with or without *potato chips* for 8 weeks are shown in Table (4).

Total lipids and cholesterol contents of the serum of rats received different diets are shown in Table (4). Higher levels of lipids and cholesterol were demonstrated in serum of rats fed 60% and 95% potato chips (A) or (B) compared to those fed control diet or diet containing 60% Home potato chips. These increment of lipids in serum may be attributed to the decrease of most enzymes of β-oxidation which act on very long chain monotonic fatty acids (Kirschner and Harris 1961). The increment of cholesterol in rats fed 60% and 95% potato chips (A) or (B) in the diet may be attributed to inhibit the activity of cholesterol ester hydrolase enzyme (Beckett and Boyd 1975). The results of the present study are in agreement with the results of Truswell (1997), who suggested that hyperlipidemia and hypercholesterolemia is expected to occur in humans received diet containing high amount of palmitic acid.

Plasma enzymes activity of AST, ALT and alkaline phosphatases (ALP) were significantly stimulated in rats received 60% or 95% of either potato chips A or B as compared to control group and rats received 60% home potato chips. The increment in liver and kidney enzyme in rats received diet containing 95 % or 60 % potato ships "B" may be attributed to the presence of high amount of long chain monoenoic fatty acids (oleic acid 58.5 % and erucic acid 2.1 %) and to the deficiency of essential fatty acids. Vles *et al.* (1978), reported that most enzyme of β-oxidation e.g. AST were less active in the presence of very long chain monoenoic fatty acids. Consequently, these intracellular enzymes are liberated in blood stream. Walmsley and White, (1994) reported that alkaline phosphatase occurs in many organs including intestine, bone, placenta and liver. Therefore, high increase in serum alkaline phosphatase activity are found in extrahepatic biliary obstruction.

