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Effect of Low Phosphorus and Potassium Diets versus Sevelamer Medication on Rats with Renal Failure: Comparative Study

Yousif Elhassaneen, Fatma El-Zahraa El-Sherif, Basma El Khateeb, Wesam Abd-El Wahab

Dept. of Nutrition and Food Sciences, Faculty of Home Economics, Menoufia University, Shibin El Kom, Egypt.

Abstract

The present study aimed to assess the effect of low phosphorus and potassium diets in comparison with sevelamer carbonate (SC) medication which does the same effect. Forty-eight male albino rats weighing 280 ± 10g were randomly classified into six groups (8 rats each) The first group served as a negative control group, fed on a basal diet only. The other five groups were fed on a basal diet containing 0.25% w/w adenine daily for 35 days to induce renal failure Then, rats reclassified into 5 groups which were positive control and treated rat groups that were sevelamer carbonate medication 1000 mg/kg/day, the rest of the three subgroups of rat fed experimental diet containing 25, 50 and 75% of their low nutritional needs of phosphorous and potassium. The treatment period is designed for twelve weeks. Results showed that feeding RF rats with 25, 50 and 75% of RPK prevent the increase in hyperphosphatemia and hyperkalemia. The results revealed that levels of fibroblast growth factor 23 enzyme, parathyroid hormone, renin enzyme and insulin intolerance were decreased compared with the negative group and RF rats treated with SC. Subsequently, improvement in the kidney functions of all treated groups were exhibited. In conclusion, feeding with 50% of RPK is effective in improving kidney functions in renal failure rats.

Keywords*: hyperphosphatemia, hyperkalemia, renin- angiotensin -aldosterone system, rats, fibroblast growth factor 23 enzyme.*

Introduction

Renal failure (RF) is a serious, universal, and popular health problem that its incidence is increasing rapidly (Akbari et al., 2016). More than one million people with RF are dying

every year (Spasovski, 2013). Elevated serum phosphate (hyperphosphatemia) and potassium (hyperkalemia) levels are the unavoidable clinical consequence of the advanced stages of RF (Kasiske et al., 2010). Hyperkalemia is associated with sudden cardiac death in hemodialysis patients and hyperphosphatemia is associated with an increase in cardiovascular events and mortality in RF patients (Pun, 2014). The management of renal failure is focused on nutrition therapy, drug, and dialysis (Goyal and Jialal, 2020). Hyperphosphatemia and hyperkalemia in RF managed using binders including aluminum-containing binders, calcium carbonate, lanthanum carbonate, carbonate, sodium polystyrene sulfonate, and sevelamer carbonate (Askar, 2015 and Kovesdy, 2017). Unfortunately, the positive effects of these drugs are counteracted by serious side effects such as the increased risk of gastrointestinal intolerance, particularly nausea, toxicity, and adynamic bone disease. Therefore, it is necessary to search for new nutritional therapy that can improve kidney functions in renal failure disease. Nutritional treatment has always represented a major feature of renal failure management. Over the decades, the use of nutritional treatment in RF patients has been marked by several goals. The first of these include the attainment of metabolic and fluid control together with the prevention and correction of signs, symptoms, and complications of advanced RF. The aim of this first stage of management the prevention of malnutrition and a delay in the commencement of dialysis. Subsequently, nutritional manipulations have also been applied in association with other therapeutic interventions in an attempt to control several cardiovascular risk factors associated with RF and to improve the patient's overall outcome. Over time and in reference to multiple aims, the modalities of nutritional treatment have been focused not only on protein intake but also on other nutrients such as phosphorus and potassium (Vincenzo et al., 2016). The strict control of serum phosphorus and potassium concentrations is important for the prevention of various complications and improving the prognosis of patients with chronic kidney disease (Barreto et al., 2019).

Dietary therapy in chronic renal failure emphasizes the goal of avoiding metabolic problems-particularly those relating to excess dietary protein and phosphorus. Lowering phosphorus and potassium to levels at the recommended level for normal adults has beneficial effects. However, the issue of what level of intake is adequate or safe has not been fully addressed (Akchuri, 2019). Also, Bellizzi et al., (2016) and Akchuri, (2019) analyzed that the impact of moderately restricted low-phosphorus potassium diets on the improved kidney function of patients with advanced RF, therefore, the standard low phosphorus and potassium diets Lowering phosphorus and potassium to levels at the recommended level for renal failure disease are suggested to control hyperphosphatemia and hyperkalemia. A simple and effective approach to reducing a load of dietary phosphorus and potassium without reducing protein and other nutrients supply consists

of reducing consumption of foods high in absorbable phosphorus and potassium (e.g., processed cheese, Potatoes, and egg yolk), to avoid foods containing additives based on polyphosphates (such as certain types of soft-drinks), and to prefer vegetable-based foods (such as chicory, chickpea, corn, olive oil, apple, and soy milk) that have lower potassium and phosphorus absorption (Cupisti and Kalantar-Zadeh, 2013). This study aimed to determine the effect of low phosphorus & potassium diets and compare their effects with SC drugs on rats with renal failure.

Materials and methods

Materials

The foods used in this study were chickpea (*Cicer arietinum L*.), soy milk (*Glycin max milk*), olive oil (*olea euro paea oil*), chicory (*Cichorium intybus L*.), apple (*malus domestica*) and maize (*Zea mays*) which were purchased from Ministry of Agriculture of Research Center, Giza, Egypt. Renagel medication (sevelamer carbonate) were purchased from El-Nasr Pharmaceutical Chemicals, Cairo, Egypt. All analyses kits were purchased from Bio diagnostic Co., Giza, Egypt. Diet materials such as casein, sucrose, cellulose, choline bitartrate, tert-butyihdroquinone, mineral mixture and vitamin mixture were purchased from Cairo lab Company. Other chemicals used throughout the experiments were obtained from El-Gomhoriya Company for Trading Drugs, Chemicals and Medical Instruments. Rats were purchased from the Animal Facility of Home Economic, Menoufia University, Egypt. feed

Methods

Preparation of food

Chickpea, chicory, apple and maize were carefully washed several times with tap water and rinsed several times with distilled water. The rinsed foods were dried at room temperature first, then dehydrated in an electric draft oven at 45±2°C for 2 hrs. The dried foods were ground in a grinder, after that these ingredients were mixed with soybean milk powder and olive oil in the shape of mixture to form a nutritional formula after estimating the chemical composition to those food then formula prepared in the shape on a mixture by mixing ingredients at following ratio: (1g olive oil: 3g chicory: 4g chickpea: 4g maize: 21g soybean and 77g apple) so as to get the same percent of P and K from them. The purpose of preparation the nutritional formula is diversification phosphorus and potassium sources and taking into account the aspect absorption.

