CHAPTER 7

Effect of accessions of *Colocasia esculenta*-based diets on the hepatorenal endpoints of weanling Wistar rats
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EFFECT OF ACCESSIONS OF COLOCASIA ESCULENTA-BASED DIETS ON THE HEPATORENAL ENDPOINTS OF WEANLING WISTAR RATS*

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*This chapter has been submitted for publication in this format to the Journal of Medicinal Food.
Effect of accessions of *Colocasia esculenta*-based diets on the hepatorenal endpoints of weanling Wistar rats

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Running title: Effect of *Colocasia esculenta*-based diets on rats

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ABSTRACT

The liver and kidney functional endpoints of weanling albino rats (Rattus norvegicus) maintained on different accessions of cooked Colocasia esculenta (cocoyam)-based diets (UFCe1-UFCe7) for 28 days were investigated. All the accessions of C. esculenta based diets did not significantly (P>0.05) alter the serum levels of albumin, globulin, inorganic phosphorus, calcium, magnesium and uric acid of the animals by the end of the feeding period. The total protein and total bilirubin levels decreased only in the UFCe3 and UFCe4 fed animals respectively. Whereas UFCe1 and UFCe2 significantly decreased the conjugated bilirubin levels, UFCe3 and UFCe6 increased it. While all the accessions of C. esculenta based diet decreased the serum ALP activity, that of GGT increased. UFCe1 and UFCe5 increased the serum ALT activity whereas UFCe4 decreased the activity of the enzyme. UFCe3 and UFCe1 increased the serum creatinine and AST activity of the animals. Whereas UFCe6 and UFCe7 increased the level of sodium in the serum of the animals, UFCe4 and UFCe5 decreased the chloride level. The serum urea level was decreased by UFCe1, UFCe3, UFCe4 and UFCe5 whereas the potassium level was increased in the UFCe4, UFCe6 and UFCe7 fed animals. The results revealed that all the accessions of C. esculenta produced selective alterations on the hepatorenal indices of weanling rats. The highest alterations were produced by the UFCe4 while the least was from UFCe2. These alterations may have consequential effects on the normal functioning of the liver and kidney of the animals. The UFCe2 exhibited the least toxicity risk among the accessions of C. esculenta growing in KwaZulu-Natal Province of South Africa.

Keywords: Accession, amadumbe, cocoyam, Colocasia esculenta, hepatorenal endpoint, toxicity risk
INTRODUCTION

*Colocasia esculenta*, belonging to the family *Araceae*, is an edible aroid commonly known as *Taro* cocoyam. It is an important crop in Hawaii, Japan, Egypt, Ghana and Nigeria.¹ The crop is an important staple food throughout the tropical and subtropical regions of the world, particularly Asia and Pacific Island. It is cultivated mainly for its edible corms, cormels, leaves and other traditional uses by subsistence farmers.² ³ The leaves are also consumed as a vegetable.⁴

The tubers can be eaten boiled, fried or pounded into paste and consumed with soup. It can also be made into porridge or pottage, as well as chips and flour. Cooked tubers can be eaten alone or with stew and also as soup thickeners. The crop can be processed into several food and feed products and industrial inputs, similar to that of potatoes in the Western world. In addition to being a good source of nutrients, cocoyam also has some medicinal properties.⁵

In South Africa, however, cocoyam referred to as *Amadumbe*, is not well known despite having been cultivated for centuries in some remote parts of KwaZulu-Natal Province. The species is considered as food for the poor and commercial farmers have not shown much interest in the crop.

