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EFFECTS OF WATER HYACINTH LEAF PROTEIN CONCENTRATE ON GROWTH AND HAEMATOLOGICAL PROPERTIES OF RATS

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ABSTRACT

In this study, edible form of water hyacinth leaf protein concentrate (WHLPC) was extracted. The WHLPC was used to formulate feed using different concentrations (7.73, 15.46, 23.19, and 30.92) %w/w. A control feed was formulated with soybean (15.46%w/w) in place of WHLPC. The resulting feeds were fed to different groups of rats. The feeding exercise was for a period of twenty (20) weeks during which haematological properties and growth of rats were monitored. Growth response curve of rats placed on formulated feed showed positive slope. At the end of the experiment, rats in various groups gained weight, gain in body weight measured in Control rats (55.35 g), WHLPC1 rats (57.75 g) were not significantly different (p>0.05). Haematological properties of experimental rats favourably responded to the formulated feeds and there was no significant difference among the test rats relative to the control (p>0.05). Evidence from this study suggests that WHLPC maintains blood integrity and supports normal growth in rats. WHLPC was also found to be well tolerated and therefore may be a good raw material for food and beverage industries.

KEYWORDS: Water hyacinth; leaf protein concentrate; haematology; formulated diet; feeding exercise.

INTRODUCTION

Originally from South America, water hyacinth, *Eichhornia crassipes* (Mart.) Solms, is one of the world's most prevalent invasive aquatic plants. Water hyacinth, a floating vascular plant, is known to cause major ecological and socio-economic changes.[1] It commonly forms dense, interlocking mats due to its rapid reproductive rate and complex root structure. Water hyacinth reproduces both sexually and asexually. Ten to 100% of its existing seeds are found to germinate within six months. Nutrients and temperature are considered the strongest determinants for water hyacinth growth and reproduction.[2] Salinity constraints generally limit water hyacinth establishment in coastal areas and within estuaries. Low temperatures and winter ice cover currently limit water hyacinth from spreading into cooler latitudes; however, recent climate change models suggest that the distribution of aquatic invasive species is likely to expand in temperate regions.

Water hyacinth has invaded freshwater systems in over 50 countries on five continents; it is especially pervasive throughout Southeast Asia, the southeastern United States, central and western Africa, and Central America.[3,4] It is prevalent in tropical and subtropical water bodies where nutrient levels are often high due to agricultural runoff and insufficient wastewater treatment. Its success as an invader is attributed to its abilityto outcompete native vegetation and phytoplankton for light and its release from organisms that feed on it (*Neochetina eichhorniae* and *N. bruchi*) found within its native range. Changes in water hyacinth density have the potential to affect other ecological and human communities in areas where it is established; these changes may be perceived as positive or negative depending on the designated or beneficial uses of the water body.[5]

Leaf protein concentrate (LPC) is a concentrated form of the proteins found in the leaves of plants. It has been examined as a human or animal food source, because it is potentially the cheapest, most abundant source of available protein. Although humans can derive some protein from the direct consumption of leaves as leaf vegetables, the human digestive system would not be able to deal with the enormous bulk of leaves needed to meet dietary protein requirements with leaf vegetables alone.[6] LPC was first suggested as a human food in the 1960s, but it has not achieved much success, despite early promise.[7,8] Leaf protein is a good source of amino acids, with methionine being a limiting factor.[9]

Changes in body and organ weights as well as haematological properties have long been accepted as a sensitive indicator of chemically induced changes to organs.[10,11,12] Weighing of organs of treated animals may reveal specific organ changes related to the treatment.[13] Leaf proteins can also be rich in polyphenols and other antinutritional factors, such as phytate, cyanide and tannins.[14] In this study, we have evaluated the response of haematological properties as well as body and organ weights of rats fed with water hyacinth leaf protein concentrate over a period of 20 weeks.

