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**Original Research Article**

# Suitability of Routine Sample Containers, Sampling Conditions, and Diet Types on Some Renal Function Parameters

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## Abstract

The widely accepted belief that plain and lithium heparin containers are the choice for the collection of samples for renal function testing was investigated. This was conducted in addition to the effect of sampling conditions and diet types on renal function testing. A total of 100 subjects were recruited for the study, and renal function parameters such as creatinine, urea, uric acid, sodium, potassium, chloride, bicarbonate, and glucose were estimated using the Randox (UK) test kits on a semi-automated chemistry analyser (Contec-China). The containers used for the analysis include plain, lithium heparin, fluoride oxalate, and $K_2$EDTA, whereas the sampling conditions were grouped into fasting, starvation, and random. The diet types consisted of carbohydrates, protein, and lipids. The results of the investigations were statistically analysed using One-Way Anova (Post-Hoc) on SPSS version 18-20 and level of significance pegged at 95%. The findings reaffirmed the suitability of plain and lithium heparin containers as the choice for renal function testing. Furthermore, sampling conditions were found not to have a palpable effect on the accuracy and precision of renal function parameters, whereas, lipid-rich diet impacted creatinine and urea concentrations. Conclusively, the gradation of the suitability index of routine containers for renal function test is plain > lithium heparin > $K_2$EDTA>fluoride oxalate. Also, diet types should be considered when considering the clinical implication of renal function parameters.

**Keywords:** Sample containers; analytes; electrolytes; laboratory methods; accuracy and precision.



## INTRODUCTION

An estimated 70% of medical decisions are based on the results from laboratory testing [1]. The renal system, in humans, includes the kidneys, where urine is produced, and the ureters, bladder, and urethra for the passage, storage, and voiding of urine. These organs, together, are responsible for the elimination of waste products from the body. The kidneys, however, both secrete and actively retain within the body certain substances that are as critical to survival as those that are eliminated.

The functions of the renal system can be compromised, resulting in renal diseases. These diseases could be categorized into acute or chronic kidney diseases. Acute kidney disease, also known as acute kidney injury (AKI), is a sudden episode of kidney failure or damage that occurs within a few hours or days. Chronic kidney disease (CKD) is a progressive disease characterized by changes in the structure and function of the kidneys for various reasons [2-3]. The global burden of CKD is substantial and growing. Chronic kidney disease (CKD) has become a paramount public health concern worldwide, impacting millions of people globally, with a global prevalence estimated to be between 10.5% and 13.1% [4-5].

In 2017, 697.5 million cases of all-stage CKD were recorded, with a global prevalence of 9.1%. Since 1990, the global all-age prevalence of CKD has increased by 29.3%. Globally, in 2017, 1.2 million people died from CKD. Between 1990 and 2017, the global all-age mortality for CKD increased by 41.5% [6]. Chronic kidney disease imposes a substantial financial burden on global healthcare systems. In 2021, the prevalence of CKD among American Medicare beneficiaries over the age of 65 was 13.5%, but this group accounts for a quarter ($76.8 billion) of total Medicare spending [7-9].

The epidemiological data presented above are based on laboratory diagnosis, which is termed 'renal function tests (RFTs)'. Renal function tests are medical investigations carried out to assess how well your kidneys are functioning by measuring various biochemical parameters in the blood or urine. These parameters include serum creatinine, blood Urea Nitrogen (BUN), estimated glomerular filtration Rate (eGFR), and urinalysis. Others are uric acids and electrolytes such as potassium, sodium, chloride, and bicarbonate [10-11].