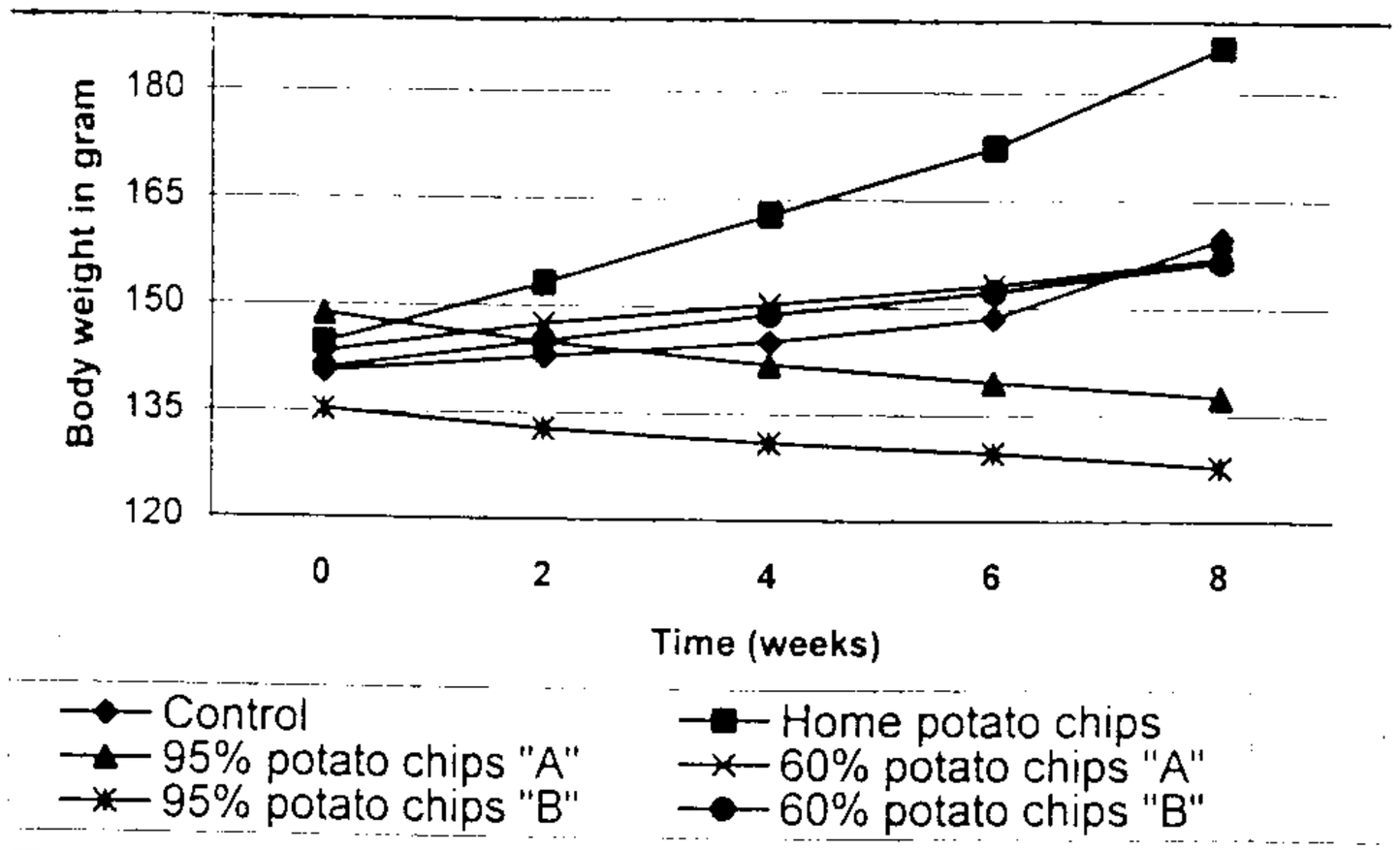


Fig (2) : Effect of dietary Potato chips on body weight of rats.