MATERIALS AND METHODS

Extraction of Water Hyacinth Leaf Protein Concentrate (WHLPC)

The water hyacinth leaf protein concentrate (WHLPC) was extracted following the method described by Pirie.[7]

Experimental Animals and Management

Hundred Albino rats (*Rattus novergicus*) were obtained from the Animal Holding of the Department of Anatomy University of Benin, Benin-City, Nigeria. The experimental animals were kept inside 5 plastic cages containing 20 animals each. The rats were classified into 5 groups as follows;

Group I: control rats fed with soybean as protein source
Group II: rats fed with WHLPC1 as protein source
Group III: rats fed with WHLPC2 as protein source
Group IV: rats fed with WHLPC3 as protein source
Group V: rats fed with WHLPC4 as protein source

Feed Formulation

Five kinds of diets were prepared in accordance with the composition of source materials and the daily nutrient requirements which were named Control and WHLPC1, WHLPC2, WHLPC3, WHLPC4, respectively. Details of each feedstuff formula are presented in Table 1. The assay diets were set at a protein and oil level of 15.46% and 8%, respectively. All the components of the formulated feedstuffs of each group were well mixed together and pressed into sticks by employing a screw extrusion presser.

Feeding period

Experimental rats were placed on respective diet over a period of 20 weeks. However, 4 rats were picked out from each group on that day, to determine basal levels of parameters to be monitored, and at week 5, 10, 15 while the remaining rats were picked out at the 20th week. The rats were sacrificed on the day they were picked out; a portion of blood were collected into EDTA bottles for haematology studies.

Anaesthetisation of Animals and collection of blood for haematological analysis

The rats were anaesthetized by placing them in a jar containing cotton wool soaked with chloroform before being sacrificed by jugular puncture. The vein, after being slightly displaced, was sharply cut with sterile surgical blade and an aliquot (2 ml) of the blood was collected into ethylene diamine tetra-acetic acid (EDTA) embedded sample bottles (BD Diagnostics, preanalytical systems, Midrand, USA) for haematological analysis.

Determination of Haematological Parameters

Haemoglobin concentration of the blood of experimental animals was determined following the method described by Mitruka and Rawnsley.[15] Red blood count (RBC) Packed cell volume (PCV), White blood cell (WBC) count was determined using standard methods.[16] Platelet count was determined following Rees-Ecker method.[17]

Statistical Analyses

All numerical results were obtained from the five (5) groups (control and treated). Data were presented as mean±SEM and analysed using one way analysis of variance (ANOVA) and Duncan Multiple Range Test using SPSS-18.0 (Statistical packages for social Scientists – version 18.0) statistical program. P values<0.05 were considered significant.

RESULTS

Figure 1: shows the growth response curve of rats fed with feed formulated with WHLPC. Rats in the five groups showed positive response to the formulated feed. At the end of the feeding experiment, the weight of rats in groups I and II are not significantly different (p>0.05) but are significantly higher (p<0.05) than weight of rats in the remaining groups. Particularly, weights gained by rats in various groups are; Groups I (55.35±5.77g), II (57.75±6.26g), III (44.92±2.22g), IV (49.84±6.67g) and V (43.03±2.95g). Although the gain in weight by animals in Groups III and V are significantly lower than those of other groups of rats, still animals in the two groups responded positively to the formulated feed.

The relative liver weight of rats placed on WHLPC is shown in Figure 2. No significant difference in the relative liver weight among the experimental rats (p>0.05). Generally, relative liver weights of rats in all the groups fell significantly at week 5 relative to the first week; however the weights began to rise at week 10 through week 15 to week 20. All the experimental rats both control (Group I) and test (Groups II-V) showed the same pattern of relative liver weight and this could be adjudged to be normal.

Figure 3 presents the relative kidney weight of rats placed on feed formulated with WHLPC. Relative kidney weights of rats in groups II and IV were found to be significantly (p<0.05) higher than those of rats in other groups throughout the period of experiment. Generally, the relative kidney weight of the rats in Groups I to V decreased significantly at week 5 and began to rise again at week 10 through week 15 and the weight was sustained to week 20.

Figure 4 presents the relative heart weight of rats placed on feed formulated with WHLPC. Rats in Groups I and IV displayed a similar pattern in the growth curve of relative heart weight. The relative weighs of hearts of rats in the two groups fell at week 5 and rises at week 10 to week 15 before it became stable. The curves of the relative heart weight of rats in the remaining groups do not follow any definite pattern. However, relative heart weights of all groups of rats at the start of experiment is not significantly different (p<0.05) from the value at the end of the experiment.

Results of haematological analysis of rats at the start of the experiment are presented in Table 2. The basal haematological parameters of rats in all the groups were not significantly different (p>0.05).