The accuracy and precision of RFTS are crucial for the effective diagnosis and management of renal diseases. Laboratory investigations are known to be affected by preanalytical factors, resulting in inaccurate and imprecise results and, concomitantly, wrong or poor disease diagnosis and management. Factors considered in this article include sampling containers, sampling conditions, and dietary types. These factors are known to drastically affect the accuracy and precision of laboratory results. Furthermore, severally studies on this thematic area are quite contradictory with various viewpoints, and the dearth of literature in this respect in Nigeria, brought about the quest for this study [12-15]. This study is therefore designed to empirically fill these gaps

## MATERIALS AND METHODS

### Location Area

The study was conducted at Otuoke in Ogbia Local Government Area of Bayelsa State. Otuoke hosts the Federal University Otuoke, the institution the subjects of the study were drawn [16-20]. The subjects were students of the Department of Biochemistry undergoing their final year projects. The sampling component of the study was conducted at the Federal Medical Centre, Yenagoa, Otuoke Outreach. Similarly, the analysis was carried out at Eni-Yimini Laboratories (eL) Limited, Yenezue Gene-Epie, Yenegoa, Bayelsa State. The study spanned six months, beginning in December 2024 and terminating in June 2025.

### Research Design/Population Size

A quantitative experimental design was the chosen research design for the study, involving the establishment of the cause-and-effect relationship among the study groups. The sample size was pegged at one hundred (100) as validated by Araoye [21].

### Selection Criteria

All subjects recruited for the study were subjected to medical fitness checks by the university clinician and found to be healthy and free of chronic diseases, and not on any form of medication or hard drugs. The acceptable age bracket of the study was pegged between 18-40 years.

### Ethical Approval

The ethical approval was granted by the Directorate of Research and Quality Assurance (DR&QA) of the Federal University Otuoke, following the laid-down requirements and processes, with a registry number of DR&QA/199/2024.

### Sample Collection

Blood samples were collected using a simple phlebotomy method by an expert Medical Laboratory Scientist. The samples were collected into plain containers, $K_2$EDTA, lithium heparin, and fluoride oxalate tubes aseptically. The samples were then spun at 3000 rpm for the extraction of serum for the plain containers, and plasma for the anticoagulated containers. Furthermore, the subjects were exposed to diets rich in carbohydrates, proteins, and lipids for three days, and samples were collected in a fasting state, starvation state, and random state into the above-stated blood collection tubes.

### Laboratory Methods

The renal function tests (RFTs) parameters analysed included creatinine, urea, uric acid, potassium, sodium, chloride, bicarbonate, anion gap (AG), and glucose. The parameters were all analysed spectrophotometrically on a semi-automated analyser (Contec-China) using Randox reagents (UK).

### Statistical Analysis

Data were analyzed with the Statistical Package for Social Sciences (SPSS) program (SPSS Inc., Chicago, IL, USA; Version 18–21) and Microsoft Excel. A one-way ANOVA (Post Hoc-LSD) was used to compare the means of the various biochemical parameters of the various groups

## RESULTS

**Table 1: Age Distribution of Participants**

| Age | Frequency | Percentage |
|---|---|---|
| 18-25 | 68 | 68% |
| 26-35 | 32 | 32% |
| **TOTAL** | **100** | **100%** |

**Table 2: Gender Distribution of Participants**

| Gender | Frequency | Percentage |
|---|---|---|
| Male | 47 | 47% |
| Female | 53 | 53% |
| **Total** | **100** | **100%** |

**Table 3: Multiple comparison of the effect of plain electrolytes based on sampling conditions**

| Parameter | Control | Fasting | Starvation | Random | F. Value | P-Value |
|---|---|---|---|---|---|---|
| **Sodium** (mmol/L) | 125.57± 1.57 | 143.22±10.25 | 126.13± 6.57 | 133.00±8.22 | 33.25 | 0.20 |
| **Potassium** (mmol/L) | 3.39 ± 0.42 | 3.45± 1.90 | 3.34 ± 1.08 | 3.07±0.30 | 23.02 | 0.11 |
| **Chloride** (mmol/L) | 81.03 ± 21.08 | 91.03±10.10 | 79.00±19.34 | 81.07±4.12 | 2.16 | 0.23 |
| **Bicarbonate**(mmol/L) | 31.11± 4.70 | 29.22±4.10 | 28.11 ± 5.18 | 31.11±4.33 | 2.27 | 0.28 |
| **Anion Gap** | 16.20 ± 1.70 | 26.64±1.20 | 22.34 ± 2.10 | 23.89±4.92 | 9.90 | 0.28 |
| **Glucose** (mmol/L) | 1.16 ± 0.21 | 2.21± 0.29[a] | 2.99 ± 1.20[a] | 1.34±0.69 | 11.29 | 0.05 |

