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Formulation and Development of Low Protein Menu for Slowing Down the Progression of Chronic Kidney Disease

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ABSTRACT

Background: CKD is defined as the continuous loss of kidney function or an estimated glomerular filtration rate less than 60 ml/min, which is enduring for 3 months or more. In CKD nutrition plays a vital role in reducing the progression of kidney damage and delaying dialysis phase.

Aim: The aim is to formulate a low protein menu for CKD.

Objective: The objective is to formulate a standardized low protein menu for CKD and to evaluate the sensory properties and nutrient analysis of the developed menu.

Materials and Methods: The study design of the present study is experimental design (formulation study) without supplementation. Four menus were formulated using low protein, low sodium, low potassium ingredients and according to the weight of reference men and women for 0.6g/kg protein and 0.8g/kg protein. The formulated menus were objected to organoleptic Evaluation and nutrient analysis.

Results: The results obtained from nutrient analysis were compared with IFCT which showed a minor difference in the nutrients for all the four menus that were formulated. Statistical Analysis were done for nutrient analysis values and IFCT values, all the four menus were not significant ($p > 0.05$) and statistical analysis for sensory evaluation was calculated in which the mean scores were not significant ($p > 0.05$)

Conclusion: The study has concluded that the formulated menus can be supplemented in CKD patients for further studies to evaluate the effect of the low protein diet in the progression of chronic kidney disease.

Keywords: CKD; Low Protein; CVD; Kidney Damage; Metabolic Acidosis; IFCT

Abbreviations: CKD: Chronic Kidney Disease; GFR: Glomerular Filtration Rate; BP: Blood Pressure; CVD: Cardiovascular Disease; IFCT: Indian Food Comparission Table

Introduction

Chronic kidney disease (CKD) is defined as the state of kidney injury or a fall in estimated glomerular filtration rate (eGFR) less than 60 ml/min, for more than 3 months. Persistent loss of kidney function for a prolonged time can lead to renal replacement therapy (dialysis or transplantation) [1]. According to a study in 2015 in India, diabetes, and hypertension account for about 40–60% cases of CKD. As per data in International diabetes federation, prevalence of diabetes in Indian adult population has raised to 8.9% in 2020, with rising prevalence of hypertension and diabetes in India, prevalence of CKD associated mortality is expected to rise [2]. Maintaining the kidney health is a global priority. Kidneys play a major role in filtering blood to maintain fluid and electrolyte balance, removing waste from the body, releasing hormones to control blood pressure (BP) and stimulating the red blood cell production which can ultimately reduce the incidence of CVD and anemia in CKD, and activating vitamin D to maintain bone health. Generally CKD can be predominantly diagnosed in patients with comorbidities such as hypertension, diabetes mellitus and cardio vascular disease and vice versa.

Studies suggest that proper maintenance of the comorbidities can effectively lower the risk of progression of kidney damage in CKD. CKD in initial stages are asymptomatic, but in later stages (stage 3 - 5) symptoms are positively related to the progressive kidney abnormalities [3]. Protein intake in CKD is considered as a major determinant in the function of the kidneys and consumption of high protein diet is associated cross-sectionally with higher GFR (Glomerular Filtration Rate) but longitudinally with greater GFR decline over time. High protein intake in CKD patients may lead to increased intraglomerular pressure and glomerular hyperfiltration which leads to further impairment in glomerular structure. Thus, a dietary protein intake of 0.6–0.8 g/kg/day is often recommended for the management of CKD [4]. Low protein diet intake still remains a cornerstone in the treatment of CKD. Initially, low protein intake was beneficial in lowering the uremic symptoms, delay the process of kidney failure, and achieve significant metabolic improvement in hyperphosphatemia and hyperparathyroidism [5].

The Low protein Diet persuades the constriction of the afferent arterioles and reduces the rate of intraglomerular hyperfiltration along with the vasodilatory effect of RAAS blockers on the efferent arterioles [6]. 0.6 to 0.8 g per kilogram of body weight every day is the most as often as possible prescribed objective for adults with moderate to severe kidney disease and for the management of proteinuria [7]. Many studies have clinically proven the positive effect of low protein diet in CKD which helped in improving the kidney function and subsiding the symptoms prevailing in CKD patients. A high protein diet can significantly increase the pressure in the glomerular and causes hyperfiltration or aggravates further damage in the kidneys. A low Protein intake of 0.6g/kg/BW - 0.8g/kg/BW in CKD is being prescribed to control further damage in the kidneys and may prevent patients from moving to dialysis. In this study a low protein menu will be formulated for the whole day using low sodium, low potassium food sources. The study aims in formulating a low protein menu plan for CKD.