Results of haematological analysis of rats placed on WHLPC formulated feed over a period of five weeks is presented in Table 3. At week 5, the haematological parameters of rats in the 5 groups of rats are not significantly different (p>0.05). However, haematological parameters of all the groups of rats at week 5 were found to be better than that of their corresponding basal values.

Table 4 presents haematological analysis of experimental rats at week 10. Again, an improvement was observed in the values of haematological parameters of the 5 group of rats at week 10 over those of week 5. Generally, no significant difference (p>0.05) was found in the results of haematological analysis among the different groups of rats.

Haematological analysis results of experimental rats at week 15 are presented in Table 5. Again, no significant difference (p>0.05) was found of the haematological properties among the different group of rats. It was found that the values of the haematological parameters were lower than those of week 10 but there was no significant difference (p>0.05) between the haematological properties of rats at week 10 and week 15. No significant difference (p>0.05) exists among haematological parameters of rats in all the groups at week 15.

Table 6 presents the haematological properties of experimental rats at week 20. No significant difference (p>0.05) exists among haematological parameters of rats in all the groups at week 20. Also, no significant difference (p>0.05) in the haematological properties of experimental rats among the various duration under investigation (Weeks, 5, 10, 15 and 20), the basal haematological properties of rats were sustained over the 20 weeks period of the experiment.

Table 1: Ingredient composition (%) of the experimental diets

Group	Corn starch	Protein sources	Soy oil	Fish meal	Vitamins + Minerals
Control	60	15.46*	8	15.22	1.32
WHLPC1	60	7.73	8	22.71	1.32
WHLPC2	60	15.46	8	15.22	1.32
WHLPC2	60	23.19	8	7.49	1.32
WHLPC3	60	30.92	8	0.00	1.32

WHLPC – Water hyacinth leaf protein concentrate
*Soy protein

Table 2: Haematological properties of rats to be placed on feed formulated with water hyacinth leaf protein concentrate (WHLPC) over a period of twenty weeks.

HAEMATOLOGICAL PARAMETERS	GROUP OF RATS				
	I	II	III	IV	V
RBC (x 10mm^{-3})	9.6±0.22^a	9.4±0.21^a	9.2±0.22^a	9.5±0.23^a	9.3±0.21^a
Hb (gdL^{-1})	13.6±0.32^a	13.5±0.41^a	13.4±0.42^a	13.5±0.51^a	13.6±0.39^a
MCV (µ3)	48±3.1^a	49±2.7^a	49±3.2^a	50±3.4^a	49±3.2^a
MCH (µg)	13.9±0.89^a	14.3±0.67^a	14.7±0.81^a	14.2±0.65^a	13.9±0.92^a
MCHC (%)	30±2.1^a	28±2.2^a	30±3.1^a	29±2.1^a	29±2.3^a
PCV (%)	49±2.1^a	48±2.1^a	48±2.3^a	49±2.2^a	49±2.1^a
ESR (mm h^{-1})	0.9±0.011^a	0.88±0.011^a	0.87±0.011^a	0.9±0.011^a	0.86±0.011^a
Platelets (x 10^3 mm^{-3})	195±4.2^a	190±5.6^a	188±5.4^a	194±6.1^a	193±5.7^a
WBC (x 10^3 mm^{-3})	9.8±0.65^a	9.7±0.68^a	9.8±0.66^a	9.6±0.69^a	9.8±0.67^a
Neutrophils (x 10^3 mm^{-3})	2.45±0.22^a	2.44±0.21^a	2.44±0.2^a	2.43±0.22^a	2.46±0.22^a
Eosinophils (%)	0.03±0.001^a	0.03±0.001^a	0.03±0.001^a	0.03±0.001^a	0.03±0.001^a
Basophils (x 10^3 mm^{-3})	0.02±0.001^a	0.02±0.001^a	0.02±0.001^a	0.02±0.001^a	0.02±0.001^a
Lymphocytes (x 10^3 mm^{-3})	6.5±0.21^a	6.9±0.23^a	6.7±0.22^a	6.8±0.21^a	6.6±0.22^a
Monocytes (x 10^3 mm^{-3})	0.03±0.001^a	0.03±0.001^a	0.03±0.001^a	0.03±0.001^a	0.03±0.001^a

Each value represents mean ± SEM of two determinations of blood from four different animals. Values in the same column bearing different superscripts are significantly different (p<0.05).