Preparation of low phosphorus and potassium diets

The diets were prepared in such a way that they gave the rats less than phosphorus and potassium of recommended dietary intake (RDI), as the rats' need of phosphorus 3000

mg/kg and potassium 3600 mg/kg according to Reeves et al., (1993). The diets are designed to give the rats 25, 50 and 75% of their dietary requirements from phosphorus and potassium. Therefore, the chemical composition of the diets and mineral mixture have been changed and the nutritional formula has been added to obtain the requested percent from them of P and K in each diet. The experimental formula has been added to diets to be a source for a percent of the rat's dietary requirements from phosphorus and potassium nutritional formula has been added with ratio 10, 20 and 30/100g diet respectively in diets which represent 25, 50 and 75% from the recommended of rats from the phosphorus and potassium respectively. Formula was added with diets to the diversity of food sources from P and K and taking into account the aspect of nutritional absorption. Therefore, the proportions of the component of protein, fibers, fat and corn starch were modified for the diets as a result of addition the formula to keep the percent of these component constant and getting the amounts of phosphorus and potassium which researchers want in the third food diets.

Chemical analysis

Protein, fat, moisture, and ash contents were determined in chickpea, chicory, corn, soybean milk, apple, olive oil and experimental nutritional formula according to AOAC, (2010). The carbohydrate was calculated by difference. Phosphorus and potassium were analyzed using Perkin Elmer 2380, atomic absorption spectrophotometer according to the method of Fraser et al., (1986).

Experimental design

Forty-eight adult male Albino rats at (9-10) weeks age, initially weighting about (280±10 g). The work was carried out at the Animal lab Faculty of Home Economic, Menoufia University, Egypt. Rats were fed a basal diet according to AIN-93 guidelines (Reeves et al., 1993) for one week as an adaptation period. The basal diet containing phosphorus (0.3%), potassium (0.36%), calcium (0.5%), sodium (0.1%), chloride (0.15%), magnesium (0.5%), iron (0.003%), sulfur (0.3%), zinc (0.003%) crude protein (14%), fat (4%), fiber (5%), and the remained is starch (46.5%). Salt mixture and vitamins were prepared according to Reeves et al., (1993). Following an acclimatization period, rats were randomly divided into four groups. The experiment was carried out in two periods.in the first period (35 days). Except for the first group which maintained as negative control group, renal failure was induced via fed rats a diet containing adenine (0.25% w/w in feed daily for 35 days) according to Ali et al., (2015). After that blood samples taken from rats to measure serum creatinine, urea and uric acid to sure that all rats infected with chronic renal failure induced. Also, measured serum phosphorus, potassium, calcium and sodium to confirm this adenine-induced renal injury model is suitable to study hyperphosphatemia and hyperkalemia in renal failure.

In the second period (12 week) rat with renal failure were divided into three subgroups. The negative control and one RF group (positive control) were fed on basal diet. The second RF group fed on a basal diet and received a daily SC drug (1000 mg/kg/day) (Behets et al., 2005 and King et al., 2021), whereas the remaining RF group was fed on low Phosphorus and potassium diets. The rest of the three subgroups of rat fed experimental diet containing 25, 50 and 75% from their dietary requirements from phosphorus and potassium fig (1). rats were housed in an individual cage in the beginning of second period (12 weeks) to collect the urine. Ethical guidelines for the care and treatment of animals were strictly followed in accordance with the rules of the Egyptian Animal Protection. At the end of experimental period (12 weeks), rats were anesthetized with diethyl ether after fasting for 12h and blood samples were collected, then serum was separated by centrifugation. Serum was frozen and kept at−20°C for later analysis.

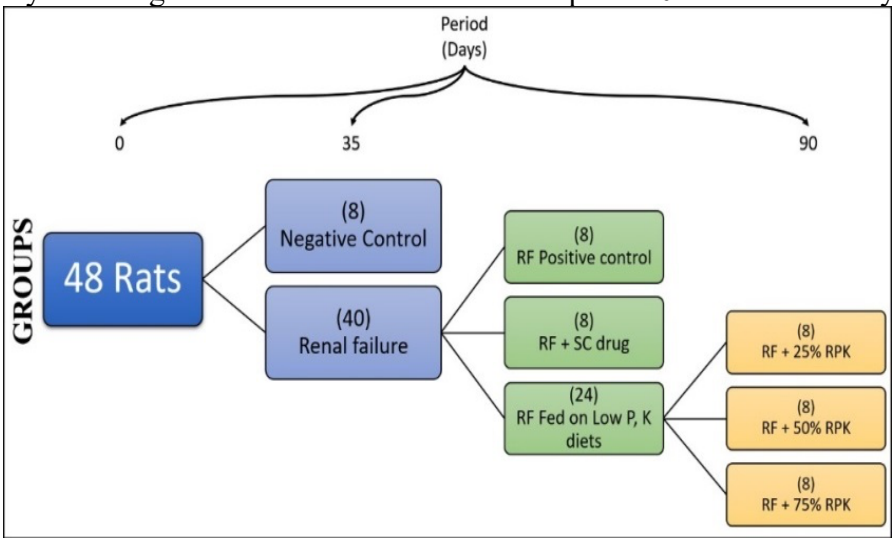

Fig (1): Experimental design of the groups.

Biochemical analysis:

Phosphorus, potassium, calcium, glucose (because of glycolysis, glucose should be determined directly after collecting blood samples) and sodium were carried out by colorimetric methods described by Kind and King (1954), Henry (1964); Lewin et al., (1969) Marks (1996) and Henry (1974) respectively. Creatinine, urea, uric acid, blood urea nitrogen and total protein were determined with kits according to Bartels and Bohmer (1971); Patton and Crouch (1977); Fossati et al., (1980); Patton and Crouch (1977) and Gomal et al., (1949) respectively. The renin enzyme, aldosterone hormone, Parathyroid hormone, 1, 25 di hydroxy vit D3, insulin hormone and fibroblast growth factor 23 enzyme levels in the plasma samples were determined using enzyme-linked

immunosorbent assay (ELISA) according to Lever et al., (1964); Cartledge and Lawson (2000); Paik et al., (2010); Wang et al., (2011); Purohit (2012) and Chathoth et al., (2016) respectively. The clearance index were determined according to Gounden and Jialal (2020).

Biological evaluation:

During the experimental period , the diet consumed was recorded daily and body weight of rats was recorded twice weekly. Biological evaluation of the different tested groups was carried by determination of feed intake (FI), body weight gain (BWG) and food efficiency ratio (FER) according to Chapman et al., (1959).

Statistical Analysis:

Results were expressed as the mean and SD. Data for multiple variable comparison were analyzed by one- way analysis of variance (ANOVA) (Steel and Torri 1980).

Results and Discussion

Phosphorous and Potassium Contents of chickpea, chicory, corn, soybean milk, apple and olive oil were shown in Table (1). From such data it could be noticed that the tasted foods have mostly low to modest contents of phosphorus and potassium. The highest content of P and K was recorded for olive oil as it contains 407.6 and 1186.7 mg/100g, respectively followed by chickpea, chicory and corn as 321.53, 51.63 and 248.07 mg/100g, respectively and 79.73, 452.53 and 123.67 mg/100g , respectively. soybean milk and apple were recorded less content levels of minerals as 6.53 and 14.27 mg/100g respectively and 6.17 and 71.43 mg/100g respectively for Phosphorous and Potassium.