**Table 4: Multiple comparison of the effect of plain containers on renal function markers based on sampling conditions**

| Parameters | Control | Fasting | Starvation | Random | F-Value | P-Value |
|---|---|---|---|---|---|---|
| Creatinine(µmol/L) | 78.35 ± 0.69 | 80.15 ±45.50 | 65.81 ± 7.67 | 79.27± 51.89 | 0.38 | 0.77 |
| Urea(mmol/L) | 3.13 ± 0.01 | 2.29 ± 0.46 | 2.10 ± 0.58 | 2.61 ± 0.96 | 23.43 | 0.09 |
| Uric Acid(mmol/L) | 0.53 ± 0.03 | 0.51 ± 0.61 | 0.36 ± 0.11 [a,b] | 0.36 ± 0.07 [a,b] | 7.89 | 0.02 |

**Table 5: Multiple comparison of the effect of lithium heparin electrolytes based on sampling conditions**

| Parameter | Control | Fasting | Starvation | Random | F-Value | P-Value |
|---|---|---|---|---|---|---|
| Sodium (mmol/L) | 122.47± 1.77 | 139.52±15.25 | 123.13± 6.77 | 130.45±18.10 | 20.55 | 0.08 |
| Potassium (mmol/L) | 3.34 ± 0.01 | 3.52± 0.59 | 3.19 ± 0.88 | 2.87±0.60 | 2.02 | 0.13 |
| Chloride (mmol/L) | 78.93 ± 0.88 | 88.33±14.40 | 76.29±17.64 | 78.57±9.52 | 1.86 | 0.15 |
| Bicarbonate (mmol/L) | 28.88± 3.60 | 29.71±3.40 | 27.03 ± 1.58 | 30.75±3.33 | 1.67 | 0.18 |
| Anion Gap | 18.00 ± 0.40 | 25.00±0.60 | 23.00 ± 0.30 | 24.00±0.90 | 1.33 | 0.18 |
| Glucose (mmol/L) | 1.06 ± 0.01 | 2.14± 0.39[a] | 2.22 ± 0.50[a] | 1.91±0.59 | 14.99 | 0.00 |

**Table 6: Multiple comparison of the effect of lithium heparin on renal function markers based on sampling conditions**

| Parameters | Control | Fasting | Starvation | Random | F-Value | P- Value |
|---|---|---|---|---|---|---|
| Creatinine(µmoll/L) | 95.36 ± 0.94 | 66.93±14.53 [a] | 62.19 ±17.27 [a] | 53.97 ± 12.32 [a] | 84.97 | 0.05 |
| Urea (mmol/L) | 1.64 ± 0.02 | 1.56 ± 0.46 | 1.50 ± 1.80 | 1.87 ± 154.65 | 3.81 | 0.21 |
| Uric acid (mmol/L) | 0.38 ± 0.01 | 0.37 ± 0.12 | 0.39 ± 0.18 | 0.29 ± 0.06 | 90.20 | 0.23 |