The use of cocoyam as food for man and animal has limiting factors such as storage and presence of antinutritional factors. The antinutritional factors found in this crop include oxalates, phytates, tannins and saponins.⁶ Oxalates have been implicated in the acrid or irritating quality found in cocoyam species when consumed. Boiling the tuber is a requirement for consumption as it helps to reduce the level of oxalates by inactivation.⁷

Previous studies on the chemical composition of cocoyam revealed that it is of high nutritional value.⁸ ⁹ ⁶have also opined that the major factor limiting the use of cocoyam as food for man and animals are storage and the presence of antinutritional factors. Similarly,
have shown that cooking significantly reduced antinutrients such as oxalate, tannins and phytates in cocoyam accessions growing in KwaZulu-Natal Province of South Africa. Despite all these, and coupled with increasing consumption of the tubers, there is no information in the open scientific literature that addressed the toxic effect or safety of the cocoyam tubers in animals. Therefore, there is need to evaluate some of the different accessions of *C. esculenta* growing in KwaZulu-Natal Province of South Africa for their safety or toxicity.

The objective of this study was to provide information on the toxic implications of the different accessions of *C. esculenta*-based diet in weanling rats by evaluating the effects of the diet on functional parameters of the liver and kidney of the rats.

**MATERIALS AND METHODS**

*Feed components*

Seven accessions of cocoyam (*Colocasia esculenta*) tubers designated as University of Fort Hare *Colocasia esculenta* 1 to 7 (UFCe1 - UFCe7) were obtained from four different villages (Umbumbulu, Makhathini, Mthwalume and Maphumulo) in KwaZulu-Natal Province of South Africa. Yellow maize (*Zea mays*) was obtained from Alice, while soybean and its oil were obtained from Kei Seeds and Feeds Ltd., East London, South Africa. Vitamin mix was a product of Ceva Animal Health Ltd., South Africa. Component chemicals of the mineral mix were products of Sigma Chemical Company Limited, St. Louis, USA.

*Animals*

Twenty-one day old, home-bred, weanling Wistar rats of both sexes (*Rattus norvegicus*) with a mean weight of 37.92 g ± 3.19 were obtained from the Animal House of the Agricultural
and Rural Development Research Institute, University of Fort Hare. The animals were housed in clean metabolic cages placed in a well ventilated house with optimum conditions (temperature 23 ± 1°C; photoperiod: 12 h natural light and 12 h dark; humidity: 45-50%). The cleaning of the cages was done daily. This study was carried out following approval from the ethical committee on the use and care of animals of the University of Fort Hare, South Africa.

**Assay kits**

The assay kits for creatinine, urea, calcium, sodium, potassium, chloride, phosphorus, albumin, bilirubin, alkaline phosphatase (ALP), gamma glutamyl transferase (GGT), alanine and aspartate aminotransferase (ALT and AST respectively) were obtained from Roche Diagnostic GmbH, Mannhein, Germany. All reagents used were of analytical grade and were supplied by Merck Chemicals (Pty) Ltd., Bellville, South Africa.

**Processing of feed components**

The seven accessions of *C. esculenta* tubers were peeled, washed, sliced and boiled at 100°C for 20 min and thereafter oven-dried at 60°C to constant weight. Yellow maize was soaked in distilled water for 48 h at room temperature and later oven-dried at 40°C to constant weight. Dried soybean and maize seeds as well as cocoyam accessions were separately milled using a Fritsch pulverisette 14® Rotor-Speed mill (Fritsch GMBH, Laborgeratebau, Germany) and stored in air-tight polythene bags. The milled soybean was later autoclaved at 120°C for 30 min. All these powder were used as components of the formulated feed.

**Composition of diet**

The control (corn starch-based) and cocoyam (*C. esculenta*-based) diets were formulated using the components depicted in Table 1. The components were thoroughly mixed and made
into pellets to ensure good handling by the animals. The feeds were packed in air-tight polythene bags and stored in the freezer to prevent microbial growth.

**Animal grouping and feeding**

Forty-eight rats of both sexes were completely randomized into eight groups (A-H) made up of six animals each. Group A consisted of the rats maintained for four weeks on corn starch based diet (the control) while animals in groups B, C, D, E, F, G and H were maintained for four weeks on the first, second, third, fourth, fifth, sixth and seventh accessions of *C. esculenta* based diet respectively and designated as UFCe1, UFCe2, UFCe3, UFCe4, UFCe5, UFCe6 and UFCe7. The animals were fasted (without food, but water) for 6 h before the commencement of the experiment. The formulated feed and water were supplied to the animals *ad libitum*. The animals were sacrificed 24 h after the four week feeding period.