Table (1): Phosphorous and Potassium Contents of Chickpea, Chicory, Corn, Soybean milk, Apple and Olive oil

Parameter	Chickpea powder	Chicory powder	Corn flour powder	Soybean milk powder	Apple powder	Olive oil	LSD
Phosphorus (mg/100g)	$321^{b}.5\pm0.8$	$51.6^{d}\pm0.3$	$248^{c}.8\pm0.67$	$6.5^{e}\pm0.05$	$6.17^{e}\pm00.03$	$407.6^{a}\pm0.5$	0.87
Potassium (mg/100g)	$79^{d}.7\pm0.6$	$452^{b}.5\pm0.4$	$123^{c}.7\pm0.55$	$14.3^{f}\pm0.47$	$71^{e}.4\pm0.57$	$1186.7^{a}\pm1$	1

values subscribed with the different letters in the same rows showed significant differences at P<0.05 as calculated by ANOVA and LSD

Chemical compositions of suggested experimental formulas were shown in Table (2). Data showed that suggested formulas provided protein (27%), fat (14%), fiber (16.67%), carbohydrates, (42.46%) moisture (11.43%), ash (5.11%), P (33 mg/100g) and K (45 mg/100g).

Table (2): Chemical compositions of experimental formula

Parameter	Nutritional experimental
Protein (g/100g)	27±0.58
Fat (g/100g)	14±0.006
Carbohydrates (g/100g)	42.46±0.58
Fiber (g/100g)	16.67±0.03
Moisture (g/100g)	11.43±0.24
Ash (g/100g)	5.11±0.01
P (mg/100g)	33±0.07
K (mg/100g)	45±0.034

values subscribed with the different letters in the same rows showed significant differences at P<0.05 as calculated by ANOVA and LSD

The effect of low phosphorus and potassium diets and SC medication on serum concentration of P, K, Ca and Na of negative and renal failure groups were shown in Table (3). It could be noticed that the levels serum of P, K and Ca in positive control group were significantly higher (P≤0.05) than corresponding values of negative control group while, sodium had the opposite direction. This data with other (Nakanishi et al., 2020) suggested that the effects of RF could be explained in the following mechanism, renal failure led to an imbalance in the hemostasis of P, K and Ca which lead to significant (P≤0.05) increase of their levels as a result of the inability of the kidneys to filter. Also, Hyperphosphatemia in RF has been associated with lower levels of blood pressure (Alonso et al., 2010). Feeding RF rats with different low percent of recommended phosphorus and potassium resulted in significantly (P ≤ 0.05) low levels of phosphorus and potassium compared with RF positive control group. This reducing in serum levels of P and K may be due to feeding rats on diets low in phosphorus and potassium which led to utilize body phosphorus and potassium stores to preserve serum osmolality. So, the case of hyperphosphatemia and hyperkalemia will be improved. Our data agreed with Akchurin (2019) who recommended that "renal" low-phosphorus formulas should be used in RF patients. Also, Clase et al., (2020) recommend limiting dietary potassium intake to prevent and treat hyperkalemia in patients with CKD. The control of serum P and K in patients with renal failure is therefore important to the prevention of increases in Ca × P product and K × Na balance (Faubert et al., 1980). Feeding rats with 50% of recommended phosphorus and potassium was more effective (P ≤ 0.05) in reducing phosphorus and potassium than rats fed with 25 and 75% of recommended phosphorus and potassium and sevelamer carbonate medication. These results are in agreement with that reported by Barreto et al., (2019) and Clegg and Gallant, (2019) who demonstrated that the recommended amount of phosphorus and potassium intake of renal failure disease are (800:1000 and 2000:3000 mg/dl) for phosphorus and potassium, respectively, which are equivalent to half required amount to normal person where the normal person needed (1000:1800 and 4700:5000 mg/day) for phosphorus and potassium, respectively. While,

feeding rats on 25 and 50% of recommended phosphorus and potassium did not significantly different (P≤0.05) in their effect on Ca level. The results in same table showed that the levels of P, K and Ca were decreased by 65. 67, 57.83 and 44.77% respectively, 47.93, 31.83 and 19.19% respectively and 5.9, 6.84 and 2.32% respectively for RF rat groups treated with 25, 50 and 75% of recommended phosphorus and potassium respectively compared with RF positive control group. On the other hand, the levels of Na were increased by 0.79, 0.39 and 0.89% respectively for RF rat groups treatment with 25, 50 and 75% respectively of recommended phosphorus and potassium compared with RF positive control group. But, feeding rats on 25, 50 and 75% of recommended phosphorus and potassium formula did not significantly differ (P ≤ 0.05) in their effect on Na level. Treating RF rats with sevelamer carbonate medication induced a significant decrease (P ≤ 0.05) in P, K and Ca contents of serum as compared to RF positive control group. This reduction in the level of P, K and Ca in serum may be due to treated with SC medication contents bind to dietary phosphate resulting in insoluble sevelamer -phosphate complexes and decrease in serum phosphate levels and induced hyperkalemia in hemodialysis patients were corrected (Sonikian et al., 2006). As shown the level of P, K and Ca in serum were significantly decreased by 44.40, 9.77 and 9.17% respectively for RF rats' groups treated with SC medication, while the level of Na increased by 1.41% compared with RF positive control group.

Table (3): Effect of low phosphorus & potassium diets and SC medication on serum Phosphorus, Potassium, Calcium and Sodium of experimental rat groups.

Minerals	Negative Control	Renal failure groups					LSD
		RF positive Control	RF+SC medication	RF+25% RPK	RF+50% RPK	RF+75% RPK	
Phosphorus (mg/dl)	5.17^{c}±0.15	13.4^{a}±0.4	7.5^{b}±0.05	4.6^{d}±0.1	5.7^{c}±0.5	7.4^{b}±^{0}.26	00.55
Potassium (mg/dl)	5.35^{d}±0.22	8.7^{a}±0.1	7.9^{b}±0.09	4.53^{e}±0.75	5.9^{d}.±0.5	7.0^{c}±0.05	0.8
Calcium (mg/dl)	11.32^{e}±.43	14.6^{a}±0.1	13.3^{d}±0.05	13.73^{c}±.05	13.6^{c}±0.0	14.3^{b}±.05	0.36
Sodium (mg/dl)	144.4^{a}±0.45	141.5^{d}±0.5	143.5^{b}±0.5	142.6^{c}±0.4	142.2^{cd}±0.1	142.8^{c}±0.1	0.56

Values are expressed as means± SD. Means in the same row with different superscript letters are significantly different (P ≤0.05). RF: Renal failure, SC: Sevelamer carbonate, RP K: Recommended phosphorus and potassium.