**Table 7: Multiple comparison of the effect of fluoride oxalate anticoagulants on electrolytes based on sampling conditions**

| Parameters | Control | Fasting | Starvation | Random | F-Value | P-Value |
|---|---|---|---|---|---|---|
| Sodium (mmol/L) | 149.80 ± 0.88 | 148.48 ± 2.36 | 146.88 ± 3.17 | 149.00 ± 2.53 | 2.82 | 0.09 |
| Potassium (mmol/L) | 3.71 ±0.88 | 46.03 ± 9.81[a] | 50.32 ± 25.93[a] | 38.61 ± 6.27[a] | 1.93 | 0.04 |
| Chloride (mmol/L) | 82.91 ± 0.88 | 95.11 ± 8.00 | 99.19 ± 12.35 [a] | 100.56 ± 20.23 | 4.11 | 0.11 |
| Bicarbonate (mmol/L) | 16.09 ± 28.11 | 81.40 ± 31.02[a] | 80.01 ± 11.21[a] | 68.68 ± 20.01[a] | 2.01 | 0.02 |
| Anion gap | 54.51±9.97 | 18.00 ± 2.01[a] | 17.91 ± 3.01[a] | 18.37 ± 2.11[a] | 3.33 | 0.03 |
| Glucose (mmol/L) | 1.11 ± 0.03 | 3.24± 0.41[a] | 4.44 ±0.17[a] | 5.01±1.57[a,b] | 10.19 | 0.02 |

**Table 8: Multiple comparison of the effect of fluoride oxalate on renal function markers based on sampling conditions**

| Parameters | Control | Fasting | Starvation | Random | F-Value | P- Value |
|---|---|---|---|---|---|---|
| Creatinine(µmol/L) | 104.14±0.87 | 83.99±23.35 | 93.34±25.59 | 73.80 ±25.31[a,c] | 3.69 | 0.02 |
| Urea (mmol/L) | 3.00 ± 0.90 | 1.14 ± 0.40[a] | 1.08 ± 0.47[a] | 1.17 ±0.32[a] | 72.25 | 0.04 |
| Uric acid(mmol/L) | 0.17 ± 0.00 | 0.18 ± 0.05 | 014 ±0.04 | 0.20 ± 0.06 | 4.44 | 0.07 |

**Table 9: Multiple comparison of the effect of $K_2EDTA$ anticoagulants on electrolytes based on sampling conditions**

| Parameters | Control | Fasting | Starvation | Random | F-Value | P-Value |
|---|---|---|---|---|---|---|
| Sodium(mmol/L) | 149.36±1.4 | 150.88±1.74 | 148.64±2.02 | 131.88±28.28[a,b,c] | 3.93 | 0.02 |
| Potassium(mmol/L) | 2.16 ± 0.01 | 33.04 ± 6.18[a] | 37.83 ± 4.57[a] | 33.77 ± 9.59[a] | 77.28 | 0.02 |
| Chloride(mmol/L) | 97.63 ± 1.73 | 74.79 ± 9.20[a] | 82.23±10.98[a] | 90.99 ± 14.13[b] | 9.79 | 0.00 |
| Bicarbonate(mmol/L) | 35.34±17.8 | 91.13 ± 25.28[a] | 86.24±22.39[a] | 58.66 ± 5.74[a,b,c] | 3.79 | 0.01 |
| Anion Gap | 18.55 ±2.13 | 18.01±1.91 | 18.00±1.66 | 16.00±2.23 | 3.34 | 0.07 |
| Glucose(mmol/L) | 2.14 ± 0.01 | 2.35 ± 0.40 | 2.26 ± .72 | 3.39 ± 0.99[a,b,c] | 8.04 | 0.00 |

**Table 10: Multiple comparison of the effect of $K_2EDTA$ on renal function markers based on sampling conditions**

| Parameters | Control | Fasting | Starvation | Random | F-Value | P- Value |
|---|---|---|---|---|---|---|
| Creatinine (µmol/L) | 107.60 ±1.75 | 84.70 ±16.52[a] | 86.70 ± 13.90 [a] | 74.90 ±28.98[a] | 5.78 | 0.00 |
| Urea (mmol/L) | 2.01 ±0.09 | 0.64 ±0.39 [a] | 0.86 ± 0.60[a] | 0.94 ± 0.40 [a] | 25.03 | 0.00 |
| Uric acid(mmol/L) | 0.34 ±0.01 | 0.41 ±0.12 | 0.37 ± 0.04 | 0.43 ±0.16 | 1.50 | 0.23 |