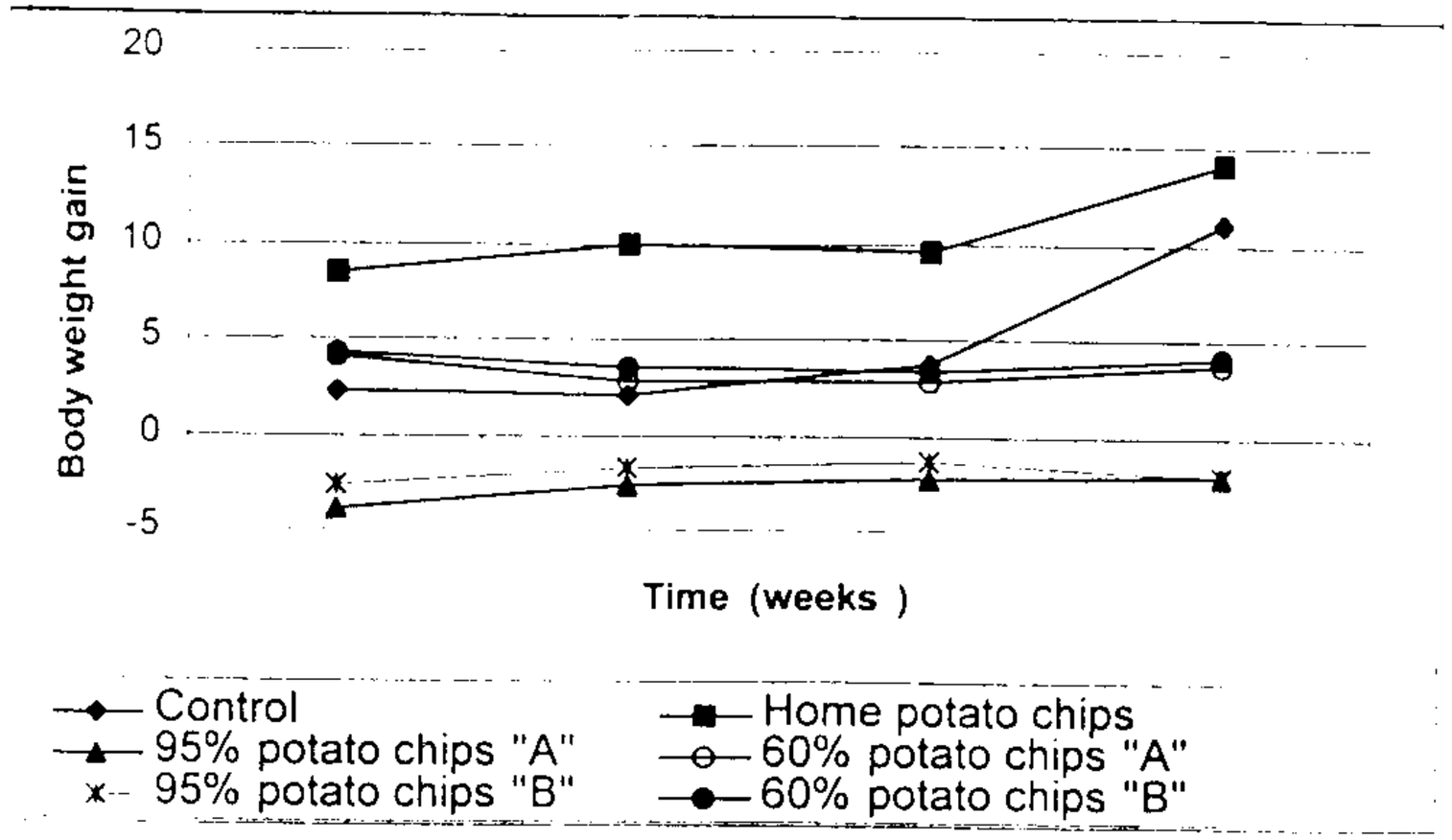


Fig (3) Effect of dietary potato chips on body weight gain of rats.

