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Nutritional and Safety Evaluation of Some Tropical Green Leafy Vegetables

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Abstract: The nutritional and safety evaluation of some commonly consumed tropical green leafy vegetables namely: *Amaranthus cruentus, Baselia alba, Solanum macrocarpon, Ocimum gratissimum, Telfairia occidentalis, Corchorus olitorus* and *Cnidoscolus acontifolius* were evaluated with regard to their protein content, nutrient utilization, growth performance, digestibility and their safety (*in vivo*). The protein content was determined by micro-Kjeldhal method, while the nutrient utilization, growth performance of the vegetables were determined using rat bioassay, the rats were fed diet containing 40% vegetable *ad lib* for 14 days. The result of the study revealed that the protein content of the vegetables ranged from 24.1% for *Amaranthus cruentus* to 38.2% for *Telfaira occidentalis* on dry weight basis. While the result of the bioassay revealed that there was a significant decrease ($P<0.05$) in the daily feed intake, daily weight gain and dry matter digestibility of those rats fed diet with vegetable when compared with the control, while there was a significant increase ($P<0.05$) in the feed; gain ratio. Furthermore, there was a significant increase ($P<0.05$) in their serum glutamate oxaloacetate transaminase (GOT), glutamate pyruvate transaminase (GPT) (except *Baselia alba* and *Solanum macrocarpon),* total protein (except *Cnidosolus acontifolius* and *Telfaira occidentalis*) and albumin (except *Cnidosolus acontifolius* and *Telfaira occidentalis*) in those rats feed with vegetable diets. It is very obvious from the study that those tropical green leafy vegetable studied will not support growth and the consumption of some these vegetables in their unprocessed forms could lead to liver damage.

Key words: Leafy-vegetables, nutrition, safety, protein content

INTRODUCTION

Green leafy vegetables are very popular and used for food in many countries of the world. Being a rich source of β-carotene, ascorbic acid, minerals and dietary fibre, they have become a part of daily diet, but their highly perishable nature demands processing for longer availability[8]. They are also good sources of dietary fiber, protein, vitamins A and B-complex, minerals, especially calcium, iron, magnesium and phosphorus and are low in carbohydrates and fats. Dark green leaves are usually more nutritious than lighter or yellowish leaves. Leaves often contain toxic substances such as oxalic acid, nitrates, glycosides of hydrocyanic acid and alkaloids. Most leaves should be boiled for 5-10 min to remove toxic substances and cooking water discarded. Many leaves vegetables are perennials and yield useful food within a minimum amount of labour. Leaf vegetables respond favourably to fertile growing conditions high in nitrogen, but excess nitrates, harmful to babies and small children, may accumulate in well-fertilized plants[7].

Green leafy vegetables are among the most widely grown group of vegetables. Growing these leafy vegetables is easy with the exception of celery and chicory. The two general uses for green leafy vegetables are as salad crops, which are eaten fresh and as greens or potherbs, which are usually cooked prior to eating. Some green leafy vegetables, including spinach, New Zealand spinach, chard, mustard *Amarantus cruentus* (Atetedaye), *Baselia allia* (Amunu tutu), *Solanum macrocarpon* (Igbagba), *Corchorus olitorius* (Ewedu) and *Ocimum gratissimum* (Efinrin) and endive can be used either fresh or cooked; hence they are very versatile for the home garden[2]

Several vegetables species abound in Nigeria which are utilized either as condiments or spices in human diets, these vegetables could be harvested at all stages in the process of growth and could be fed upon either in the fresh, processed or semi-processed. However, the presence of inherent toxic factors, as being implicated as one of the variables affecting the nutritional values of food[2]. Although a lot of information abound about both nutrientl and antinutrient content of some commonly consumed green leafy vegetables in Nigeria[2], however there are dearth of information with regard to their nutritional and safety *in vivo.* This study therefore sought to address the nutritional quality and safety of some commonly consumed green leafy vegetables in Nigeria *in vivo.*

MATERIALS AND METHODS

The vegetables used were obtained at the research farm of the Federal University of Technology, Akure, Nigeria. These vegetables include: *Amarantus cruentus* (Atetedaye), *Baselia allia* (Amunu tutu), *Solanum macrocarpon* (Igbagba), *Corchorus olitorius* (Ewedu) and *Ocimum gratissimum* (Efinrin). The chemicals were analytical grades, while the water used is glass distilled water.