**Table 11: Effect of routine containers on mean concentrations of renal function parameters of the Fasting Group**

| Parameters | Plain | Lithium | Fluoride Oxalate | $K_2EDTA$ | F-value | P-value |
|---|---|---|---|---|---|---|
| Sodium (mmol/L0 | 143.22±10.25 | 139.52±15.25 | 148.48 ± 2.36 | 150.88±1.74 | 0.18 | 0.97 |
| Potassium (mmol/L) | 3.45± 1.90 | 3.52± 0.59 | 46.03 ± 9.81 | 33.04± 6.18[a,b,c] | 13.43 | 0.04 |
| Chloride (mmol/L) | 91.03±10.10 | 88.33±14.40 | 95.11 ± 8.00 | 74.79 ± 9.20[a,c] | 45.19 | 0.02 |
| Bicarbonate (mmol/L) | 29.22±4.10 | 29.71±3.40 | 81.40 ± 31.02[a,b] | 91.13 ± 25.28[a,b] | 0.48 | 0.05 |
| Anion Gap | 26.64±1.20 | 25.00±0.60 | 18.00 ± 2.01 | 18.01±1.91 | 23.43 | 0.09 |
| Glucose (mmol/L) | 2.21± 0.29[a] | 2.14± 0.39 | 3.24± 0.41[a,b] | 2.35 ± 0.40[c] | 9.89 | 0.02 |
| Creatinine (µmol/L) | 80.15 ±45.50 | 66.93±14.53 | 83.99±23.35 | 84.70 ±16.52 | 5.18 | 0.67 |
| Urea (mmol/L) | 2.29 ± 0.46 | 1.56 ± 0.46 | 1.14 ± 0.40 [a] | 0.64 ±0.39 [a,b,c] | 34.43 | 0.04 |
| Uric acid(mmol/L) | 0.51 ± 0.61 | 0.37 ± 0.12 | 0.18 ± 0.05[a,b] | 0.41 ±0.12[c] | 7.13 | 0.02 |

**Table 12: Effect of routine containers on mean concentrations of renal function parameters of the Starvation Group**

| Parameters | Plain | Lithium | Fluoride Oxalate | EDTA | F-value | P-value |
|---|---|---|---|---|---|---|
| Sodium (mmol/L) | 126.13± 6.57 | 123.13± 6.77 | 146.88 ± 3.17[a,b] | 148.64±2.02[a,b] | 3.08 | 0.05 |
| Potassium (mmol/L) | 3.34 ± 1.08 | 3.19 ± 0.88 | 50.32 ± 25.93[a,b] | 37.83 ± 4.57[a,b,c] | 11.40 | 0.02 |
| Chloride (mmol/L) | 79.00±19.34 | 76.29±17.64 | 99.19 ± 12.35[a,b] | 82.23±10.98 | 15.10 | 0.04 |
| Bicarbonate (mmol/L) | 28.11 ± 5.18 | 27.03 ± 1.58 | 80.01 ± 11.21[a,b] | 86.24±22.39[a,b] | 1.18 | 0.04 |
| Anion Gap | 22.34 ± 2.10 | 23.00 ± 0.30 | 17.91 ± 3.01 | 18.00±1.66 | 43.43 | 0.19 |
| Glucose (mmol/L) | 2.99 ± 1.20[a] | 2.22 ± 0.50[a] | 4.44 ±0.17[a,b] | 2.26 ± .72[c] | 2.19 | 0.03 |
| Creatinine (µmol/L) | 65.81 ± 7.67 | 62.19 ±17.27 | 93.34±25.59[a] | 86.70 ± 13.90 [a] | 1.28 | 0.31 |
| Urea (mmol/L) | 2.10 ± 0.58 | 1.50 ± 1.80 | 1.08 ± 0.47 [a] | 0.86 ± 0.60[a,b] | 55.43 | 0.04 |
| Uric acid (mmol/L) | 0.36 ± 0.11 | 0.39 ± 0.18 | 014 ±0.04[a] | 0.37 ± 0.04 | 7.13 | 0.03 |