**Preparation of serum**

Serum was prepared by adopting the procedure described by.\(^{11}\) Briefly, under ether anaesthesia, rats were made to bleed through their cut jugular veins, which were slightly displaced (to prevent blood contamination by interstitial fluid). An aliquot (5 ml) of the blood was allowed to clot for 10 min at room temperature and then centrifuged at 1282 g x 5 min using Hermle Bench Top Centrifuge (Model Hermle, Z300, Hamburg, Germany). The sera were later aspirated into sample bottles with Pasteur pipettes and used within 12 h of preparation, for the determination of the liver and kidney functional parameters.

**Determination of functional parameters**

The concentrations of sodium, potassium, chloride, calcium, magnesium, inorganic phosphorus, urea, creatinine, albumin, globulin, total protein, uric acid, ALP, GGT, ALT, AST, total and conjugated bilirubin were determined in the serum of the animals by adopting
the protocol outlined in the manufacturer’s assay kit from Roche Diagnostics on Roche Modular System (model P800, Mannheim, Germany). The analyzer was calibrated for use on animal serum before the determinations were carried out.

**Statistical analysis**

Data were mean of six determinations ± SD and were subjected to one way analysis of variance (ANOVA). Means were separated by the Duncan Multiple Range Test using SAS. Values were considered statistically significant at \( P<0.05 \).

**RESULTS**

Feeding of rats for four weeks *ad libitum* on the various accessions of *C. esculenta*-based diet produced varying alterations in the concentrations of serum liver and kidney functional endpoints investigated (Tables 2 and 3). On the other hand, all the accessions of *C. esculenta*-based diets did not significantly (\( P>0.05 \)) alter the levels of albumin and globulin in the serum of the animals by the end of the feeding period. The total protein and total bilirubin levels decreased only in the UFCe3 and UFCe4 fed animals respectively (Table 2). While UFCe1 and UFCe2 decreased the conjugated bilirubin levels, UFCe3 and UFCe6 increased it. However, while all the accessions of *C. esculenta*-based diet decreased the ALP activity in the serum of the animals, GGT increased in all the diet groups. In contrast, UFCe1 and UFCe5 increased the serum ALT activity of the animals whereas the enzyme activity decreased in the UFCe4 fed animals. All the other diets did not alter the activity of the enzyme. In addition, UFCe1 brought about an increase in the serum AST activity of the animals whereas the enzyme activity compared well with the control in all the other diet groups (Table 2).
The serum inorganic phosphorus, calcium, magnesium and uric acid levels of rats maintained on all the accessions of *C. esculenta*-based diet were not significantly altered by the end of the feeding period (Table 3). However, all other kidney functional indices investigated in this study were affected by specific diet. UFCe6 and UFCe7 increased the level of sodium in the serum of the animals, whereas UFCe4 and UFCe5 decreased the chloride level. On the contrary, these electrolytes were not significantly altered by the remaining accessions of *C. esculenta*-based diets. While the serum urea level was decreased by UFCe1, UFCe3, UFCe4 and UFCe5, all other *C. esculenta* accession-based diet did not affect the urea level of the animals. UFCe3 increased the serum creatinine content of the animals whereas the value produced by the other accession of *C. esculenta*-based diet groups compared well with the control (Table 3). In addition, only the animals maintained on UFCe4, UFCe6 and UFCe7 had their serum potassium levels elevated whereas the level of the electrolyte in the other formulated diet groups were not significantly altered (Table 3). The animals maintained on UFCe4 produced the highest (38.89%) alteration in the functional indices investigated whereas the UFCe2 altered the least number (16.67%) of the parameters.