Sample preparation: The vegetables were rinsed in water and the edible portions were separated from the inedible portion. The edible portions were chopped into small pieces (500 g) and sun-dried for further analysis.

Sample analysis: The protein content of the vegetable were determined on dry weight basis using the micro-Kjeldhal method as reported in[4].

Bioassay: Wistar strain albino rats weighing 120-200 g were purchased from Biochemistry Department, University of Ilorin, Nigeria. And acclamatized for 2 weeks during which period they were maintained *ad libitum* on commercial diet. The rats were subsequently divided into eight treatment groups. Animals in group 1 were fed the basal diet (10% casein, 10% soyabeans oil, 4% vitamin/mineral premix, 76% corn starch), while animals in groups 2-8 were fed basal diet supplemented with 40% vegetable (40% vegetable, 10% soyabeans oil, 4% vitamin/mineral premix, 46% cornstarch) to give ~10% protein content. The feed and water were given *ad libitum* through out the duration of the experiment. Daily feed-intake, change in body weight and digestibility of the feed were monitored throughout the experiment. The experiment last two weeks, at the end of which the rats were sacrificed by decapitation after an 18 h fast and the blood were collected into EDTA-tubes. The serum albumin, total protein, glutamate oxaloacetate transaminase (GOT), glutamate pyruvate transaminase (GPT) were determined by the conventional methods reported by Mokaday et al. (1989).

Analysis of data: The result of the three replicates were pooled and expressed as mean±standard error (S.E.). A one-way analysis of variance (ANOVA) and the Least Significance Difference (LSD) were carried out[11]. Significance was accepted at $P \leq 0.05$.

RESULTS AND DISCUSSION

The result of the protein content of the various tropical green leafy vegetables analyzed are shown in Table 1, the result revealed that those vegetables are exceptionally rich in protein. Their protein content ranges from 24.1% for *Amaranthus crunetus* to 38.2% for *Telfairia occidentalis* (on dry weight basis). These values are far above the values reported by [2] for some sun-dried tropical leafy vegetables except in the case of *M. esculent* (22.7), *C. argenta* (26.7); *A. hybridus* V2 (26.4) and *T. occidentalis* (26.8). This variation in values could be attributed to the difference in the residual moisture content. However, the protein content of these vegetables are far above the levels of protein in edible mushrooms (8.6-14.5%)[9] and wild and cultivated yams (5.1-20.7%) in Nigeria[1]. This therefore indicate that this green leafy vegetables could be a good source of dietary protein in their dry forms, which is the form in which they are popular consumed when they are out of season, unlike the fresh vegetables they will usually have a protein content ranging from 3-5%.