**Table 13: Effect of routine containers on mean concentrations of renal function parameters of the random group**

| Parameters (mmol/L) | Plain | Lithium | Fluoride Oxalate | EDTA | F-value | P-value |
|---|---|---|---|---|---|---|
| Sodium (mmol/L) | 133.00±8.22 | 130.45±18.10 | 149.00 ± 2.53 | 131.88±28.28 | 11.18 | 0.07 |
| Potassium (mmol/L) | 3.07±0.30 | 2.87±0.60 | 38.61 ± 6.27[a,b] | 33.77 ± 9.59[a,b] | 12.22 | 0.03 |
| Chloride (mmol/L) | 81.07±4.12 | 78.57±9.52 | 100.56 ± 20.23[a,b] | 90.99 ± 14.13[b] | 22.00 | 0.02 |
| Bicarbonate (mmol/L) | 31.11±4.33 | 30.75±3.33 | 68.68 ± 20.01[a,b] | 58.66 ± 5.74[a,b] | 1.33 | 0.03 |
| Anion Gap | 23.89±4.92 | 24.00±0.90 | 18.37 ± 2.11 | 16.00±2.23[a,b] | 13.13 | 0.05 |
| Glucose (mmol/L | 1.34±0.69 | 1.91±0.59 | 5.01±1.57[a,b] | 3.39 ± 0.99[a,b,c] | 2.22 | 0.02 |
| Creatinine (µmol/L) | 79.27± 51.89 | 53.97 ± 12.32[a] | 73.80 ±25.31[b] | 74.90 ±28.98[b] | 1.33 | 0.03 |
| Urea (mmol/L) | 2.61 ± 0.96 | 1.87 ± 154.65 | 1.17 ±0.32[a] | 0.94 ± 0.40[a,b] | 11.03 | 0.02 |
| Uric acid (mmol/L) | 0.36 ± 0.07 | 0.29 ± 0.06 | 0.20 ± 0.06 | 0.43 ±0.16[b,c] | 1.10 | 0.04 |

**Table 14: Multiple comparison of the diet types on renal and electrolyte biochemical parameters**

| Parameter(s) | Control | CHO | PRO | LIPID | F-Value | P-Value |
|---|---|---|---|---|---|---|
| | (Mean ± SD) | | | | | |
| Sodium (mmol/L) | 129.90±0.88 | 149.07±1.29 | 149.40±3.64 | 143.20±22.44 | 30.71 | 0.09 |
| Potassium (mmol/L) | 3.36 ± 0.03 | 2.49 ± 0.78 | 3.72 ± 0.67 | 3.03 ± 0.86 | 2.83 | 0.07 |
| Chloride (mmol/L) | 98.61 ± 1.08 | 96.88±16.06 | 98.59 ± 4.81 | 96.03 ± 10.88 | 8.69 | 0.11 |
| Bicarbonate (mmol/L) | 16.65 ± 3.34 | 26.68 ± 4.48 | 26.53 ± 3.99 | 22.20 ± 6.23 | 2.37 | 0.08 |
| Anion Gap | 18.00±3.00 | 28.00 ± 2.10 | 27.60 ± 3.56 | 28.03 ± 2.66 | 28.65 | 0.45 |
| Glucose (mmol/L) | 1.36 ± 0.04 | 3.04 ± 0.34[a] | 3.72 ± 0.02[a] | 4.54 ± 1.11[a] | 28.65 | 0.03 |
| Urea (mmol/L) | 3.13 ± 0.01 | 1.03 ± 0.79[a] | 2.19 ± 0.78 | 1.73 ±1.14[a] | 10.99 | 0.02 |
| Creatinine (µmol/L) | 78.35±0.69 | 47.54±9.32[a] | 64.38±4.64 | 104.26±66.05[b,c] | 1.99 | 0.04 |
| Uric Acid (mmol/L) | 0.53 ± 0.03 | 0.31 ± 0.51[a] | 0.43 ± 0.03 | 1.36 ± 0.64[a,b,c] | 30.59 | 0.02 |