Methods

The study was conducted at Sri Ramachandra institute of higher education and research, Porur. Study design is the procedure under which a study is carried out. The study design of the present study is experimental design (formulation study) without supplementation. In this study a low protein menu for chronic kidney disease will be formulated according to the requirement of -.6g/kg Body weight and 0.8g/kg Body weight protein for both reference men and women using low protein, low sodium and low potassium ingredients and sent for nutrient analysis for the parameters like energy, protein, fat carbohydrates, sodium and potassium without supplementing to the subjects. After the nutrient analysis the obtained results were compared with Indian Food Composition Tables that were calculated during the formulation of the menu. The period of the study is 6 months (June - December 2020). The institutional ethics committee for student proposal, Sri Ramachandra institute of higher education and research approved the project with REF NO: CSP/20/NOV/87/217.

Procurement of Ingredients

Ingredients were selected based upon the availability and cost. The selected ingredients were fresh and are easily available local ingredients which were bought from a local supermarket (Pazha Mudhir Nilayam) in Anna Nagar Chennai and non-vegetarian sources such as prawn was selected based upon the freshness and properly deveined from local sea food market. Vegetables and fruits that were bought were washed with running tap water the recipes were prepared in a safe and hygienic place. Ingredients like milk, paneer, rice, puffed rice, chow chow marrow, cauliflower, carrot, beans, lady's finger, green leafy vegetables like Ponangani leaves and drumstick leaves, egg white, sea foods like prawn, pulses like moong dal and channa dal, fruits such as apple, papaya and pears were used in the formulation of menu in this study.

Recipe Formulation

Low protein menu was formulated for CKD according to the weight of the reference man and reference women. Four menus were developed using the selected ingredients for 0.6g/kg BW and 0.8g/kg BW for both reference men and women. The formulated menus are tabulated in table 1. Table 1 depicts the formulated low protein menus for 0.6g/kg Body weight and 0.8g/body weight protein for both reference men and women. Total protein requirement planned for 0.6g/kg body weight is 36g for reference men and 33g for reference women and the total protein requirement for 0.8g/kg body weight is 48g for reference men and 44g for reference women. Dairy product such as

milk and paneer has been selected and included in the menu due to its calcium content. Risk factors such as risk factors such as obesity, diabetes, and hypertension have been linked with chronic kidney disease. Increased oxidative stress and endothelial dysfunction may increase the risk of renal impairment ad renal damage. According to studies regular consumption of dairy product have been reported to reduces oxidative stress and confer protection against renal dysfunction in older adults with CKD [8].

Table 1: Low protein menus (0.6g/kg body weight and 0.8g/kg body weight of protein).

Meal timing	0.6g/kg – Reference men	0.6g/kg – Reference women	0.8g/kg – Reference men	0.8g/kg – Reference women
Early Morning	Milk sugar	Milk sugar	Milk sugar	Milk sugar
Break Fast	Dosa Mixed curry	Dosa prawn curry	Appam Paya	Paniyaram Tomato chutney
Mid Morning	apple	apple	Pears	Sliced papaya
Lunch	Rice Chow chow masala Ponangani leaves poriyal Boiled egg white	Rice Chow chow masala Ponangani leaves poriyal Boiled egg white	Paneer fried rice Drumstick leaves poriyal Boiled egg white	Veg paneer fried. Boiled egg white
Mid-Evening	Milk sugar	Milk sugar	Milk sugar	Milk sugar
Dinner	Wheat semolina upma Lady's finger curry	Wheat Dosa Mixed curry	Paniyaram Mint chutney	Puffed rice upma
Bedtime	Milk sugar	Milk sugar	Milk sugar	Milk sugar