Table 3: Haematological properties of rats placed on feed formulated with water hyacinth leaf protein concentrate (WHLPC) over a period of five weeks.

HAEMATOLOGICAL PARAMETERS	GROUP OF RATS				
	I	II	III	IV	V
RBC (x 10mm^{-3})	10.08±0.231 [a]	9.87±0.220 [a]	9.66±0.231 [a]	9.975±0.241 [a]	9.765±0.221 [a]
Hb (gdL-1)	14.28±0.336 [a]	14.17±0.430 [a]	14.07±0.441 [a]	14.175±0.535 [a]	14.28±0.410 [a]
MCV (µ3)	50.4±3.255 [a]	51.45±2.835 [a]	51.45±3.36 [a]	52.5±3.57 [a]	51.45±3.36 [a]
MCH (µg)	14.60±0.9345 [a]	15.02±0.703 [a]	15.435±0.850 [a]	14.91±0.682 [a]	14.595±0.966 [a]
MCHC (%)	31.5±2.205 [a]	29.4±2.31 [a]	31.5±3.255 [a]	30.45±2.205 [a]	30.45±2.415 [a]
PCV (%)	51.45±2.205 [a]	50.4±2.205 [a]	50.4±2.415 [a]	51.45±2.31 [a]	51.45±2.205 [a]
ESR (mm h^{-1})	0.95±0.012 [a]	0.924±0.012 [a]	0.9135±0.011 [a]	0.945±0.011 [a]	0.903±0.012 [a]
Platelets (x 10^{3} mm^{-3})	204.75±4.41 [a]	199.5±5.88 [a]	197.4±5.67 [a]	203.7±6.405 [a]	202.65±5.985 [a]
WBC (x 10^{3} mm^{-3})	10.29±0.683 [a]	10.185±0.714 [a]	10.29±0.693 [a]	10.08±0.724 [a]	10.29±0.704 [a]
Neutrophils (x 10^{3} mm^{-3})	2.57±0.231 [a]	2.562±0.220 [a]	2.562±0.21 [a]	2.5515±0.231 [a]	2.583±0.231 [a]
Eosinophils (%)	0.032±0.001 [a]	0.032±0.001 [a]	0.032±0.001 [a]	0.032±0.001 [a]	0.032±0.001 [a]
Basophils (x 10^{3} mm^{-3})	0.021±0.001 [a]	0.021±0.001 [a]	0.021±0.00105 [a]	0.021±0.001 [a]	0.021±0.001 [a]
Lymphocytes (x 10^{3} mm^{-3})	6.825±0.221 [a]	7.245±0.241 [a]	7.035±0.231 [a]	7.14±0.221 [a]	6.93±0.231 [a]
Monocytes (x 10^{3} mm^{-3})	0.032±0.001 [a]	0.032±0.001 [a]	0.032±0.001 [a]	0.032±0.001 [a]	0.032±0.001 [a]

Each value represents mean ± SEM of two determinations of blood from four different animals. Values in the same column bearing different superscripts are significantly different ($p<0.05$).

Table 4: Haematological properties of rats placed on feed formulated with water hyacinth leaf protein concentrate (WHLPC) over a period of ten weeks.