The same trend was observed by Savica et al., (2008) who reported that Sevelamer was prescribed in chronic kidney disease (CKD) patients to control hyperphosphatemia. Also, King et al., (2021) reported that sevelamer medication can reduce the serum phosphorus level and has a lower risk of vascular calcification and hypercalcemia in CKD rats. In the same table, there were no significant difference (P≤0.05) in serum p and K between RF group treated with 50% of recommended phosphorus and potassium and control negative group. Also, there were no significant difference (P≤0.05) in serum phosphorus between

RF group treated with SC drug and RF group treated with 75% of recommended phosphorus and potassium.

Effect of low phosphorus and potassium diets and SC medication on serum concentration of fibroblast growth factor 23 enzyme (FGF23), parathyroid hormone (PTH) and 1,25-hydroxyvitamin D3 (vit. 1,25 (OH)2 D3) of negative and renal failure groups are shown in Table (4). Positive control had significantly (P≤0.05) higher levels of FGF23 and PTH compared with negative group, renal failure groups treated with 25, 50 and 75% of recommended phosphorus & potassium, and SC drug. While Vitamin 1,25(OH)2 D3 sowed the opposite direction. Such results were in agreement with those reported by Bhan et al., (2006) and Torres et al., (2008) who found that RF induced a significant increase (P≤0.05) in FGF23 and PTH content of serum as compared to the control negative group while, RF led to a significant decrease in vitamin 1,25(OH)2 D3 in the serum. Feeding RF rats with different low percentage of recommended phosphorus and potassium resulted in significant (P≤0.05) reduced levels of FGF23 and PTH, while increased the level of vitamin 1,25 (OH)2 D3 compared with RF positive control group. The FGF23 and PTH were significantly (P≤0.05) decreased by 6.17, 42.07 and 51.53% respectively and 59.79, 48.46 and 48.30% respectively for RF rat groups treatment with 25, 50 and 75% respectively of recommended phosphorus and potassium. On the other hand, vitamin 1,25(OH)2 D3 was significantly (P≤0.05) increased by 53.21, 88.51 and 91.69% respectively for RF rat groups treated with 25, 50 and 75% of recommended phosphorus and potassium, respectively. These results were in agreement with that obtained by Ferrari et al., (2005) who reported that Serum FGF-23 and PTH levels significantly decreased while, 1,25(OH)2 D3 levels significantly increased among human on the low-phosphate diet. Treating RF rats with SC medication induced a significant (P≤0.05) decrease in FGF23 and PTH contents of serum while, Vitamin 1,25(OH)2 D3 increased as compared to RF control group. The FGF23 and PTH were significantly (P≤0.05) decreased by 51.27 and 53.94% for RF rats treated with SC medication, respectively. While the Vitamin 1,25(OH)2 D3 was significantly (P≤0.05) increased by 48.38% for RF rats treated with SC as compared with RF positive control group. These results were in agreement with those reported by Oliveira et al., (2010) who found that level of FGF-23 and PTH decreased significantly (P≤0.05) following SC treatment. While Keung and Perwad, (2018) reported that treatment RF rats with SC induced a significant (P≤0.05) increase in vitamin 1,25(OH)2 D3 contents of serum as compared to RF. In the same table, there were no significant (P≤0.05) difference in serum FGF23 between RF group treated with 50% of recommended phosphorus and potassium and RF rats treated with SC drug. Also, feeding rats on 25 and 50% of recommended phosphorus and potassium did not significantly (P≤0.05) differ in their effects on PTH level. The highest improvement of FGF23, was observed in RF group feeding with 75% of recommended phosphorus and

potassium and RF rats treated with SC. While the highest improvement of PTH was observed in RF group feeding with 25% of recommended phosphorus and potassium. However, the highest improvement of vitamin 1,25(OH)2 D3 was observed in RF groups feeding with 75% of recommended phosphorus and potassium.

Table (4): Effect of low phosphorus & potassium diets and SC medication on serum FGF23, PTH and Vit. 1,25(OH)2 D3 of experimental rat groups

Parameters	Negative Control	Renal failure groups					LSD
		RF positive Control	RF +SC medication	RF +25% RPK	RF +50% RPK	RF +75% RPK	
FGF_{23} (pg./ml)	93^{e} ±0.49	205.11^{a} ±0.34	99.93^{d} ±0.43	192.45^{b} ±0.40	118.8^{c} ±0.26	99.4^{d} ±0.43	0.71
PTH (pg./ml)	32.36^{e} ±0.32	98^{a} ±0.2	45.13^{c} ±0.15	39.4^{d} ±0.36	50.5^{b} ±0.2	50.66^{b} ±0.15	0.47
Vit. 1,25 $(OH)_2$ D_3 (ng/mL)	65.93^{a} ±0.15	30.48^{f} ±0.5	56.2^{d} ±0.0	46.7^{e} ±0.26	57.46^{c} ±0.46	58.43^{b} ±0.43	0.62

Values are expressed as means± SD. Means in the same row with different superscript letters are significantly different (P ≤0.05).). RF: Renal failure, SC: Sevelamer carbonate, RPK: Recommended phosphorus & potassium, FGF23: Fibroblast growth factor 23 enzyme, PTH: Parathyroid hormone and Vit. 1,25(OH)2 D3 :1,25-hydroxyvitamin D.

The effect of low phosphorus & potassium diets, and SC medication on serum concentration of renin enzyme, aldosterone hormone, insulin hormone and glucose of experimental rats were shown in Table (5). Results showed that positive control group had significantly (P≤0.05) low levels of aldosterone hormone and insulin hormone compared with negative group, renal failure groups treated with 25, 50 and 75% of recommended phosphorus & potassium, and SC drug. The renin enzyme and glucose had opposite direction among human. Data also showed that the aldosterone hormone was decreased from 92.43±0.40 pg/ml in control negative group to 35.13±0.32 pg/ml in control positive group. These results were in agreement with that reported by Rajkumar and Waseem, (2020) who found that hyperkalemia in renal failure induced a significant (P≤0.05) decrease in aldosterone hormone concentration. Hypoaldosteronism should be considered in any patient with persistent hyperkalemia such as renal failure. Hypoinsulinemia may lead to lower levels of aldosterone as mentioned by (Petrasek et al., 1992). Also, (Catena et al., 2006) found that in hypoaldosteronism high plasma renin activity and angiotensin II levels were reported while, the renin enzyme was increased from 1±0.02 pg/ml in control negative group to 6.56±0.46 pg/ml in control positive group. These results were in agreement with that reported by Hanner et al., (2008) who found that RF led to a significant increase in renin enzyme in the serum as compared control negative group. Moreover, the insulin hormone was decreased from 2.58±0.07 µU/ml in control negative group to 0.226 ±0.005 µU/ml in control positive group. On the other hand, the glucose was increased from 90.58±0.10 g/dl in control negative group to 392.7±0.26g/dl in control positive group. In similar study our results were in agreement