**DISCUSSION**

*Colocasia esculenta* is an important staple food throughout many regions of the world. Despite the increasing consumption of the crop, data on toxicological implication in animals appears to be lacking in open scientific literatures. Feeding of animals with accessions of *C. esculenta* growing in Kwazulu-Natal Province of South Africa revealed that the crop could alter some of the liver and kidney functional indices of weanling rats.
The biochemical indices monitored in the serum in this study are useful ‘markers’ for assessing the functional capacities of the organs. Biochemical indices of organ function if altered will impair the normal functioning of the organs.\textsuperscript{12}

Albumin, bilirubin, total and conjugated bilirubin are mixtures of biomolecules that can be used to assess the functional capacity of the liver. Albumin, synthesized in the liver, is the most abundant serum protein representing 55-65\% of the total protein.\textsuperscript{13} Bilirubin formed from the breakdown of haemoglobin in the liver is conjugated with glucuronic acid to form a soluble compound which passes down the bile duct and excreted into the gastrointestinal tract. The absence of an effect on the albumin and globulin by some of the formulated diet and coupled with alterations in the level of total protein and bilirubin might imply selective and diet specific effect on the liver. The reduction in the total protein and total bilirubin by UFCe3 and UFCe4 as well as a decrease in conjugated bilirubin level by UFCe3 and UFCe6 may imply adverse effect on the synthetic, secretory and rapid clearance of the bilirubin without commensurate synthesis of the biomolecules.

ALP is a ‘marker’ enzyme of damage to the plasma membrane and endoplasmic reticulum.\textsuperscript{14} It is often used to assess the integrity of the plasma membrane.\textsuperscript{15} Although tissue enzyme activity was not studied, the decrease in ALP activity by all the accessions of \textit{C. esculenta}-based diet may be attributed to inactivation or inhibition of the enzyme molecule at the cellular/molecular level.\textsuperscript{15} In contrast, the increase in the serum GGT suggests leakage from the tissue into the extracellular fluid, the serum. Since tissue enzymes were not measured in this study, it is impossible to really ascertain this school of thought. The enhanced levels of serum GGT could possibly indicate adverse effect on the mechanism responsible for the maintenance of the normal level of the enzyme in the blood of the animals.
ALT and AST are useful ‘marker’ enzymes of liver cytolysis. They play a key role in the metabolism of amino acids. Increase in serum ALT by the UFCe1 and UFCe5 as well as a decrease in AST activity by UFCe4 are indications of alterations in the cytosolic content of the animals. Whereas the increase in serum ALT suggests contribution from tissue enzymes, the decrease in ALT activity suggests inactivation of the enzyme molecule at the molecular level. All these alterations may have consequential effect on the amino acid metabolism of the animals.

It is noteworthy that the levels of inorganic phosphorus, calcium, magnesium and uric acid were not affected by the various accessions of *C. esculenta*-based diets. However, the increase in sodium level by UFCe4 as well as the decrease in the chloride levels by UFCe5 implies selective effect by the diets on the normal functioning of the kidney. The alterations in these electrolytes may affect processes dependent on these ions. Urea, a major catabolic product of protein is one of the principal indices for assessing kidney function. It is derived from general protein metabolism and is always at least partially reabsorbed passively in the renal tubules. The decrease in the level of urea by the UFCe1, UFCe3, UFCe4 and UFCe5 suggests enhanced rate of excretion/clearance of the kidney parameter from the blood which is not commensurate with the rate of production from the deamination of protein. Creatinine, a commonly used test of renal function, is an endogenous, nitrogenous waste product derived from creatine and creatine phosphate in muscle tissue. The increase in serum creatinine level by UFCe3 might be an indication of dysfunction at the glomerular and or tubular levels. The reduction in the levels of potassium by UFCe4, UFCe6 and UFCe7 might imply an adverse effect on the pump responsible for regulating and maintaining the constancy of the ion in the blood. All these alterations suggest that the accessions of *C. esculenta* could adversely affect the normal hepatorenal functioning of the animals.
In conclusion, the accessions of *C. esculenta* selectively altered the biochemical indices of liver and kidney function in the weanling rats. The highest alterations were produced by the UFCe4 (38.89%) while the least was from UFCe2 (16.67%). The UFCe2 exhibited the least toxicity risk among the accessions of *C. esculenta* growing in KwaZulu-Natal Province of South Africa. These alterations may have consequential effects on the normal functioning of the liver and kidney of the animals.