HAEMATOLOGICAL PARAMETERS	GROUP OF RATS				
	I	II	III	IV	V
RBC (x 10mm^{-3})	10.272±0.235 [a]	10.058±0.225 [a]	9.844±0.235 [a]	10.165±0.246 [a]	9.951±0.225 [a]
Hb (gdL-1)	14.552±0.342 [a]	14.445±0.439 [a]	14.338±0.449 [a]	14.445±0.546 [a]	14.552±0.417 [a]
MCV (µ3)	51.360±3.317 [a]	52.430±2.889 [a]	52.430±3.424 [a]	53.500±3.638 [a]	52.430±3.424 [a]
MCH (µg)	14.873±0.952 [a]	15.301±0.717 [a]	15.729±0.867 [a]	15.194±0.696 [a]	14.873±0.984 [a]
MCHC (%)	32.100±2.247 [a]	29.960±2.354 [a]	32.100±3.317 [a]	31.030±2.247 [a]	31.030±2.461 [a]
PCV (%)	52.430±2.247 [a]	51.360±2.247 [a]	51.360±2.461 [a]	52.430±2.354 [a]	52.430±2.247 [a]
ESR (mm h^{-1})	0.963±0.012 [a]	0.942±0.012 [a]	0.931±0.012 [a]	0.963±0.012 [a]	0.920±0.012 [a]
Platelets (x 10^{3} mm^{-3})	208.650±4.494 [a]	203.300±5.992 [a]	201.160±5.778 [a]	207.580±6.527 [a]	206.510±6.099 [a]
WBC (x 10^{3} mm^{-3})	10.486±0.696 [a]	10.379±0.728 [a]	10.486±0.706 [a]	10.272±0.738 [a]	10.486±0.717 [a]
Neutrophils (x 10^{3} mm^{-3})	2.622±0.235 [a]	2.611±0.225 [a]	2.611±0.214 [a]	2.600±0.235 [a]	2.632±0.235 [a]
Eosinophils (%)	0.032±0.001 [a]	0.032±0.001 [a]	0.032±0.001 [a]	0.032±0.001 [a]	0.032±0.001 [a]
Basophils (x 10^{3} mm^{-3})	0.021±0.001 [a]	0.021±0.001 [a]	0.021±0.001 [a]	0.021±0.001 [a]	0.021±0.001 [a]
Lymphocytes (x 10^{3} mm^{-3})	6.955±0.225 [a]	7.383±0.246 [a]	7.169±0.235 [a]	7.276±0.225 [a]	7.062±0.235 [a]
Monocytes (x 10^{3} mm^{-3})	0.032±0.001 [a]	0.032±0.001 [a]	0.032±0.001 [a]	0.032±0.001 [a]	0.032±0.001 [a]

Each value represents mean ± SEM of two determinations of blood from four different animals. Values in the same column bearing different superscripts are significantly different ($p<0.05$).

Table 5: Haematological properties of rats placed on feed formulated with water hyacinth leaf protein concentrate (WHLPC) over a period of 15 weeks.

HAEMATOLOGICAL PARAMETERS	GROUP OF RATS				
	I	II	III	IV	V
RBC (x 10mm^{-3})	10.099±0.231 [a]	9.889±0.221 [a]	9.678±0.231 [a]	9.994±0.242 [a]	9.784±0.221 [a]
Hb (gdL-1)	14.307±0.337 [a]	14.202±0.431 [a]	14.097±0.442 [a]	14.202±0.537 [a]	14.307±0.410 [a]
MCV (µ3)	50.496±3.261 [a]	51.548±2.840 [a]	51.548±3.366 [a]	52.600±3.577 [a]	51.548±3.366 [a]
MCH (µg)	14.623±0.936 [a]	15.044±0.705 [a]	15.464±0.852 [a]	14.938±0.684 [a]	14.623±0.968 [a]
MCHC (%)	31.560±2.209 [a]	29.456±2.314 [a]	31.560±3.261 [a]	30.508±2.209 [a]	30.508±2.420 [a]
PCV (%)	51.548±2.209 [a]	50.496±2.209 [a]	50.496±2.420 [a]	51.548±2.314 [a]	51.548±2.209 [a]
ESR (mm h^{-1})	0.947±0.012 [a]	0.926±0.012 [a]	0.915±0.012 [a]	0.947±0.012 [a]	0.905±0.012 [a]
Platelets (x 10^{3} mm^{-3})	205.140±4.418 [a]	199.880±5.891 [a]	197.776±5.681 [a]	204.088±6.417 [a]	203.036±5.996 [a]
WBC (x 10^{3} mm^{-3})	10.310±0.684 [a]	10.204±0.715 [a]	10.310±0.694 [a]	10.099±0.726 [a]	10.310±0.705 [a]
Neutrophils (x 10^{3} mm^{-3})	2.577±0.231 [a]	2.567±0.221 [a]	2.567±0.210 [a]	2.556±0.231 [a]	2.588±0.231 [a]
Eosinophils (%)	0.032±0.001 [a]	0.032±0.001 [a]	0.032±0.001 [a]	0.032±0.001 [a]	0.032±0.001 [a]
Basophils (x 10^{3} mm^{-3})	0.021±0.001 [a]	0.021±0.001 [a]	0.021±0.001 [a]	0.021±0.001 [a]	0.021±0.001 [a]