with that reported by Ahmed and Weisberg (2001) who found that hyperkalemia in renal failure induced a significant decrease (P≤0.05) in insulin hormone content of serum and RF led to insulin resistance which is a complication of advanced chronic kidney failure (CKF). Also, Pham et al., (2012) found that insulin resistance is less well characterized in earlier stages of CKD. The response of the pancreatic β cell effects on glucose tolerance, and risk of diabetes. Feeding RF rats with different low percent of recommended phosphorus and potassium resulted in significant (P≤0.05) increases in the level of aldosterone and insulin hormones compared with RF control positive group. The aldosterone and insulin hormones were significantly (P≤0.05) increased by 105.60, 107.40 and respectively 107.51 and 143.36, 417.69 and 329.20% respectively for RF rats treated with 25, 50 and 75% of recommended phosphorus and potassium, respectively. While no significant difference was observed in the level of serum aldosterone hormone between RF group treatment with 50 and 75% of RPK. On the other hand, feeding RF rats with different low percent of recommended phosphorus and potassium resulted in significant(P≤0.05) decreased levels of renin enzyme and glucose compared with RF control group, as shown that, the renin enzyme and glucose were significantly (P≤0.05) decreased by 62.80, 61.43 and 61.28 respectively and 4.48, 17.91 and 4.32% respectively for RF rats treated with 25, 50 and 75% of recommended phosphorus and potassium respectively. Treating RF rats with SC medication induced a significant (P≤0.05) increase in aldosterone and insulin hormones contents of serum as compared to positive control group. The aldosterone and insulin hormones were significantly increased by 89.09 and 23.89% respectively for RF rat treated with SC. But there was no significant difference in insulin hormone between positive control group and RF group treatment with SC. While, treated RF rats with SC medication induced a significant (P≤0.05) decrease in concentration of renin enzyme and glucose contents of serum as compared to RF. The renin enzyme and glucose were significantly (P≤0.05) increased by 66.61 and 4.43%, respectively for RF rats treated with SC medication as compared with RF control group. These improvements in results may be due to the presence of low amount of potassium in diets and administration of SC medication. But there was no significant difference in concentration of insulin hormone between RF positive control group and RF group treated with SC drug. These results had the same trend of Low and Tomalia (2015) and El-Haddad et al., (2015) results who found that hyperkalemia in CKD can be treated with low potassium ingestion and drugs that eliminate potassium such as diuretics and low potassium diet. Therefore, the level of aldosterone hormone, renin enzyme, insulin hormone and glucose improved as compared negative group. Feeding rats with 50% of recommended phosphorus potassium was more effective in improvement aldosterone hormone, glucose and insulin hormone than rats fed with 25 and 50% of recommended phosphorus & potassium and SC drug. Also, feeding rats with 75% of RPK was more

effective in improvement aldosterone hormone. While, feeding rats on 25, 50 and 75% of RPK did not significantly differ in their effect on Renin enzyme level.

Table (5): Effect of low phosphorus & potassium diets and SC medication on serum Renin enzyme, aldosterone hormone, insulin hormone and glucose of experimental rat groups

Parameters	Negative Control	Renal failure groups					LSD
		RF positive Control	RF+SC medication	RF+25% RPK	RF+50% RPK	RF+75% RPK	
Renin (pg/ml)	1^{c}± 0.02	6.56^{a} ±0.46	2.19^{b} ±0.04	2.44^{b} ±0.04	2.53^{b} ±0.05	2.54^{b} ±0.011	0.38
Aldosterone (pg/mL)	92.43^{a} ±0.40	35.13^{e} ±0.32	66.43^{a} ±0.25	72.23^{c} ±0.25	72.86^{o} ±0.05	72.9^{o} ±0.1	0.47
Insulin (µU/ml)	2.58^{a} ±0.07	0.226^{e} ±0.005	0.28^{e} ±0.005	0.55^{d} ±0.017	1.17^{b} ±0.01	0.97^{c} ±0.01	0.06
Serum glucose (g/dl)	90.58^{f} ±0.10	392.7^{a} ±0.26	375.3^{d} ±0.26	375.1^{c} ±0.26	322.33^{e} ±0.15	375.7^{b} ±0.26	0.44

Values are expressed as means± SD. Means in the same row with different superscript letters are significantly different (P ≤0.05). RF: Renal failure, SC: Sevelamer carbonate, RPK: Recommended phosphorus & potassium

The results presented in Table (6) referred to the effect of low phosphorus & potassium diets and SC medication on serum concentration of creatinine, urea, blood urea nitrogen, uric acid and total protein of the experimental rats. RF rats had significant (P≤0.05) increased levels of creatinine, urea and blood urea nitrogen compared with negative group, renal failure groups treatment with 25, 50 and 75% of recommended phosphorus & potassium and SC medication. While uric acid and protein had recorded the opposite direction. It is worth to mention that the serum creatinine (Cr), urea (U) and blood urea nitrogen (BUN) which were 0.86±0.055, 22.93±0.40 and 48.1±0.36 mg/dl, respectively in normal rats which were markedly increased at level 2.005±0.065, 101.31±0.57 and 112.7±0.2 mg/dl respectively in RF rats. It is well known that the elevated Cr, U and BUN are considered as an indicator for a defect in renal nephrons.

Overall the current results were supported those data. For example, Pandya et al., (2016) denoted that in renal disease the Cr, U and BUN increased. Such increasing in Cr, U and BUN above the normal level may reflect a destroy of 50% of renal nephron. In addition, Van der Slikke et al., (2020) found that the urea-to-creatinine ratio may predict the course of AKI and CKD. While the serum uric acid (UA) and total protein (TP) which were (4.46±0.20 and 9.43±0.15 mg/dl) respectively in normal rats were markedly decreased at level (2.56±0.14 and 7.1±0.5 mg/dl) successively in RF rats. These results had the same trend of Wiedermann et al., (2017) who showed that Hypoalbuminemia is common in patients with renal disease. Moreover, Park and Lee (2020) reported an association between hypouricemia and CKD. RF rats had significant increased (P≤0.05) levels of Cr, U and BUN compared with control negative group and renal failure treatment group