ACKNOWLEDGEMENTS

The authors thank the National Research Foundation of South Africa for financial support.

Author Disclosure Statement

No competing financial interests exist.

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References


Table 1: Components of the diets

<table>
<thead>
<tr>
<th>Feed components</th>
<th>Cocoyam-based diet (g/kg)</th>
<th>Corn starch-based (control) diet (g/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soybean</td>
<td>250</td>
<td>250</td>
</tr>
<tr>
<td>Corn starch</td>
<td>----</td>
<td>516</td>
</tr>
<tr>
<td>Cocoyam tuber</td>
<td>516</td>
<td>----</td>
</tr>
<tr>
<td>Soybean oil</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>Cellulose</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>Sucrose</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>DL Methionine</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Vitamin mix&lt;sup&gt;a&lt;/sup&gt;</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>Mineral mix&lt;sup&gt;b&lt;/sup&gt;</td>
<td>10</td>
<td>10</td>
</tr>
</tbody>
</table>

Soybean oil: polyunsaturated fatty acids (58%), monounsaturated fatty acids (29%), saturated fatty acids (13%).

<sup>a</sup> Vitamin mix (per kg of diet): bioflavanoids, 500 mg; vitamin A, 1 000 000 IU; vitamin D3, 245 000 IU; vitamin E, 1 000 IU; vitamin K, 500 mg; D-Pantothenic acid, 1 000 mg; riboflavin (vitamin B2), 500 mg; thiamine (vitamin B1), 300 mg; folic acid, 50 mg; niacin, 2 500 mg, pyrodoxine (vitamin B6), 100 mg; vitamin B12, 3 mg; ascorbic acid (vitamin C), 500 mg. Also contains dextrose, potassium 1,05% and sodium 21, 20% (as salts).
Mineral mix (g/kg): CoCl$_2$.6H$_2$O (0.001), CuSO$_4$.5H$_2$O (0.079), MnSO$_4$.7H$_2$O (0.178), KI (0.032), NaCl (3.573), ZnCO$_3$ (1.60), CaSO$_4$ (11.610), MgSO$_4$.7H$_2$O (2.292), K$_2$HPO$_4$ (10.559), FeSO$_4$.7H$_2$O (1.078).
Table 2: Effect of *Colocasia esculenta*-based diets on the liver functional indices of weanling Wistar rats. Data are in $\bar{X} \pm SD$, n = 6