Lymphocytes (x 10^3 mm^{-3})	6.838±0.221 [a]	7.259±0.242 [a]	7.048±0.231 [a]	7.154±0.221 [a]	6.943±0.231 [a]
Monocytes (x 10^3 mm^{-3})	0.032±0.001 [a]	0.032±0.001 [a]	0.032±0.001 [a]	0.032±0.001 [a]	0.032±0.001 [a]

Each value represents mean ± SEM of two determinations of blood from four different animals. Values in the same column bearing different superscripts are significantly different (p<0.05).

Table 6: Haematological properties of rats placed on feed formulated with water hyacinth leaf protein concentrate (WHLPC) over a period of 20 weeks.

HAEMATOLOGICAL PARAMETERS	GROUPS OF RATS				
	I	II	III	IV	V
RBC (x $10mm^{-3}$)	10.013±0.229 [a]	9.804±0.219 [a]	9.596±0.229 [a]	9.909±0.240 [a]	9.700±0.219 [a]
Hb (gdL-1)	14.185±0.334 [a]	14.081±0.428 [a]	13.976±0.438 [a]	14.081±0.532 [a]	14.185±0.407 [a]
MCV (µ3)	50.064±3.233 [a]	51.107±2.816 [a]	51.107±3.338 [a]	52.150±3.546 [a]	51.107±3.338 [a]
MCH (µg)	14.498±0.928 [a]	14.915±0.699 [a]	15.332±0.845 [a]	14.811±0.678 [a]	14.498±0.960 [a]
MCHC (%)	31.290±2.190 [a]	29.204±2.295 [a]	31.290±3.233 [a]	30.247±2.190 [a]	30.247±2.399 [a]
PCV (%)	51.107±2.190 [a]	50.064±2.190 [a]	50.064±2.399 [a]	51.107±2.295 [a]	51.107±2.190 [a]
ESR (mm h^{-1})	0.939±0.011 [a]	0.918±0.011 [a]	0.907±0.011 [a]	0.939±0.011 [a]	0.897±0.011 [a]
Platelets (x 10^3 mm^{-3})	203.385±4.381 [a]	198.170±5.841 [a]	196.084±5.632 [a]	202.342±6.362 [a]	201.299±5.945 [a]
WBC (x 10^3 mm^{-3})	10.221±0.678 [a]	10.117±0.709 [a]	10.221±0.688 [a]	10.013±0.720 [a]	10.221±0.699 [a]
Neutrophils (x 10^3 mm^{-3})	2.555±0.229 [a]	2.545±0.219 [a]	2.545±0.209 [a]	2.534±0.229 [a]	2.566±0.229 [a]
Eosinophils (%)	0.031±0.001 [a]	0.031±0.001 [a]	0.031±0.001 [a]	0.031±0.001 [a]	0.031±0.001 [a]
Basophils (x 10^3 mm^{-3})	0.021±0.001 [a]	0.021±0.001 [a]	0.021±0.001 [a]	0.021±0.001 [a]	0.021±0.001 [a]
Lymphocytes (x 10^3 mm^{-3})	6.780±0.219 [a]	7.197±0.240 [a]	6.988±0.229 [a]	7.092±0.219 [a]	6.884±0.229 [a]
Monocytes (x 10^3 mm^{-3})	0.031±0.001 [a]	0.031±0.001 [a]	0.031±0.001 [a]	0.031±0.001 [a]	0.031±0.001 [a]

Each value represents mean ± SEM of two determinations of blood from four different animals. Values in the same column bearing different superscripts are significantly different (p<0.05).