while, uric acid and protein had the opposite direction. Feeding RF rats with different low percent of recommended phosphorus and potassium resulted in significantly ($P \leq 0.05$) decreased levels of Cr, U and BUN compared with the RF control group. While, the level of UA and TP had the opposite direction. The Cr and U were significantly decreased by 48.97 and 34.16 and 19.32 and 19.75% for RF rat's treatment with 50 and 75% of recommended phosphorus and potassium respectively. While there were no significant difference ($P>0.05$) in Cr and U between positive RF positive group and RF group treatment with and 75% of recommended phosphorus and potassium. The BUN was significantly decreased by 32.95, 49.01 and 48.01% for the RF rat's treatment with 25, 50 and 75% of recommended phosphorus and potassium, respectively. When taking about UA and TP parameters we found that UA and TP were significantly increased by 40.62, 40.62 and 40.62% and 22.53, 31.40 and 15.91% for RF rat's treatment with 25, 50 and 75% of recommended phosphorus and potassium, respectively. These results had the same trend of Cases et al., (2019) who found that low phosphorus and potassium diets led to decrease in Cr, U and BUN while, increase in uric acid and protein. Treating RF rats with SC induced a significant ($P \leq 0.05$) decrease in Cr, U and BUN contents of serum as compared to RF control group. The Cr, U and BUN were significantly decreased by 41.64, 36.33 and 37.50% for RF rat's treatment with SC medication, respectively. These results had the same trend of Nagano et al., (2003) who showed that treatment with SC induced significant decreases ($P \leq 0.05$) in creatinine, urea, blood urea nitrogen contents of serum as compared to RF. While, treating RF rats with sevelamer medication were induced significant increases ($P \leq 0.05$) in contents of serum as compared to RF control group. The UA was significantly increased by 40.62% for RF rat's treatment with SC drug respectively. While there were no significant difference ($P \leq 0.05$) in TP between RF group treatment with sevelamer and RF positive group. These results are in agreement with that reported by Ohno et al., (2009) who found that sevelamer is capable of improvement serum uric acid levels. Also, no significant difference was in TP between RF group treatment with 25 and 75% of recommended phosphorus and potassium. There were no significant difference in U and BUN between RF group treated with 50 and 75% of recommended phosphorus and potassium. Furthermore, there were no significant difference in U between negative control and RF group treatment with 50% of recommended phosphorus and potassium. The highest improvement of Cr and BUN were observed in RF group treatment with 50 and 75% of recommended phosphorus and potassium while the highest improvement of U was observed in RF group treatment with sevelamer drug. Also, there were no significant difference in UA between RF group treatment with sevelamer and RF group treatment with 25, 50 and 75% of recommended phosphorus and potassium.

Table (6): Effect of low phosphorus & potassium diets and SC medication on serum creatinine, urea, blood urea nitrogen, uric acid and total protein of experimental rat groups

Parameter	Negative Control	Renal failure groups					LSD
		RF positive Control	RF+SC medication	RF+25% RPK	RF+50% RP K	RF+75% RPK	
Creatinine (mg/dl)	0.86^{c} ±0.055	2.005^{a} ±0.065	1.17^{b} ±0.06	1.79^{a} ±0.06	1.023^{bc} ±0.15	1.32^{b} ±0.27	0.27
Urea (mg/dl)	22.93^{d} ±0.40	101.31^{a} ±0.57	64.5^{c} ±0.5	101.33^{a} ±0.25	81.73^{b} ±0.025	81.3^{b} ±0.51	0.77
Blood urea nitrogen (mg/dl)	48.1^{e} ±0.36	112.7^{a} ±0.2	70.43^{c} ±0.40	75.56^{b} ±0.40	57.46^{d} ±0.45	57.5^{d} ±0.1	0.60
Uric acid (mg/dl)	4.46^{a} ±0.20	2.56^{c} ±0.14	3.6^{b} ±0.40	3.6^{b} ±0.1	3.6^{b} ±0.2	3.6^{b} ±0.0	0.27
Total protein (mg/dl)	9.43^{a} ±0.15	7.1^{c} ±0.5	6.9^{c} ±0.1	8.7^{b} ±0.26	9.33^{a} ±0.35	8.23^{b} ±0.15	0.56

Values are expressed as means± SD. Means in the same row with different superscript letters are significantly different (P ≤0.05). RF: Renal failure, SC: sevelamer carbonate, RPK: Recommended phosphorus & potassium.

Effect of low phosphorus & potassium diets and SC drug on urinary excretion of creatinine (UCr), urea (UU), urea nitrogen (UUN), uric acid (UUA) and total protein (UTP) in urine of experimental rats are shown in table (7). RF positive group had significant decreased ($P \leq 0.05$) levels of creatinine, urea and urea nitrogen compared with negative control group and RF treated group while, uric acid and total protein had opposite trend. The obtained results showed that the UCr, UU and UUN per day were dramatically decreased for control positive group to levels (0.77±0.05, 134.9±0.05 and 3.6 ±0.1 mg/dl) respectively compared to that of the normal rats being (1.15±0.05, 151.36±0.47 and 9.83±0.20 mg/dl) regularly. These results had the same trend of Di Micco et al., (2013) who showed that in persons with CKD stages 3 and 4, urine creatinine declines at a rate of 16 mg/d per year, lower urine creatinine excretion predicts greater risk of kidney failure and patient mortality. Also, Tyagi and Aeddula (2020) mentioned that a decreased excretion of urea and urea nitrogen in urine is observed in impaired glomerular filtration of blood Plasma (this state is called azotemia). While the UUA and UTP per day were dramatically increased for control positive rats to levels (10.4±0.45 and 1.13±0.05 mg/dl) respectively compared to that of the normal rats being (4.48±0.41 and 0.41±0.02 mg/dl). These changes between normal and induced rats reflect the inverse correlation between serum and urine in these profiles. Julian et al., (2010) Proteinuria is a frequent manifestation in afflicted patients, but the origin of the proteins with renal diseases. Feeding RF rats with different low percent of recommended phosphorus potassium resulted in significantly ($P>0.05$) increased The level of UCr, UU and UUN compared with RF positive control group. The UCr and UUN were significantly decreased by 20.77, 25.97 and 23.89 and 10, 59.16 and 54.16% for RF rats fed with 25, 50 and 75% of recommended phosphorus & potassium respectively. Also, The UU was

significantly increased by 0.7 and 6.17% for RF rats fed with 50 and 75% of recommended phosphorus & potassium respectively. While the reduction in UU was non-significant in RF group treatment with 25% of recommended phosphorus & potassium when compared with control positive group.

On the other hand, feeding RF rats with different low percent of recommended phosphorus potassium resulted in significantly ($P \leq 0.05$) decreased the level of UUA and UTP compared with RF control group. The UUA and UTP were significantly decreased by 17.30, 52.78 and 11.92 and 46.01, 47.78 and 44.24 % for RF rats fed with 25, 50 and 75% of recommended phosphorus & potassium respectively. Treated RF rats with SC medication induced a significant increase ($P>0.05$) in creatinine, urea, urea nitrogen contents of urine while, uric acid and total protein decrease as compared to positive control group. The UCr, UU and UUN were significantly decreased by 12.98, 11.04 and 5.55% for RF rat's treatment with SC medication respectively. The UUA and UTP were significantly decreased by 39.80 and 38.05% for RF rat's treatment with SC medication respectively. In the same table the results showed no change in urine protein levels were observed in RF group fed with 25, 50 and 75% of recommended phosphorus& potassium. Also, there were no significant difference ($P>0.05$) in UCr and UUA between RF groups fed with 25 and 75% of recommended phosphorus & potassium Moreover, there were no significant difference ($P>0.05$) in UUA between RF positive group and RF group fed with 50% of recommended phosphorus & potassium.