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Control</th>
<th>UFeC1</th>
<th>UFeC2</th>
<th>UFeC3</th>
<th>UFeC4</th>
<th>UFeC5</th>
<th>UFeC6</th>
<th>UFeC7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total bilirubin (µmol/L)</td>
<td>7.00±0.82&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>6.00±0.82&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>7.00±0.82&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>7.75±0.96&lt;sup&gt;a&lt;/sup&gt;</td>
<td>5.25±0.50&lt;sup&gt;c&lt;/sup&gt;</td>
<td>7.75±0.96&lt;sup&gt;a&lt;/sup&gt;</td>
<td>6.00±0.82&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>7.25±0.96&lt;sup&gt;ab&lt;/sup&gt;</td>
</tr>
<tr>
<td>Conjugated bilirubin (µmol/L)</td>
<td>2.25±0.96&lt;sup&gt;abcd&lt;/sup&gt;</td>
<td>1.50±0.58&lt;sup&gt;cd&lt;/sup&gt;</td>
<td>1.25±0.50&lt;sup&gt;d&lt;/sup&gt;</td>
<td>3.25±0.50&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.50±0.58&lt;sup&gt;abc&lt;/sup&gt;</td>
<td>2.00±0.82&lt;sup&gt;bcd&lt;/sup&gt;</td>
<td>3.00±0.82&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>2.25±0.50&lt;sup&gt;abcd&lt;/sup&gt;</td>
</tr>
<tr>
<td>Albumin (g/L)</td>
<td>14.50±1.29&lt;sup&gt;a&lt;/sup&gt;</td>
<td>14.75±0.96&lt;sup&gt;a&lt;/sup&gt;</td>
<td>13.50±1.00&lt;sup&gt;a&lt;/sup&gt;</td>
<td>13.25±1.50&lt;sup&gt;a&lt;/sup&gt;</td>
<td>13.50±1.73&lt;sup&gt;a&lt;/sup&gt;</td>
<td>14.50±1.29&lt;sup&gt;a&lt;/sup&gt;</td>
<td>13.25±0.50&lt;sup&gt;a&lt;/sup&gt;</td>
<td>12.75±0.96&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Globulin (g/L)</td>
<td>32.75±0.96&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>35.00±2.16&lt;sup&gt;a&lt;/sup&gt;</td>
<td>32.75±2.06&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>30.25±1.26&lt;sup&gt;b&lt;/sup&gt;</td>
<td>34.75±1.26&lt;sup&gt;a&lt;/sup&gt;</td>
<td>32.75±0.96&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>34.50±1.92&lt;sup&gt;a&lt;/sup&gt;</td>
<td>32.25±2.22&lt;sup&gt;ab&lt;/sup&gt;</td>
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<tr>
<td>Total protein (g/L)</td>
<td>47.25±2.22&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>49.75±1.89&lt;sup&gt;a&lt;/sup&gt;</td>
<td>46.25±2.63&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>43.50±1.29&lt;sup&gt;c&lt;/sup&gt;</td>
<td>48.25±2.75&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>47.25±0.96&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>47.75±1.71&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>45.00±2.31&lt;sup&gt;bc&lt;/sup&gt;</td>
</tr>
<tr>
<td>Alkaline phosphatase (U/L)</td>
<td>1362.30±80.04&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1030.00±99.05&lt;sup&gt;c&lt;/sup&gt;</td>
<td>669.00±81.29&lt;sup&gt;e&lt;/sup&gt;</td>
<td>835.25±68.03&lt;sup&gt;d&lt;/sup&gt;</td>
<td>1053.50±72.33&lt;sup&gt;c&lt;/sup&gt;</td>
<td>1213.00±92.64&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1214.50±77.04&lt;sup&gt;b&lt;/sup&gt;</td>
<td>799.50±56.69&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>Gamma glutamyl transferase (U/L)</td>
<td>6.25±0.96&lt;sup&gt;e&lt;/sup&gt;</td>
<td>8.00±0.82&lt;sup&gt;de&lt;/sup&gt;</td>
<td>8.25±0.96&lt;sup&gt;d&lt;/sup&gt;</td>
<td>9.50±1.29&lt;sup&gt;cd&lt;/sup&gt;</td>
<td>13.50±1.29&lt;sup&gt;a&lt;/sup&gt;</td>
<td>10.75±1.50&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>10.75±1.71&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>12.50±1.00&lt;sup&gt;ab&lt;/sup&gt;</td>
</tr>
<tr>
<td>Alanine aminotransferase (U/L)</td>
<td>116.00±9.42&lt;sup&gt;c&lt;/sup&gt;</td>
<td>149.50±14.01&lt;sup&gt;a&lt;/sup&gt;</td>
<td>122.00±14.45&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>121.00±10.49&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>98.25±6.08&lt;sup&gt;d&lt;/sup&gt;</td>
<td>135.75±11.62&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>115.75±8.14&lt;sup&gt;c&lt;/sup&gt;</td>
<td>108.25±7.46&lt;sup&gt;cd&lt;/sup&gt;</td>
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<tr>
<td>Aspartate aminotransferase (U/L)</td>
<td>214.00±12.73&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>278.50±19.54&lt;sup&gt;a&lt;/sup&gt;</td>
<td>231.75±14.89&lt;sup&gt;b&lt;/sup&gt;</td>
<td>235.00±31.61&lt;sup&gt;b&lt;/sup&gt;</td>
<td>199.00±14.67&lt;sup&gt;c&lt;/sup&gt;</td>
<td>215.00±16.97&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>197.50±16.84&lt;sup&gt;c&lt;/sup&gt;</td>
<td>208.00±14.86&lt;sup&gt;bc&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Values with different superscripts along the row for each diet are significantly different (P<0.05).
Table 3: Effect of *Colocasia esculenta*-based diets on the kidney functional indices of weanling Wistar rats. Data are in $\bar{X} \pm SD$, n = 6