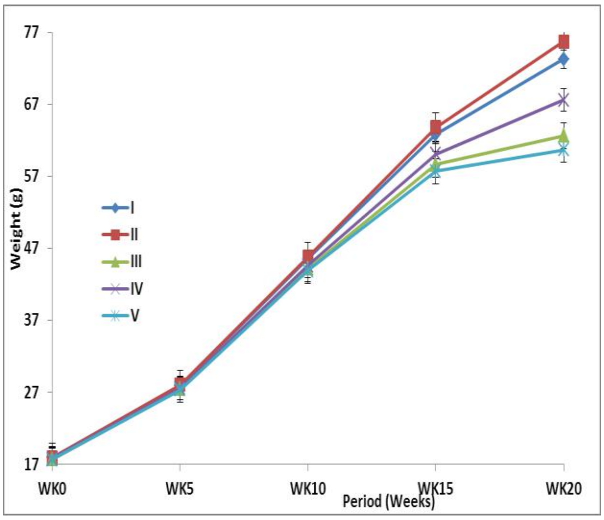

Figure 1 presents the growth response of rats placed on feed formulated with water hyacinth leaf protein concentrate (WHLPC) over a period of twenty weeks. Each value represents mean ± SEM of two determinations from four different animals.

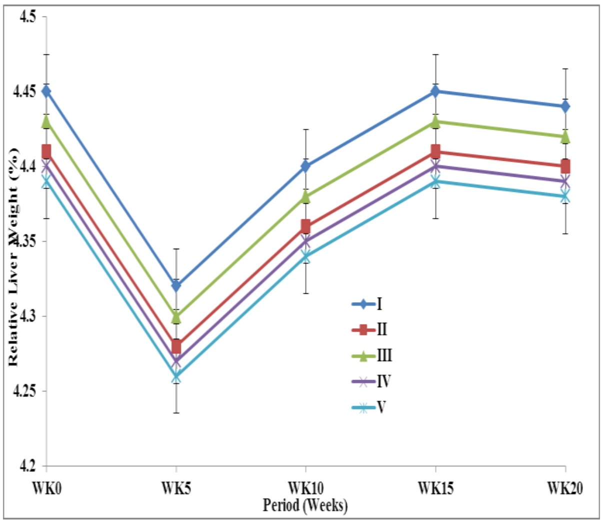

Figure 2: Relative liver weight (%) of rats placed on feed formulated with water hyacinth leaf protein concentrate (WHLPC) over a period of twenty weeks. Each value represents mean ± SEM of two determinations from four different animals.

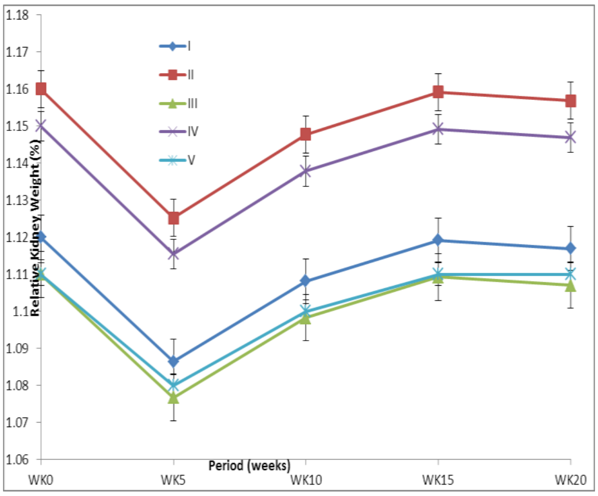

Figure 3: Relative kidney weight (%) of rats placed on feed formulated with water hyacinth leaf protein concentrate (WHLPC) over a period of twenty weeks. Each value represents mean ± SEM of two determinations from four different animals.

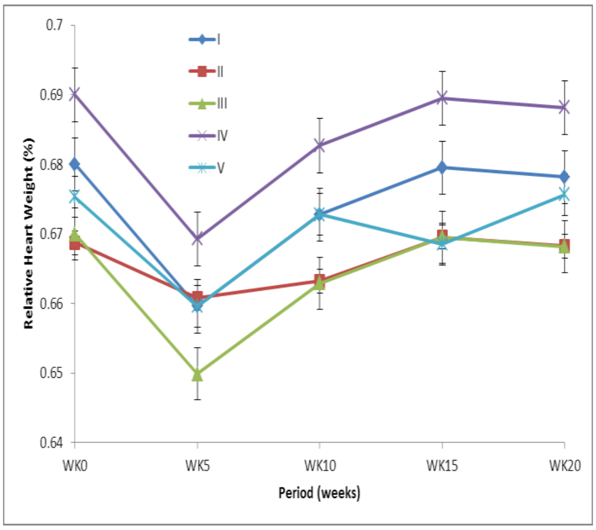

Figure 4: Relative heart weight (%) of rats placed on feed formulated with water hyacinth leaf protein concentrate (WHLPC) over a period of twenty weeks. Each value represents mean ± SEM of two determinations from four different animals.