Table (7): Effect of low phosphorus& potassium diets and SC medication on urinary excretion of creatinine, urea, urea nitrogen, uric acid and total protein of experimental rat groups

Parameter	Negative Control	Renal failure groups					LSD
		RF positive Control	RF+SC medication	RF +25% RPK	RF +50% RPK	RF +75% RP K	
UCr (mg/24hrs)	$3.92^{a} \pm .06$	$0.144^{a} \pm .005$	$0.87^{c} \pm 0.005$	$.926^{b} \pm .005$	$0.97^{b} \pm 0.005$	$0.943^{b} \pm .0026$	.047
UU (mg/24hrs)	$260.49^{a} \pm .49$	$50.51^{e} \pm .49$	$143.1^{b} \pm .1$	$135^{a} \pm 0$	$135.95^{c} \pm .051$	$143.3^{b} \pm .26$	0.54
UUN (mg/24hrs)	$9.83^{a} \pm .20$	$3.6^{a} \pm .1$	$3.8^{ca} \pm 0.2$	$3.96^{c} \pm .05$	$5.73^{b} \pm 0.15$	$5.55^{b} \pm .13$	0.26
UUA (mg/24hrs)	$4.48^{a} \pm 0.41$	$10.4^{a} \pm .45$	$6.26^{c} \pm 0.25$	$8.6^{b} \pm .36$	$4.91^{a} \pm 0.41$	$9.16^{b} \pm .51$	0.73
UTP (mg/24hrs)	$0.41^{a} \pm .02$	$1.13^{a} \pm 0.05$	$0.7^{b} \pm 0.01$	$.61^{c} \pm .41$	$0.59^{c} \pm 0$	$0.63^{c} \pm .02$	0.05

Values are expressed as means± SD; means in the same raw with different letter are significantly different ($P < 0.05$). RF: Renal failure, SC: sevelamer carbonate, RPK: Recommended phosphorus & potassium, UCr: urine creatinine, UU: urine urea, UUN: urine urea nitrogen, UUA: urine uric acid, UTP: urine total protein.

The data presented in table (8) illuminate the clearance index (creatinine clearance or glomerular filtration rate, urea clearance and uric acid clearance) for negative and renal failure groups.

It is important to notice that the creatinine clearance (CrC) or glomerular filtration rate (GFR) was dramatically decreased form (0.0116±0.0005 ml/min) in normal rats to (0.00121±0.0001 ml/min) in infected rats. These data denoted the deterioration in kidney function where it is well known that low level of clearance related to impaired renal functions as imported by Deska Pagana and Pagana, (2002). In addition to Gowda et al., (2010) who mentioned that the glomerular filtration rate (GFR) describes the flow rate of filtered fluid through the kidneys, the biochemical marker creatinine found in serum and urine is commonly used in the estimation of GFR, creatinine clearance (CrCl) is the volume of blood plasma cleared of creatinine per unit time. It is a rapid and cost-effective method for the measurement of renal function. Both CrCl and GFR can be measured using the comparative values of creatinine in blood and urine. Finally, Gounden et al., (2020) indicated that creatinine clearance will have fallen to about half before a rise in blood of creatinine is detectable, eGFR (clearance tests) equations are used to determine the presence of renal disease, stage of CKD, and to monitor response to treatment.

While there were no significant difference (P>0.05) in urea clearance (UC) between renal failure rats and normal rats. These results had the same trend of Deska Pagana and Pagana, (2002) who showed that urea clearance is a poor indicator of glomerular filtration rate as its overproduction rate depends on several non-renal factors, including diet and urea cycle enzymes. On the other hand, uric acid clearance (UAC) was dramatically increased form (0.003±0.0001 ml/min) in normal rats to (0.07±0.0005 ml/min) in infected rats. These results are agreement with those reported by Park and Lee, (2020) who found that reports have indicated an association between hypouricemia and CKD, so renal failure induced a significant (P>0.05) increase in UAC.

Feeding RF rats with different low percent of recommended phosphorus& potassium resulted in significantly (P > 0.05) increased the level of CrC while, UAC decreased compared with RF positive control group. By focusing on the results which were due to the consumption of low phosphorus & potassium diets, it could be observed a significant increase (P>0.05) in CrC reaching (0.006±0.0005, 0.0132±0.0001 and 0.0120±0.0005 ml/min respectively) in RF rat groups treatment with 25, 50 and 75% of recommended phosphorus & potassium respectively from (0.00121±0.0001 ml/min successively) in RF positive control group. While UAC was 0.003±0.0001 in normal rats and increased (0.07±0.0005) in RF positive control group.

Treated RF rats with sevelamer carbonate medication induced a significant increase (P>0.05) in CrC while, UAC decreased as compared to RF control group. CrC levels was significantly higher in RF rats treated with SC medication (0130 ± .0005 vs. .00121 ±

.0001ml/min, p>0.05) than in RF positive control group. These results are agreement with those reported by Cozzolino et al., (2003) who found that treated RF rats with SC medication induced a significant increase (P>0.05) in creatinine clearance as compared to RF rats. While UAC level were significantly lower in RF rat's treatment with SC medication (.03 ±.001 vs. .07 ±.0005 ml/min, p < 0.05) than in RF positive control group. On the other hand, Feeding RF rats with different low percent of recommended phosphorus & potassium and SC drug did not significantly differ (p>0.05) in their effect on UC. In the same table, there were no significant difference (P<0.05) in CrC between RF group treated with 50% of recommended phosphorus & potassium and positive control group treated with drug. The highest improvement of clearance index (creatinine clearance or glomerular filtration rate) was observed in RF group treatment with 50% of recommended phosphorus & potassium.

Table (8): Effect of low phosphorus& potassium diets and SC medication on creatinine clearance, urea clearance and uric acid clearance of experimental rat groups

Parameter	Negative Control	Renal failure groups					LSD
		RF positive Control	RF +SC medication	RF +25% RPK	RF +50% RPK	RF +75% RPK	
CrC (ml/min)	0.0116^{a}±0.0005	0.00121^{e}±0.0001	0.0130^{b}±0.0005	0.006^{d}±0.0005	0.0132^{b}±0.0001	0.0120^{c}±00.0005	0.0004
UC (ml/min)	0.040^{a}±0.002	0.0087^{a}±.0	0.152^{a}±0.19	0.015^{a}±0.00005	0.022^{a}±0.001	0.029^{a}±0.0003	0.14
UAC (ml/min)	0.003^{f}±0.001	0.07^{a}±0.0005	0.03^{c}±0.001	0.026^{d}±0.005	0.018^{e}±0.001	0.042^{b}±0.0005	0.001

Values are expressed as means± SD; means in the same raw with different letter are significantly different (P < 0.05). RF: Renal failure, SC: sevelamer carbonate, RPK: Recommended phosphorus & potassium CrC: creatinine clearance, UC: urea clearance and UAC: uric acid clearance