Table 1 shows the age distribution of the subjects. The majority of participants (68%) fall within the 18-25 age range, while the remaining 32% are between 26 and 35 years old. Table 2 presents the gender distribution of the subjects. The sample consists of 47% males and 53% females, suggesting a fairly balanced gender representation. Tables 3-10 show the effect of sampling conditions on renal parameters in plain, lithium heparin, fluoride oxalate, and $K_2EDTA$, respectively. In a similar vein, Tables 11-13 show the impact of sampling containers on renal function parameters in fasting, starvation, and random sampling conditions, respectively. Similarly, Table 14 shows the effects of dietary types on renal function parameters.

## DISCUSSION

The demographic presentation captured both age brackets and gender (Tables 1 & 2). This portrayal reflects the unbiased and unskewed tendencies of the study, which form the foundation of empirical studies. Empirical studies are typically designed to minimize bias by applying random sampling and avoiding discriminatory tendencies. This study followed the same approach as posited in other empirical studies [22-23]. Demographics are crucial in empirical studies, considering their palpable effects on physiological and anatomical derailments [24-25].

The effect of sampling conditions on clinical chemistry investigations is a discourse with various perspectives or schools of thought [26-29]. This study, therefore, explored these gaps in renal function parameters on commonly used routine anticoagulants and plain containers (Tables 3-10). The significant differences associated with the controls when compared to other parameters could be attributed to their predetermined concentrations (Tables 3-10). It is worth noting that control, as a quality control guide in laboratory analysis, is to ensure result accuracy and precision. Hence, all comparisons concerning the control served basically as a quality check on the analysis carried out.

The analysis of plain container samples revealed distortions in glucose and uric acid concentrations in the studied sampling conditions (Tables 3-4). Significant elevation in glucose concentrations during both fasting (2.21±1.20mmol/L) and starvation states (2.99±1.20mmol/L) reflects the expected physiological response to caloric restriction. These findings align with previous research carried out by Landau *et al.,* [30], which demonstrates how enhanced gluconeogenesis during fasting states causes the body to mobilize non-carbohydrate sources to maintain glucose homeostasis. The progressive increase from fasting to starving suggests that there is a time-dependent metabolic adaptation. Also, uric acid interestingly showed significant reductions during both starvation (0.36±0.11) and random sampling (0.36±0.07) compared to the control and fasting groups. These findings lack a clinical explanation, as prolonged and mild fasting have been shown not to affect uric acid [31]. The stability observed for other renal function parameters as affected by sampling conditions in plain containers further affirmed its suitability and negligible influence as posited in other studies [32, 12].

The lithium heparin samples (Table 5-6) revealed glucose elevation patterns like the plain containers during fasting and starvation periods. But creatinine concentrations reduced across all groups apart from the control, which has a concentration of 95.36±0.94µmol/L, suggesting the predetermined concentration as posited above. This has further affirmed the suitability of lithium heparin as a container of choice for the determination of renal function parameters [33].