DISCUSSION

Coastal plants like water hyacinth can perform a number of ecological functions ranging from food production to coastal protection.[18] With the evolutionary competitive edge that water hyacinth has over other plants it is virtually impossible to fully eliminate. This fact has been proven by over 100 years of money spent on water hyacinth abatement. For this reason it is better to adapt and use water hyacinth to meet the food, energy and coastal preservation needs of society in a beneficial way rather than wasting resources in an effort to eliminate the plant, an effort that for the past century has been proven to be futile.[18]

This study is significant as it uncovers the natural resources in water hyacinth by extracting its leaf protein concentrate (LPC) in edible form. The nutritional evaluation of a food with respect to the protein quality requires estimation of the protein content as well as evaluation of the usefulness of the protein for growth. Therefore, apart from the amino acid pattern of a particular protein, which determines whether it is adequate for nutrition, the true nutritive value also needs to be determined by means of feeding trials. The rats used in the feeding trials showed ideal growth and development. However, the water hyacinth leaf protein concentrate (WHLPC) formulated feed set at 7.73% (Group II) produced statistically the same effect as the soy bean formulated feed set at 15.46% (Group I). It could be inferred that the usability of WHLPC is more efficient in rats than the usability of soy bean protein. Onobanjo *et al.* (2009) reported that the biological usefulness of protein for body function is dependent on its bioavailability. The other feed formulated with WHLPC set at 15.46%, 23.19% and 30.92% also produced positive growth in rats but the growth was observed to be significantly lower ($p<0.05$) than that observed for rats in Groups I and II. This observation further points to the fact that the inclusion of WHLPC in diet should be adjusted to 7.73% for biological efficiency.

In toxicological experiments, comparison of organ weights between treated and untreated groups of animals have conventionally been used to evaluate the toxic effect of the test article.[19] Organ weight evaluation is an essential part of the toxicologic and risk assessment of drugs, chemicals, biologics, food additives, and medical devices. The establishment of organ weight reference values at each testing facility for laboratory animals used in toxicological studies has become a standard practice. Once organized, these background data values may be used, in addition to the concomitant control group, as base-line values to compare study results.[20] In this study, no significant difference was observed among the relative organ weight of the rats in all the groups (Figures 2-4). This could be that the WHLPC formulated feed is well tolerated by the liver, kidney and heart. These organs are sensitive to predict food toxicity; often reflective of physiologic perturbations and metabolism; they correlates well with histopathological changes; there is little animal-to-animal variability.[19]

Blood is a good indicator to determine the health of an organism. It also acts as pathological reflector of the whole body hence haematological indices are useful tool in diagnosing the functional status of exposed animal to toxicant, food additives and drugs.[21] Nutritional status of an individual is dependent on dietary intake and effectiveness of metabolic processes. These can be determined by either or combinations of clinical, anthropometric, biochemical or dietary methods. The value of blood components is partly an indication of availability of nutrients for synthesis of blood cells.[22] In the present study, no significant difference ($p<0.05$) was observed for all haematological indices monitored among the various group of rats throughout the 20 week duration of the experiment (Tables 2 - 6). This observation presents WHLPC as a source of quality dietary protein. The WHLPC in combination with concentrate of other feeds has proved to be a good quality protein source for animal feed.[23] Dried water hyacinth was found to be a suitable artificial feeds for the culture of tilapia.[24] Growth and haematological indices from the present study adjudge WHLPC as a probable suitable dietary protein for man especially for growing children. All haematological parameters measured for the various groups of rats are within the normal range, it could also be inferred from this study that the WHLPC is, perhaps, not haematotoxic. A recent study reported that any chemical agent, food, food additive, biologic and medical agent that does not adversely affect haematological indices could be classified as haematoprotective agent.[25]

CONCLUSION

Experimental evidence from the present study revealed that;

- Water hyacinth is a good source of leaf protein concentrate
- WHLPC supports normal growth in rats and compared favourably with soybean
- WHLPC is haematoprotective, as deduced from results of haematological studies
- WHLPC is a good candidate as raw materials for the food and beverage industries

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