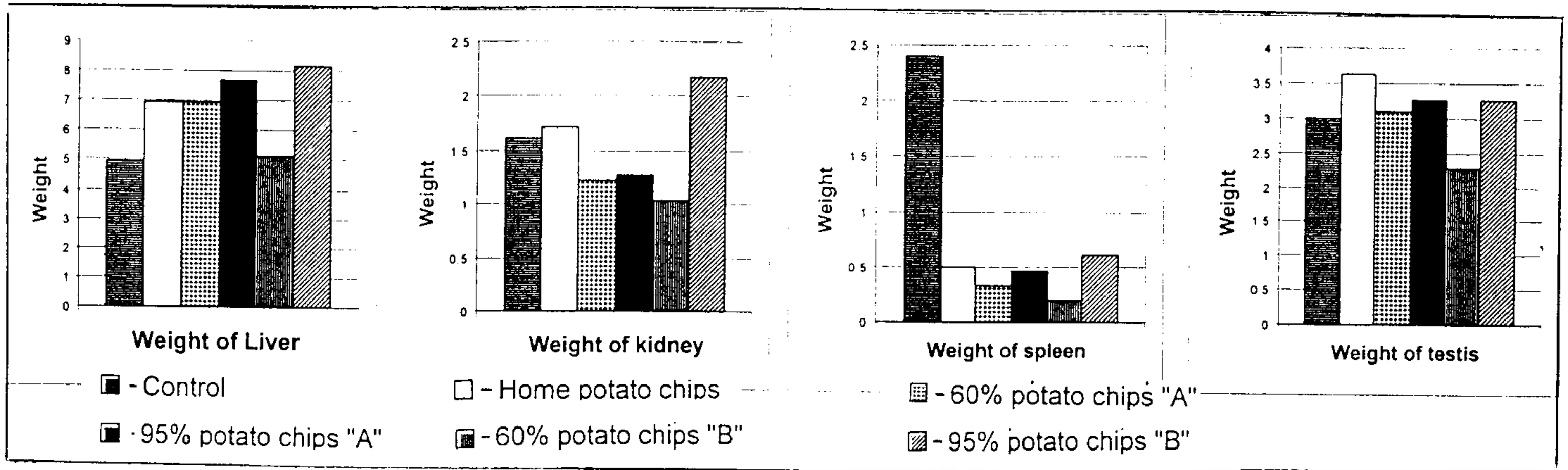


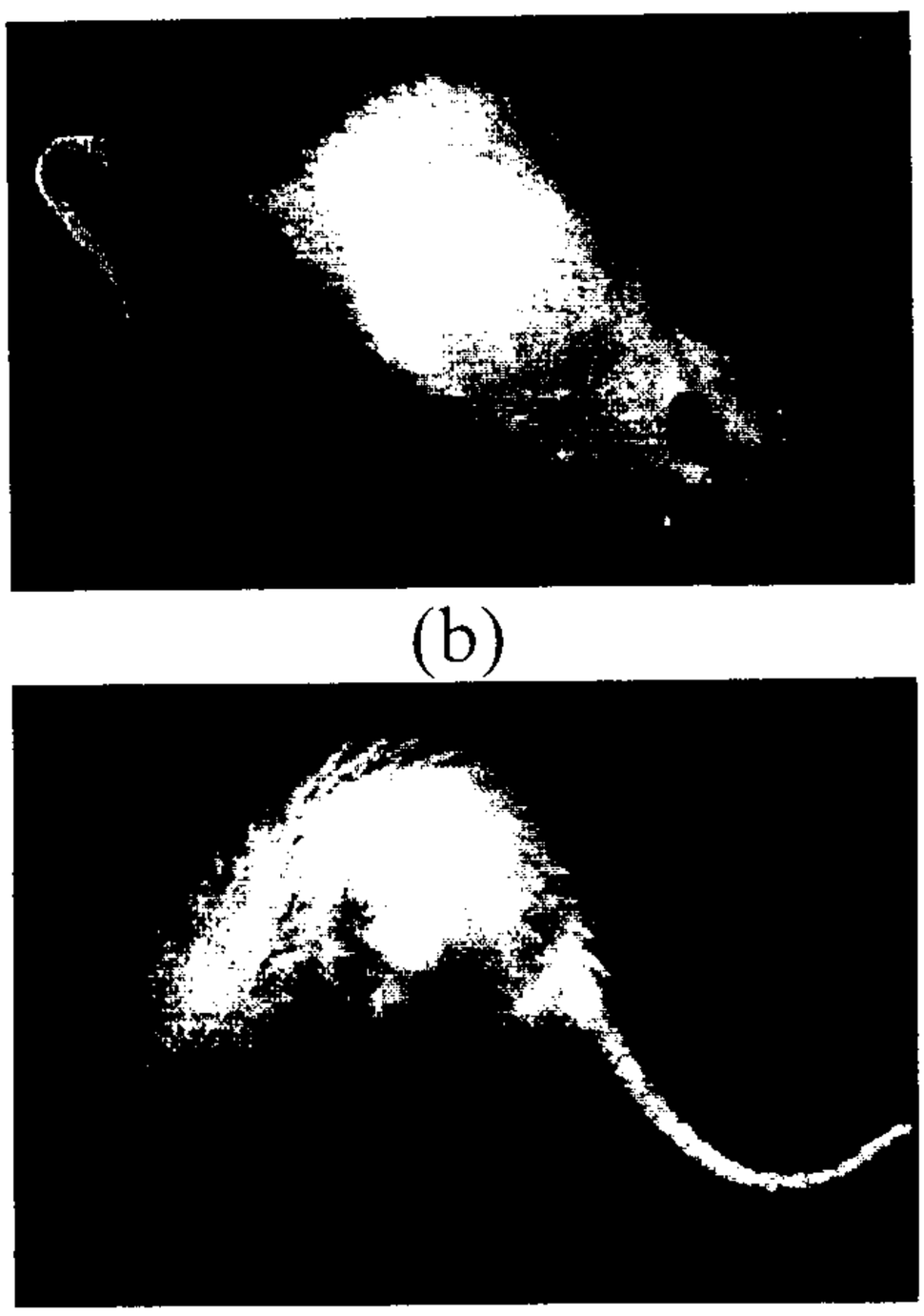
Fig (4) : Effect of dietary potato chips on weight of liver , kidney , spleen and testis of rats.

Table (4): Effect of dietary potato chips on serum lipids, liver and kidney functions.

Diet	Total lipids (mg/dl)	Total choles-terol (mg/dl)	ALT U/L	AST U/L	ALP U/L	Creatin-ine (mg/dl)	Urea (mg/dl)
Basal diet (Control)	305.1 ±18.0	86.9 ±5.11	56.2 ±6.3	126.0 ±13.1	78.1 ±6.5	0.80 ±0.1	28.6 ±1
Diet with 60 % home potato chips	314.3 ±22.4	88.21 ±4.50	58.1 ±5.5	128.2 ±12.0	80.5 ±5.1	0.96 ±0.09	30.1 ±2.2
Diet with 95% Potato chips (A)	464.0 ±23.2	146.30 ±6.3	85.3 ±5.0	186.5 ±11.2	121.2 ±8.6	1.60 ±0.08	46.9 ±2.1
Diet with 60 % potato chips (A)	480.2 ±19.5	153.33 ±4.2	87.11 ±7.1	190.3 ±13.2	119.3 ±7.1	1.70 ±0.09	54.6 ±3.1
Diet with 95 % potato chips (B)	492.0 ±28.1	158.21 ±3.5	90.82 ±5.5	197.2 ±8.0	123.9 ±10.1	1.70 ±0.06	50.4 ±6.1
Diet with 60% potato chips (B)	507.8 ±30.8	156.90 ±6.6	91.00 ±6.0	189.6 ±14.1	126.3 ±8.9	1.75 ±0.05	53.6 ±3.4
L.S.D.	23.5	12.3	11.01	15.2	5.05	0.05	3.01