The ability of the protein to support growth were assessed by feeding albino rats with diet containing ~40% of the dry green leafy vegetable (~10% protein) as protein as against the control where casein (10% protein) serves as protein source. The result of the study revealed that there was a significant decrease in the average daily feed intake [4.8 (*Baselia alba*)-6.8 (*Cnidoscolus acontifolus*)] and weight gain [(0.9 (*Baselia alba, Amaranthus crentus,Ocimum gratissimum, Corchorus olitorus*)-1.1 (*Solanum macrocarpon, Cnidoscolus acontifolius*)], except in *Telfaira occidentalis* where there was no significant difference ($P<0.05$) in daily feed intake, however there was significant ($P<0.05$) decrease in the daily weight gain. Furthermore, the result of the feed: gain ratio indicate that there was a significant ($P<0.05$) increase in the parameter in those rats fed diet containing green leafy vegetables [5.2 (*Ocimum gratissimum*)-7.2 (*Corchorus olitorus*)] when compared to the control (3.8), this indicates that the protein in those green leafy vegetables are of low quality, not only that they will not support growth. However, *Ocimum gratissimum* (5.2), *Baselia alba* (5.3), *Telfairia occidentalis* (5.7) and *Solanum macrocarpon* (5.8) protein appears to be of better quality and support growth than that of *Amaranthus cruentus* (6.1), *Cnidoscolus acontifolius* (6.2) and *Corchorus olitorus* (7.2). When rats gain weight and show good feed-conversion efficiency and overall performance, it is a good indicator that the diets fed to them are of high enough quality[10].

Table 1: Protein content (% dry weight) of some tropical green leafy vegetables

Sample	Content
Amaranthus cruentus	$24.1^{b}\pm0.4$
Baselia alba	$34.5^{a}\pm0.2$
Solanum macrocarpon	$24.4^{b}\pm0.1$
Ocimumgratissimum	$25.4^{b}\pm0.5$
Corchorus olitorus	$24.5^{b}\pm0.3$
Telfairia occidentalis	$38.2^{a}\pm0.6$
Cnidoscolus acontifolus	$37.7^{a}\pm0.2$

Values represent means of triplicate, Values with the same alphabet along the same column are not significantly different ($P>0.05$)

Table 2: Nutrient utilization and growth performance of albino rats fed diet containing 40% some tropical green leafy vegetables

Sample	DFI (g/day)	DWG (g/day)	Feed: Gain Ratio	DMD (%)
Control	7.5ᵃ±0.4	2.0ᵃ±0.1	3.8ᵈ±0.3	95.5ᵃ±0.4
Amaranthus crunetus	5.5ᶜ±0.4	0.9ᵇ±0.1	6.1ᵇ±0.2	78.7ᶜ±0.2
Baselia alba	4.8ᵈ±0.2	0.9ᵇ±0.3	5.3ᵇᶜ±0.2	83.1ᵇ±0.1
Solanum macrocarpon	6.4ᵇ±0.5	1.1ᵇ±0.3	5.8ᵃᵇ±0.1	71.9ᵈ±0.2
Ocimum gratissimum	4.7ᵈ±0.2	0.9ᵇ±0.2	5.2ᵇᶜ±0.3	72.9ᵈ ±0.1
Corchorus olitorus	6.5ᵇ±0.3	0.9ᵇ±0.1	7.2ᵃ±0.2	81.9ᵇ±0.2
Telfairia occidentalis	7.4ᵃ±0.1	1.3ᵇ±0.2	5.7ᵃᵇ±0.4	80.5ᵇ±0.1
Cnidoscolus acontifolus	6.8ᵇ±0.2	1.1ᵇ±0.1	6.2ᵇ±0.1	82.4ᵇ±0.2

DFC= Daily Feed Intake; DWG= Daily Weight Gain; DMD= Dry Matter Digestibility
Values represent means of triplicate, Values with the same alphabet along the same column are not significantly different (P>0.05)

Table 3: Serum biochemistry of albino rats fed diet containing 40% some tropical green leafy vegetables