Note: *Kg- Kilogram

Vegetables like cauliflower, carrot, beans, chow chow and ladys's finger has been selected and included in the menu. Cruciferous vegetables like cauliflower are rich in vitamin C and dietary fiber and have a low amount of sodium and potassium. Carrots are low in potassium and sodium which helps in reducing the risk of damaging the kidneys and slower the progression of CKD to ESRD.Carrots are an excellent source of B- vitamins, beta carotene and dietary fiber which acts as Reno protective agents in reducing the free radical formation and inflammation [9]. Beans are naturally low in sodium and are rich in dietary fiber and antioxidants. Vidya et al., stated that increased fiber intake in CKD patient's decreases the serum C - reactive protein levels which reduces the risk of inflammation and mortality in CKD patients [10]. Chow chow marrow (chayote squash) is low in protein and sodium content and has high water content in it. chayote contains vitamin C, minerals, folic acid and vitamin K. (IFCT, 2017) [11].

Green leafy vegetables like Ponangani leaves and drumstick leaves are used in the menu because they have very less sodium content. Sundaram et al identified through an investigation that Ponangani leaves (Alternanthera sessilis) is capable of resolving kidney disease related complications. Drumstick leaves (Moringa oleifera) has many essential nutrients like vitamin C, antioxidants, beta carotene, amino acids, antioxidant content present in the leaves acts as a free radical scavenger and helps in reducing the inflammation in kidneys [12]. Boiled egg white was selected because of its high protein value and it is considered as High biological value protein (HBV). Whole egg was not included in the menu because the phosphorus content in the egg yolk was comparatively high than the egg white. Egg yolk also contain trimethylamine N-oxide precursor, choline which may provoke toxic effects in CKD [13]. Prawns were selected for the menu because it is locally available and inexpensive. Prawns contain low potassium and are rich in antioxidants which reduce the inflammation in the cells and acts as a free radical scavenger [14]. Parboiled rice and puffed rice was selected in the menu formulation because they are easily available and white rice is regarded as the stable food of south India which is versatile in meal planning. White rice is low in sodium, potassium and phosphorus and also good source of energy. Guzman, and puffed rice is low in sodium, potassium and is an excellent source of energy [15]

Moong dal is included in the menu because they are excellent source of protein, vitamins, minerals, dietary fiber and antioxidants and bioactive compounds which has beneficial effect in reducing the risk of chronic diseases and regulating blood pressure levels which is linked with CKD [16]. Fruits like apple, papaya and pears were selected as mid-morning snack because apples are an excellent source of pectin a soluble fiber which helps in regulating blood glucose levels and cholesterol levels which is identified as one of the complications

in CKD (NKF). Papayas are naturally low in sodium and potassium and are rich in carotenoids. Pears are rich in dietary fiber along with low sodium and potassium content [17].

Sensory Evaluation

The sensory evaluations of the formulated recipe were done using 9 point hedonic scale by 10 semi- trained panelists. Sensory evaluation was carried out for all the four menus.

Nutrient Analysis

The low protein menu that was prepared was sent to the lab for nutrient analysis. The nutrients that were analyzed are Energy, protein, carbohydrates, Fat, Sodium and Potassium.

Inferential Statistics

The obtained results were tabulated and interpreted. Mean standard deviation and f - test was calculated for the obtained results using MS Excel software.

Results

Organoleptic Evaluation

From the evaluated scores of 0.6g/kg body weight menu (reference men and women) milk, dosa and mixed curry, boiled egg white, wheat semolina upma and and prawn curry and wheat dosa has got the highest score and graded as liked very much and liked extremely. From the evaluated scores of 0.8g/kg body weight menu (reference men and women) milk, appam, veg paya, boiled egg white and paniyaram with tomato chutney has got the highest score and the overall acceptability was good.

Nutrient Analysis

In 0.6g/kg BW - reference men menu, the total protein requirement planned was 36g and the total protein value that is calculated from the nutrient analysis report is 30g.The total sodium and potassium content acquired from nutrient is 256mg of sodium and 790mg of potassium. In 0.6g/kg BW - reference women, the total protein requirement planned was 33g and the total protein value that is calculated from the nutrient analysis report is 33g. The sodium and potassium content acquired from nutrient analysis is 918mg of sodium and 1024mg of potassium. In 0.8g/kg BW - reference men, the total protein requirement planned was 48g and the total protein value that is calculated from the nutrient analysis report is 37g. The total sodium and potassium content acquired from nutrient analysis is 695mg of sodium and 900mg of potassium. In 0.8g/kg BW - reference women, the total protein requirement planned was 44g and the total protein value that is calculated from the nutrient analysis report is 26g. The sodium and potassium content acquired from nutrient analysis is 596mg of sodium and 720mg of potassium. The obtained results from the nutrient analysis is tabulated in Table 2. Table 2 shows the total energy, protein fat, carbohydrates, sodium and potassium values obtained from the nutrient analysis.