Fluoride oxalate containers produced vividly elevated potassium concentrations across all sampling conditions (Tables 8-9). Potassium concentrations were elevated to the concentration of 46.03±9.81mmol/L in the fasting period, 50.32±25.93mmol/L in the starvation period, and 38.61±6.27 for random sampling. These values reveal an increase of over 10-15 times above physiological ranges and would be incompatible with life if they reflected true hyperkalaemia (Cornes *et al.,* 2008). An empirical reason for the unusual concentration of potassium may be due to the compound leaching from fluoride salts or its chelating property [34]. Glucose elevations in these samples are not abnormal, as they represent the intended preservative effect of the inhibition of enolase enzymes in the glycolytic cycle [35]. Furthermore, the significant decrease in creatinine concentration in the random, compared to the starvation, is quite empirical as muscular breakdown is more prominent in the latter [36].

Dipotassium ethylenediaminetetraacetic acid ($K_2EDTA$) samples exhibited severe potassium elevations, however, not as high as that of fluoride oxalate, with the concentrations ranging from 33.04±6.18 to 37.83±4.57 mmol/L across different sampling conditions (Tables 9-10). These values, even though they are lower than those of fluoride oxalate, still represent severe pseudohyperkalemia that can lead to inappropriate clinical responses [37]. The potassium concentrations observed in $K_2EDTA$ arise from the potassium salt in the anticoagulant used in these tubes, coupled with its chelating properties [38-39,34].

The distortions observed in sodium, chloride, and bicarbonate in the $K_2EDTA$ containers, irrespective of the sampling conditions, could be attributed to the chelating property inherent in the anticoagulant. On the contrary, the increase in glucose concentration in the random sampling, comparable to the fasting and starvation, is vividly due to the intake of food associated with glucose [40-41]. Dipotassium ethylenediaminetetraacetic acid could serve as an alternative anticoagulant for the estimation of urea and creatinine due to the observed stability, as agreed in similar studies [42-43].

The effects of routine anticoagulated and plain containers on renal function parameters using different sampling conditions are presented in Tables 11-14. The findings revealed a significant increase in the concentrations of potassium and bicarbonate in fluoride oxalate and $K_2EDTA$, when compared to plain and lithium heparin containers in fasting, starvation, and random samples (Tables 11-14). The basis of the increases is synonymous with that advanced above. This has further affirmed the non-suitability of $K_2EDTA$ and fluoride oxalate as a choice anticoagulant for the estimation of electrolytes [34,38-39].

In a similar vein, glucose concentration increased in the fluoride oxalate container compared to the other studied containers in all the sampling conditions (Table 11-14). The basis of the increase is suggestive of the halting or retardation of glycolysis resulting from the inhibition of the enzyme enolase, as also advanced above. This has further reaffirmed the conventional acceptance of fluoride oxalate as the choice anticoagulant for the determination of glucose concentration.

Urea and uric acid concentrations were also erratic in fluoride oxalate and $K_2EDTA$ across the sampling conditions. The unpredictable patterns observed in the measurement of urea and uric acid could be due to the synergic effect of the sampling conditions and the anticoagulant influence. Chen et al. [44] also advanced similar sentiments regarding anticoagulant effects on metabolite detection, such as urea and uric acid.

Furthermore, this study looked at the perspective of the effect of dietary types on the accuracy and precision of renal function parameter determination (Table 14). The findings revealed a significant decrease in the concentrations of glucose in the control, compared to the various dietary types, whereas urea increased. Similarly, the concentration of creatinine and uric acid increased in the control and lipid-rich diet compared to the carbohydrate and protein rich diet. The control comparison basis has been advanced above; however, the increase observed in the lipid-rich diet is suggestive of a nutritional influence. The stability of glucose across the major diet classifications is an affirmation of the insignificant influence of dietary types on sugar estimation, especially when using random samples.

## CONCLUSION

The findings of the study have further affirmed the suitability of plain and lithium heparin containers as the choice for sampling blood for renal function parameters estimation. Furthermore, the result showed that sampling conditions do not have an overt effect on the accuracy and precision of renal function parameter estimation. However, the finding showed a significant effect of a lipid-rich diet on the accuracy and precision of urea and creatinine concentrations.

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