Serum urea and creatinine were determined as indicators of kidney functions, since the increase in these components means that the kidney are less active or in abnormal case (Hood 1980). Mean values of serum urea and creatinine were elevated in rats feeding with 60 % or 95 % of either potato chips A or B. The significant uremia was noticed during the 8th week of treatment compared with rats received 60 % home potato chips, Table (4). The elevation of blood urea and creatinine in treated rats may be attributed to the disordered effect of any compound produced through potato chips processes which led to reduce the glomerular filtration rate of the kidney and consequently retention of urea. Elevated blood urea level may reflect an accelerated rate of protein catabolism rather than decreased urinary excretion of urea. While severe hepatic insufficiency causes decrease blood urea level, apparently because of impaired urea synthesis (Finco, 1989). Creatinine is a nitrogenous waste derived from creatine. It is removed from the circulation by filtration through the glomeruli, and a little is secreted by the tubules. Since creatinine production is endogenous, being depend on muscle mass, its level in the blood is usually independent of diet, unlike urea (Anderson and Cockayne, 1989).

The morphological features of the rats illustrates by Fig. (5) revealed that the examined potato chips (A and B) might be of undesired effect on rats growth as a final product of deterioration of their kidney and liver functions.



(b)

(a)

(d)

(c)

(f)

(e)

Fig (5) : Effect of treatments on the tested rats received:

(a) Control diet. (b) 60% home potato chips

(c) 95% potato chips "A" (d) 60% potato chips "A"

(e) 95% potato chips "B" (f) 60% potato chips "B"

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تأثير التغذية بشرائح البطاطس المقلية على الوزن الحى ووظائف الكبد والكلى فى الفئران.

أحمد على أحمد عبد الرحمن

قسم الكيمياء الزراعية ــ كلية الزراعة بمشتهر جامعة الزقازيق/فرع بنها

يهدف البحث الى عمل دراسة مقارنة من ناحية التركيب الكيميـــائى وكذلـــك تأثير التغذية بشرائح البطاطس المنتجة فى السوق المحلية على الوزن الحى وكذا علـــى درجة نشاط انزيمات الكبد والكلى فى الفئران.

ولتحقيق هذه الدراسة تم جمع عدد خمسة منتجات من شرائح البطاطس وهـى (الجوهرة – كرا نشى – شيبسى – كرسبى – ليون) وتم مقارنتها بشـــرائح البطـــاطس المجهزة منزليا ولقد أوضحت النتائج أن :

- جميع منتجات البطاطس تتقارب فى محتواها المرتفـــع مـــن الدهـــون) ٣٤,٩٦ – ٣٦,٠٨%) وكذلك فى محتواها من البروتين (٥,٩٩ – ٦,٦٨ %) والكربوهيدرات (٤١,٦٨ – ٤٢,٤٣%) والنسبه المئوية للرماد (٣،٧٧–٤،٠٠)
- ارتفاع قيمة رقم البيروكسيد فى جميع منتجات شرائح البطـــاطس (٢٦,٣٨ – ٣٧,٢ ملليمكافى/ كيلو جرام) مقارنة بشرائح البطاطس المجهزة منزليا) ٥,٩٣ ملليمكـــافى /كيلو جرام زيت(
- أوضحت الدراسة باستخدام الأشعة تحت الحمراء أن جميع زيوت شرائح البطـــلطس تحتوى على نسبة صغيرة من الأحماض الدهنية الغير مشبعة فى الصورة ترانس.
- التغذية ب ٦٠% أو ٩٥% شرائح بطاطس (من النوع أ أو النوع ب) تؤدى الـــــى انخفاض معنوى فى وزن الفئران ومعدل النمو بينما تؤدى الى زيادة معنويـــة فـــى محتوى السيرم من الليبيدات الكلية –الكوليسترول – الكريانتين – اليوريا كما تؤدى الى زيادة معنوية فى درجة نشاط انزيمات ALT, AST, ALP وذلـــك مقارنـــة بالتغذية ب ٦٠% شرائح بطاطس مجهزة منزليا أو مقارنة بالتغذية علـــــى عليقـــة خالية من شرائح البطاطس (الكونترول).