Table 2: Nutrient Analysis Results of The Formulated Menus.

Menu	Nutrient analysis					
	Energy (kcal)	Protein (g)	Sodium (mg)	Potassium (mg)	Fat (g)	Carbohydrates (g)
0.6g/kg bw Reference Men	1054	29.21	254	872	16.85	200
0.6g/kg bw Reference women	1161	32	918	1025	20	217
0.8g/kg BW REFERENCE MEN	1502	37	693	900	22.02	248
0.8g/kg BW Reference women	1034	26	596	720	13.75	161

Inferential Statistics

The inferential statistics were calculated for nutrient analysis values and IFCT values and for organoleptic evaluation scores. The results of the inferential statistics are tabulated in Table 3. F test was carried out for the organoleptic scores obtained which was not significant where p value > 0.001. f test was calculated for the nutrient analysis results compared with IFCT values where the P value> 0.001 which is not significant. During the comparison of nutrient analysis values and Indian Food Composition Tables prepared by the national institute of nutrition did not show any major difference in the calculated nutrient requirements such as energy, protein, Fat, carbohydrates, sodium and potassium. Table 4 shows the overall %Met of all the nutrient parameters when compared between nutrient analysis results with Indian Food Composition Tables. Figures 1-4 depicts the bar graph which shows the comparison of Nutrient Analysis values and Indian Food Composition Table. Table 3 shows the results of level of significance of all the four low protein menus and inferential analysis of organoleptic scores. From the obtained results it was observed that the p >0.05 for all the four menus. Therefore, all the four menus were not significant.

Table 3: Inferential Analysis of Low Protein Menus and Organoleptic Evaluation.

Mean Standard Deviation and Level of Significance of Low Protein Menus				Mean Standard Deviation and Level of Significance of Organoleptic Evaluation				
MENU	Mean ± SD	F value	P value	MENU	Mean ± SD	F value	P value	Remarks
0.6g/kg Reference men	488.51±583.96	0.128	0.728	0.6g/kg Reference men	7.42 ±0.29	0.60	0.74	Not significant
0.6g/kg Reference women	647.30±734.03	0.011	0.917	0.6g/kg Reference women	7.42± 0.29	1.09	0.38	Not significant
0.8g/kg – Reference men	608.65±713.47	0.037	0.851	0.8g/kg – Reference men	7.33 ± 0.33	0.30	0.94	Not significant
0.8g/kg – Reference women	472.59±522.08	0.090	0.769	0.8g/kg – Reference women	7 ± 0.77	0.14	0.99	Not significant

Table 4: %Met for Nutrient Analysis and Indian Food Composition Table.

MENU	% MET					
	Energy	Protein	Sodium	Potassium	Fat	Carbohydrates
0.6g/kg bw Reference Men	>100	80	>100	50	>100	>100
0.6g/kg bw Reference women	>100	91	>100	65	>100	>100
0.8g/kg BW REFERENCE MEN	>100	76	>100	41	>100	>100
0.8g/kg BW Reference women	>100	60	>100	49	47	85

Note: *IFCT- Indian Food Composition Table.

From the figure 1 energy, protein and fat had minor difference than sodium and potassium when compared with Indian Food Composition Table. Figure 2 shows a major difference in potassium and sodium than other nutrients when compared with Indian food composition tables. From figure 3 energy and fat has met fairly than other parameters when compared with Indian Food Composition Tables. From figure 4 energy and carbohydrates have met fairly than other nutrients when compared with Indian Food Composition Table. Table 4 shows the %MET of all the four menus. The %MET is calculated by comparing the nutrient analysis values of all the four menus according to energy, protein, sodium, potassium, fat and carbohydrates. According to the above table in 0.6g/kg BW menu energy, sodium, fat and carbohydrates have met >100. For 0.8g/kg menu (reference men and women) energy. Sodium, fat and carbohydrates have met >100.