Effect of low phosphorus potassium diets and sevelamer carbonate (SC) medication on body weight gain (BWG), food intake (FI/day) and food efficiency ratio (FER) for control negative and renal failure (RF) groups are showed in table (9). Data showed that the BWG, FI and FER in positive control group were lower (P≤0.05) than negative control group. These results were in agreement with those reported by Al Suleimani et al., (2017) who found that found that renal failure in rats induced a significant decrease (P ≤ 0.05) in BWG, FI and FER as compared to the RF positive group. Feeding RF rats with different low percent of recommended phosphorus & potassium resulted in significantly (P > 0.05) increase the BWG% and FER compared with RF positive control group. The obtained results showed that BWG, FI/day and FER were dramatically increased significantly (P>0.05) for RF groups fed with 25, 50 and 75% of recommended phosphorus & potassium to level of (0.088 ±0.002 g, 19.13 ±.23 g/day and 0.004 ±0% respectively, 0.054 ±0.01 g, 23.1 ±0.17 g/day and0.023 ±0.0001% respectively and0.374 ±0.003 g,

21.56 ±0.40 g/day and0.016 ±0.0002% respectively) surpassing the level recorded for RF positive control group (-0.314±0.012g, 18.43±0.37 g/day and - 0.01±0.0001% respectively). This finding were in agree with Jason et al., (1997) who found that feeding graded doses of soybean meal, corn meal chicory meal and chickpea meal in which are available in low phosphorus and potassium diets resulted in linear (P>0.05) increases in weight gain. Also, Aziz, (2009) added that Soybean seeds treatment alone resulted in an improvement of body weight. Treated RF rats with SC drug induced a significant increase (P > 0.05) in BWG, FI and FER as compared to RF control positive group. These results were in agreement with those reported by Törmänen et al., (2014) who found that BWG, FI and FER in renal failure rats increased significantly (P>0.05) following SC treatment. Feeding rats with 50 % of recommended phosphorus & potassium was more effective (P > 0.05) in increase BWG, FI and FER than rats treated with 25 and 75% of recommended phosphorus & potassium, sevelamer carbonate medication and positive control group. On the other hand, there were no significant difference was observed in BWG between rats fed with 25% of recommended phosphorus & potassium, sevelamer carbonate medication. While, feeding rats on 50% of recommended phosphorus and potassium and negative control group did not significantly different (P≤0.05) in their effect on FER .

Table (9): Effect of Effect of low phosphorus potassium diets and SC medication on BWG, FI and FER of experimental rat groups

Parameter	Negative Control	Renal failure groups					LSD
		RF positive Control	RF +SC medication	RF +25% RPK	RF +50% RPK	RF +75% RPK	
Body weight gain (g)	0.582a±0.019	-0.314e± 0.012	0.095d±0.004	0.088d±0.002	0.054b±0.01	0.374c±0.003	0.018
Feed intake (g/day)	24.66a±0.30	18.43f±0.37	20.23d±0.25	19.13e±.23	23.1b±0.17	21.56c±0.40	0.53
Feed Efficiency Ratio (%)	0.023a±0.0 0005	-0.01 e±0.0001	0.0045c±0.0 0005	0.004d±0	0.023a±0.00 01	0.016b±0.0 002	0.00002

Values are expressed as means± SD; means in the same raw with different letter are significantly different (P < 0.05). RF: Renal failure, SC: sevelamer carbonate, RPK: Recommended phosphorus & potassium.

Conclusion and recommendations

Dietary therapy for hyperphosphatemia and hyperkalemia in RF experimental animal by low phosphorus and low potassium diets had predominant benefits not less important than pharmacological intervention to reduce disease progression. Feeding with 50% of recommended phosphorus and potassium were effective in improving kidney functions in renal failure disease followed by RF group which treated with 75% of recommended phosphorus and potassium. Feeding with 25% of recommended phosphorus and potassium led to reverse results. So, it is recommended to feed the renal failure patients

with 50% of recommended phosphorus and potassium for its potential effect to reduce the risks of hyperphosphatemia and hyperkalemia.

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تأثير الوجبات منخفضة الفوسفور والبوتاسيوم ودواء سيفيلامير على الفئران المصابة بمرض الفشل الكلوي: دراسة مقارنة

يوسف الحسانين، فاطمة الزهراء الشريف، بسمة الخطيب ،وسام عبد الوهاب
قسم التغذية وعلوم الأطعمة، كلية الاقتصاد المنزلي، جامعة المنوفية، شبين الكوم، مصر

الملخص العربي:

تهدف الدراسة الحالية إلى تقييم تأثير الأنظمة الغذائية منخفضة الفوسفور والبوتاسيوم ومقارنة تأثيرها مع عقار كربونات سيفيلامير الذي له نفس التأثير على الفئران المصابة بالفشل الكلوي. أجريت الدراسة على ثمانية وأربعين فأر من ذكور الألبينو الذي يتراوح أوزانهم بين280±10 تم تقسيمهم إلى مجموعتين رئيسيتين. المجموعة الرئيسية الأولى تم تغذيتها على الوجبة القياسية كمجموعة ضابطة سالبة. المجموعة الرئيسية الثانية تم تغذيتها على نظام غذائي يحتوي على الأدينين للإصابة بالفشل الكلوي، ثم اعادة تقسمهم المجموعة الضابطة الموجبة وتم تغذيتها على الوجبة القياسية. والمجموعة التى عولجت بعقار السيفيلامير والمجموعة التى تغذت على وجبات منخفضة الفوسفور والبوتاسيوم بنسب 25، 50 و75٪ من احتياجات الفئران من الفوسفور والبوتاسيوم. أدت تغذية الفئران المصابة بحميات تمثل 25، 50 و75٪ من الاحتياج للفوسفور والبوتاسيوم إلى منع تدهور حالة فرط فوسفات الدم وفرط بوتاسيوم الدم حيث أظهرت النتائج انخفاض في مستويات إنزيم عامل نمو الأرومة الليفية 23، هرمون الغدة الجار درقية، إنزيم الرينين ومقاومة الأنسولين بالمقارنة بالمجموعة السالبة والمجموعة التي تم علاجها باستخدام السيفيلامير. بعد ذلك، الوجبات منخفضة الفوسفور والبوتاسيوم أظهرت تحسن معنوى في وظائف الكلى لجميع المجموعات المعالجة. في الختام، تشير نتائج الدراسة الحالية إلى أن التغذية بنسبة 50٪ من الفوسفور والبوتاسيوم الموصى بهما فعال في تحسين وظائف الكلى في أمراض الفشل الكلوي.

الكلمات المفتاحية: فرط فوسفات الدم، فرط بوتاسيوم الدم، نظام الرينين – أنجيوتنسين- الألدوستيرون، الفئران، إنزيم عامل نمو الأرومة الليفية 23.