Sample	GOT (IU/L)	GPT (IU/L)	Total Protein ($g\ mL^{-1}$)	Albumin ($g\ mL^{-1}$)
Control	15.0ᶠ ±0.3	30.0ᶜ±0.4	6.0ᶜ±0.1	3.2ᵇᶜ±0.2
Amaranthus crunetus	110.0ᵃ±0.2	50.0ᵃ±0.4	7.7ᵇ±0.5	3.7ᵇ±0.5
Baselia alba	55.0ᶜᵈ ±0.3	20.0ᵈ±0.4	8.4ᵃ±0.5	4.4ᵃᵇ±0.6
Solanum macrocarpon	42.0ᵈᵉ±0.4	25.0ᶜᵈ±0.3	7.7ᵇ±0.5	4.3ᵃᵇ±0.2
Ocimum gratissimum	50.0ᵈ±0.2	25.0ᶜᵈ±0.4	7.3ᵇ±0.4	4.5ᵃ±0.2
Corchorus olitorus	40.0ᵉ ±0.4	50.0ᵃ±0.2	8.4ᵃ±0.3	5.0ᵃ±0.3
Telfairia occidentalis	60.0ᶜ±0.3	50.0ᵃ±0.3	5.6ᶜ±0.3	3.0ᵇᶜ±0.3
Cnidoscolus acontifolus	80.0ᵇ±0.4	40.0ᵇ±0.1	5.8ᶜ±0.4	2.5ᶜ±0.2

GOT=Glutamate oxaloacetate transaminase; GPT= Glutamate pyruvate transaminase
Values represent means of triplicate, Values with the same alphabet along the same column are not significantly different (P>0.05)

The result of the dry matter digestibility is also shown in Table 1, the result indicated that there was a significant (P<0.05) decrease in the dry matter digestibility of the rats fed diet containing green leafy vegetables (71.9-83.1%) when compared to the control (95.5%). The dry matter digestibility is far below that of Saccharomyces *cerevisae* fermented cassava flour (86.5%), raw sweet potatoes (85.4%) and cooked sweet potatoes (90.4%) diet[5]. This clearly show that the vegetables are not that digestible, this reason for the low digestibility will not be far fetch from the high dietary fibre content of green leafy vegetables [2, Negy and Roy, 2001). However, *Baselia alba* (83.1%) was more digestible among all the vegetable assessed, while *Solanum macrocarpon* (71.9%) had the least digestibility.

The result of the change in some serum enzymes and metabolites of rats fed diet containing green leafy vegetables (40%) is shown in Table 3. The result of the study revealed that there was a significant (P<0.05) increase in the serum glutamate oxaoloacetate transaminase (GOT), glutamate pyruvate transaminase (GPT) (except those fed diet containing *Solanum macrocarpon, Baselia alba*), total protein and albumin (except those fed diet containing *Cnidoscolus acontifolus, Telfairia occidentalis*). The fact that there were significant increase in serum GPT and GOT in some of the rats indicate a possible damage to some organ such as the liver and heart by those vegetables. GPT and GOT are enzymes that are located in the liver cells and leak out and make their way into the general circulation when liver cells are injured[3, 6]. However, GPT is regarded to be a more specific indicator of liver inflammation, since GOT may be elevated in diseases of other organs such as heart disease or muscle disease[3, 6]. However, there was a significant (P<0.05) decrease in the serum total protein and albumin in those rats fed diet containing *Cnidoscolus acontifolus* and *Telfairia occidentalis,* respectively, this clearly confirm that both vegetables in their unprocessed forms could lead to liver damage, since albumin is produced mainly in the liver[3, 6] and therefore its estimation is a test of liver function and this clearly show that those vegetables will interfere with albumin biosynthesis, although other vegetables may not.

Furthermore, since there was no significant change in the serum GPT (which is a more specific indicator for liver damage) in those rats fed diet containing *Baselia alba,Ocimum gratissinum* and *Solanum macrocarpon* coupled with the significant increase the serum total protein and albumin, clearly indicates that those vegetable may not cause damage to the liver, however the elevated serum GOT indicates that they could cause damage to either the heart or muscles. While in the case of *Corchorus olitorus* and *Amaranthus cruentus*, they could be considered has been toxic to the liver, however, they may not interfere with albumin biosynthesis. Conclusively, this study clearly show that green leafy vegetables, although very rich in protein, its protein will not support growth, moreover they are not safe for consumption in their unprocessed form.

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