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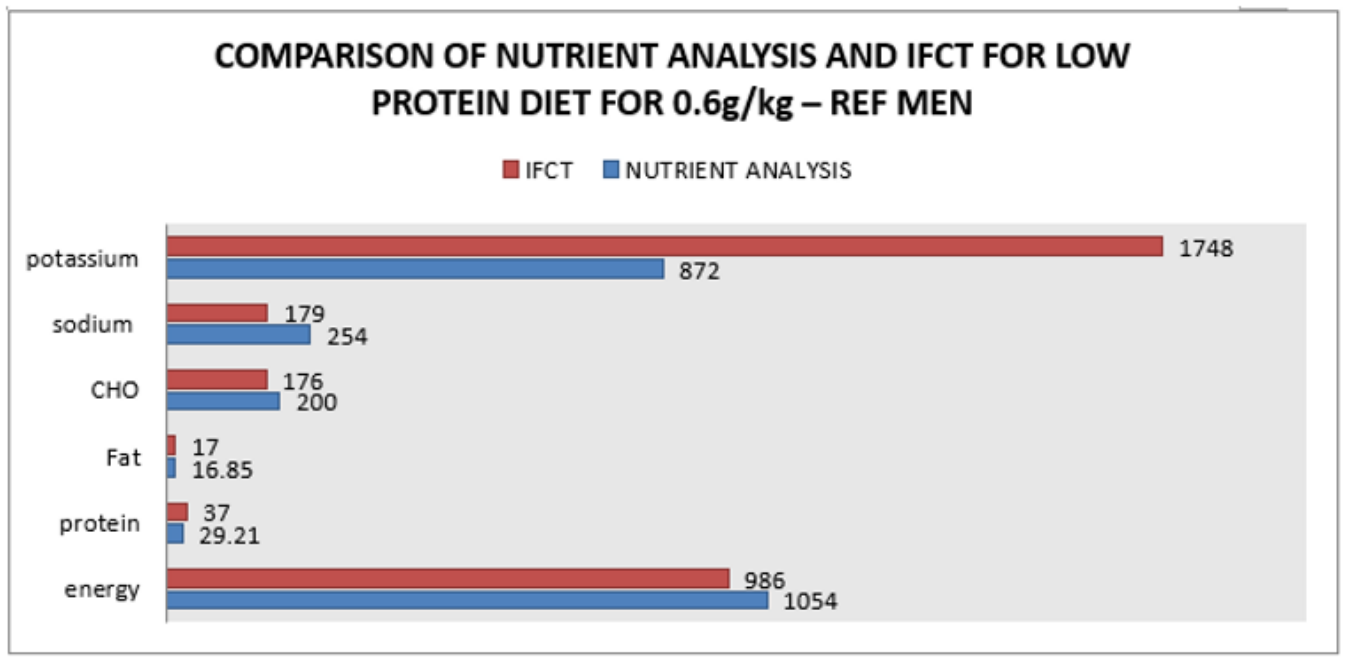

Figure 1: Comparison Between Nutrient Analysis and IFCT For 0.6g/Kg BW-Ref Men.