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Control</th>
<th>UFCe1</th>
<th>UFCe2</th>
<th>UFCe3</th>
<th>UFCe4</th>
<th>UFCe5</th>
<th>UFCe6</th>
<th>UFCe7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium (mmol/L)</td>
<td>139.25±1.71a</td>
<td>139.25±1.71a</td>
<td>140.25±1.26a</td>
<td>139.75±0.96a</td>
<td>140.75±1.71a</td>
<td>140.50±1.73a</td>
<td>143.00±2.45b</td>
<td>142.75±0.50b</td>
</tr>
<tr>
<td>Potassium (mmol/L)</td>
<td>5.80±0.08a</td>
<td>6.03±0.33a</td>
<td>6.05±0.31a</td>
<td>5.90±0.80a</td>
<td>6.43±0.44b</td>
<td>6.15±0.71a</td>
<td>6.70±0.66b</td>
<td>6.43±0.50b</td>
</tr>
<tr>
<td>Chloride (mmol/L)</td>
<td>108.50±2.89a</td>
<td>105.00±2.16a</td>
<td>104.50±2.52a</td>
<td>107.50±1.29ab</td>
<td>103.25±2.50c</td>
<td>103.25±1.26c</td>
<td>105.50±3.32abc</td>
<td>105.25±1.71abc</td>
</tr>
<tr>
<td>Inorganic phosphorus (mmol/L)</td>
<td>2.95±0.30a</td>
<td>2.70±0.28a</td>
<td>2.75±0.19a</td>
<td>2.88±0.10a</td>
<td>2.75±0.06a</td>
<td>2.70±0.27a</td>
<td>2.85±0.27a</td>
<td>2.70±0.14a</td>
</tr>
<tr>
<td>Urea (mmol/L)</td>
<td>7.45±0.51a</td>
<td>5.40±0.59bc</td>
<td>7.55±0.95a</td>
<td>5.23±0.76bc</td>
<td>5.70±0.85bc</td>
<td>5.03±0.97c</td>
<td>7.55±0.65ab</td>
<td>7.65±0.93a</td>
</tr>
<tr>
<td>Creatinine (µmol/L)</td>
<td>35.50±2.89ab</td>
<td>38.25±3.50ab</td>
<td>37.00±4.90abc</td>
<td>41.25±2.06d</td>
<td>36.00±2.58abc</td>
<td>32.25±0.96c</td>
<td>34.25±2.99bc</td>
<td>36.50±2.89abc</td>
</tr>
<tr>
<td>Calcium (mmol/L)</td>
<td>2.37±0.09a</td>
<td>2.37±0.07a</td>
<td>2.40±0.12a</td>
<td>2.31±0.11a</td>
<td>2.37±0.09a</td>
<td>2.39±0.03a</td>
<td>2.38±0.04a</td>
<td>2.38±0.09a</td>
</tr>
<tr>
<td>Magnesium (mmol/L)</td>
<td>1.08±0.06a</td>
<td>1.06±0.03a</td>
<td>1.07±0.03a</td>
<td>1.03±0.08a</td>
<td>1.01±0.08a</td>
<td>1.02±0.03a</td>
<td>1.03±0.05a</td>
<td>1.01±0.07a</td>
</tr>
<tr>
<td>Uric acid (mmol/L)</td>
<td>0.06±0.02a</td>
<td>0.09±0.03a</td>
<td>0.07±0.01a</td>
<td>0.09±0.01a</td>
<td>0.09±0.01a</td>
<td>0.08±0.01a</td>
<td>0.08±0.01a</td>
<td>0.08±0.01a</td>
</tr>
</tbody>
</table>

Values with different superscripts along the row for each diet are significantly different (P<0.05).