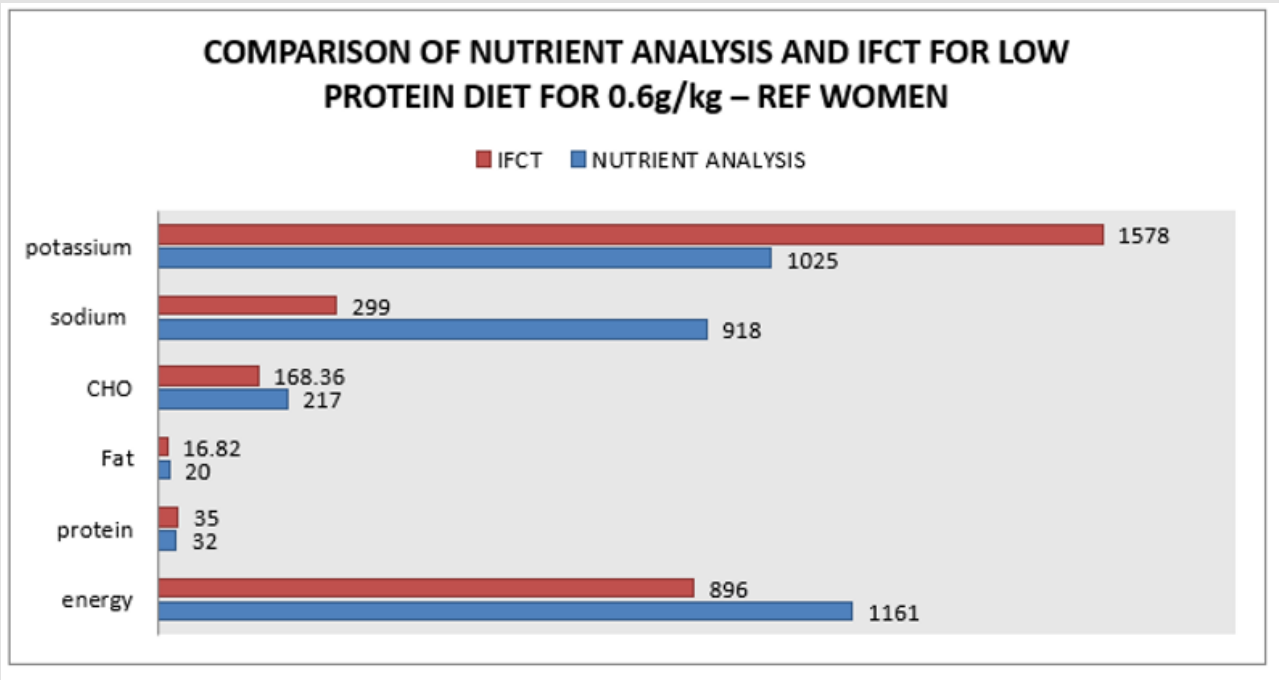

Figure 2: Comparison Between Nutrient Analysis and IFCT For 0.6g/Kg BW-Ref Women.

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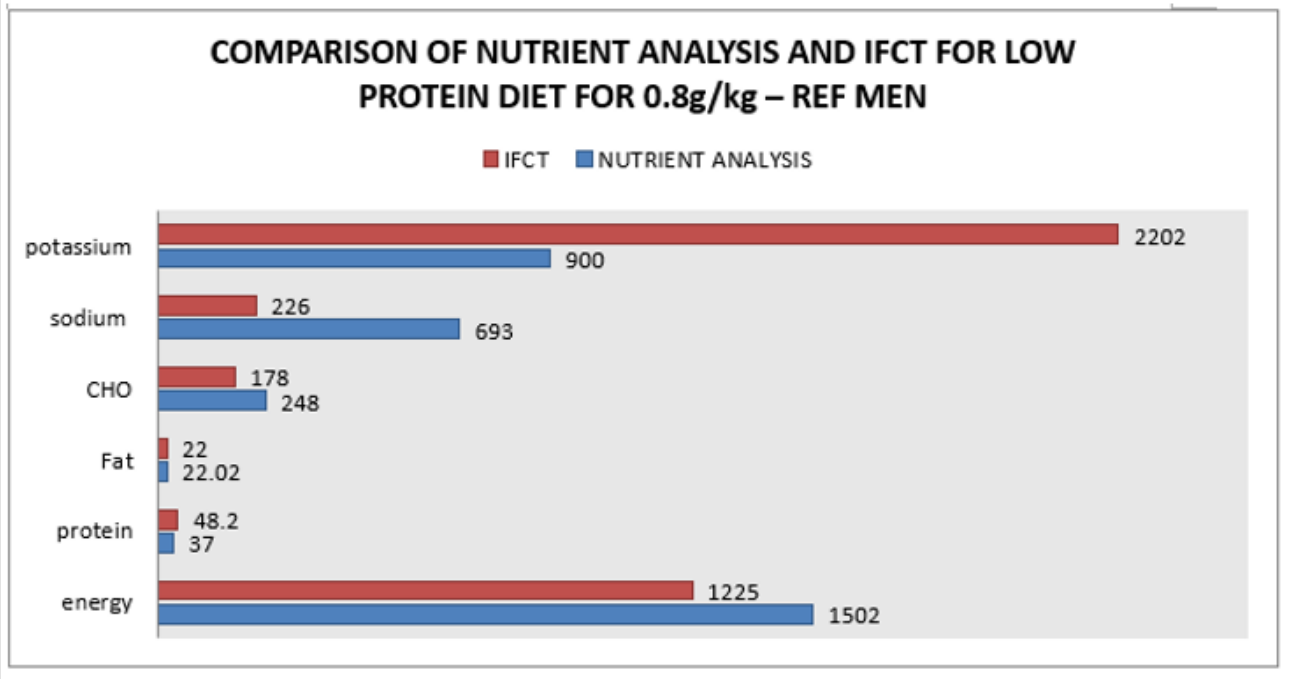

Figure 3: Comparison Between Nutrient Analysis and IFCT For 0.8g/Kg BW-Ref Men.

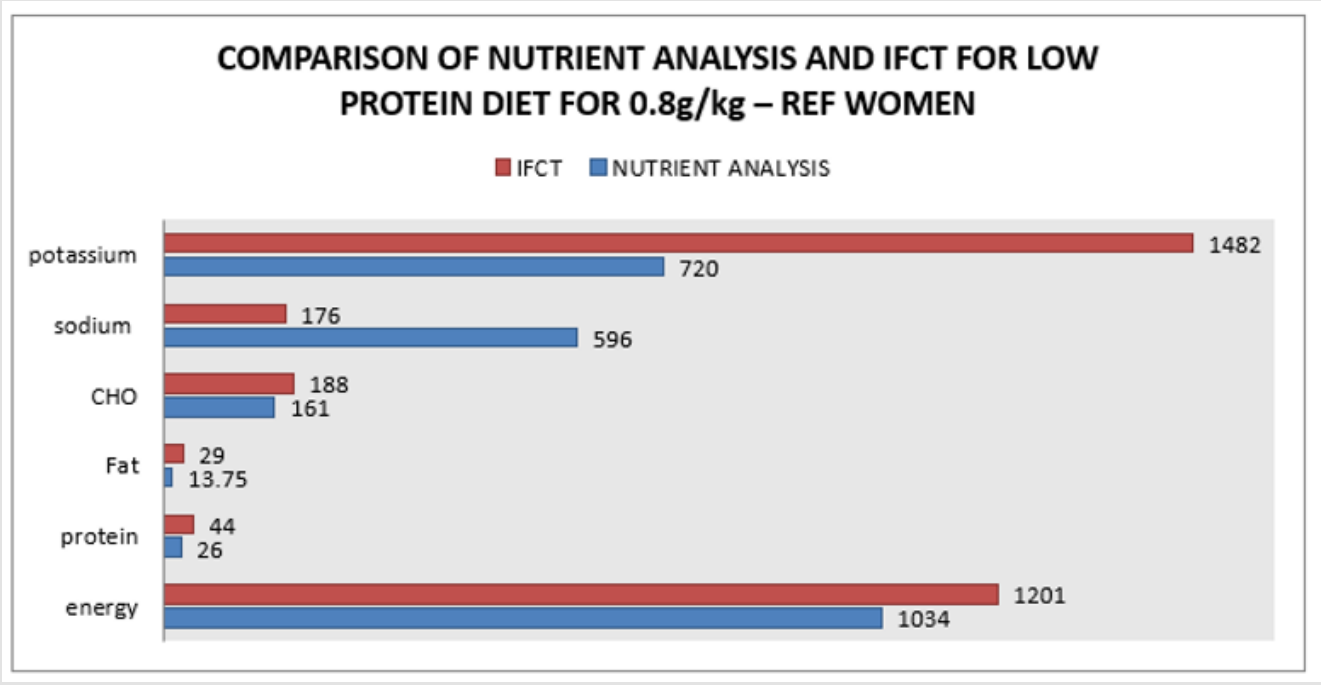

Figure 4: Comparison Between Nutrient Analysis and IFCT For 0.8g/Kg BW-Ref Women.

Conclusion

Four low protein menus were formulated according to the weight of the reference men and women for both 0.6g/kg and 0.8g/kg. Organoleptic evaluation was carried along with nutrient analysis. According to the nutrient analysis report the formulated recipes were low in protein, sodium and potassium which is suitable for the CKD patients. The obtained nutrient analysis results were compared with Indian food composition tables which resulted in minor variation.

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Conflict of Interest

There are no conflicts of interest.

Financial Support

Self-funding.

Ethical Approval

The institutional ethics committee for student proposal, Sri Ramachandra institute of higher education and research approved the project with REF NO: CSP/20/NOV/87/217.

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