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Full Length Research Paper

The effect of sun and shade drying on chemical composition of *Vitex doniana, Ipomoea aquatica* and *Cohcorus* and their soups

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This study investigated the effect of sun and shade drying on chemical composition of African black plum "Uchakoro" (*Vitex doniana*) Bush okro leaf "Ewedu" (*Corchorus*) and wild lettuce "yaririn" (*Ipomoea aquatica*) vegetables and their soap meals. These vegetables were bought in bulk from Ibaji Local market in Kogi State, Nigeria. The foods were washed with clean water, plucked from the stalk, sun and shade dried to mimic the traditional food processing techniques. The fresh vegetables served as the controls. A portion of each processed vegetable was pulverized, sieved, packaged in name labeled polythene bags and kept in cool dry place until used for various chemical analysis. The other portions as well as the fresh vegetables were used to prepare various traditional indigenous soup meals using similar consistency traditional recipes for each soup. The chemical composition of both the vegetables and their soups were determined using standard assay methods on dry matter basis. Means, standard deviation and least significant difference (LSD) were adopted to separate and compare means from data generated. The protein, ash, fat and fibre values for both the sun and the shade dried vegetables were higher than those of fresh samples (P<0.05). The fresh vegetables had higher calcium, iron and zinc than the sun and the shade dried vegetables. On the other hand, sun and shade drying decreased beta carotene and ascorbate as against those of the fresh samples. The protein, ash, fat and carbohydrate values for soups prepared with dried vegetables were much higher than those of their controls. The soups prepared with dried vegetables had lower iron, calcium, zinc and iodine than those prepared with fresh vegetables (P<0.05). The higher, iodine, zinc, beta carotene and ascorbate values for shade dried samples regardless of the types of vegetables indicated that shade drying had an edge over sun drying as traditional food processing technique to preserve nutrients in these vegetables.

Key words: Dry methods, vegetables, nutrient, preservation.

INTRODUCTION

Traditional dishes are amongst the oldest and deeply ingrained aspects of African culture. Historical evidence of African dishes dating back to the Stone Age was discovered in Olorgesailie, Kenya. This is a historical site on the floor of the Great Rift Valley, South of Nairobi. Over 5,000 years ago hunter-gathers, commonly called the ndorobo, occupied much of East Africa. The ndorobo were assimilated by migrants as such lost much of their cultural identity, such as knowledge of their traditional dishes (Katz and Weaver, 2003). Interestingly, Eaton and Konner (1995) investigated dietary shifts over several millennia in Africa. They concluded that the human diet was far superior with the hunting and gathering subsistence of Paleolithic times as compared with the present-day dishes largely based on processed and manufactured foods. External influences (Western life styles) caused changes in African dishes. This has never been more apparent than the present day Nigeria and Ibaji community in particular. The faster people adopt new food pattern, the less likely traditional dishes knowledge will be passed on to the next generation. The loss of traditional dishes precipitated decrease in culture-specific food activities and decreased dietary diversity.

There is need to investigate the nutrient content of traditional African dishes. This information is necessary for understanding how traditional dishes could potentially

improve the health status of indigenous populations throughout Africa intensive exploration of traditional African dishes could provide insight into the vast and nutrient-rich diversity of foods (dishes) available in various regions of this vast continent. Historical evidenced of the richness of traditional African dishes is currently on nutrient content of the dishes. This new evidence has the potential to trigger more thorough study of traditional African dishes today (Vanden et al., 2000; Wu and Wall, 2000).

It is imperative to collect historical and most current data on some traditional Nigerian dishes, particularly those of my community (Ibaji) in Kogi State of Nigeria that are at the verge of extinction. Raising awareness and inspiring study of traditional dishes may be of significant cultural and health related importance for the indigenous people of Ibaji in Kogi State, Nigeria. The present study tends to evaluate the chemical compositions of three indigenous vegetables and their traditional soup meals. These vegetables were African black plum (*Vitex doniana*), Bush okro leaf "Ewedu" (C*orchorus*) and wild lettuce (*Ipomoea aquatica*). The result of this work might add to information for compiling Nigerian food composition table.

MATERIALS AND METHODS

African black plum (*V. doniana*), wild lettuce (*I. aquatica*) and bush okro leaf "Ewedu" (*Corchorus*) were purchased in bulk from Unale-Ibaji market Kogi State, Nigeria.

Sample preparation

These three vegetables were carefully plucked, washed with clean water, and divided each into three equal portions. The fresh portions served as controls. The other two portions of each vegetable were sun and shade dried for 8days and 10 days respectively at individual constant level of drying to 98% dry matter using gravimetric method (Figure 1). *V. doniana* "Uchakoro" was the only vegetable blanched to mimic the traditional method to remove its bitter taste that might adversely affect the acceptability of its soup meal. Each dried sample was divided into two portions. One portion of each dried vegetable was pulverized into fine flour after sieving with 70 mesh screen, packaged in name labeled polythene bags and stored in a cool dry place at 25±2℃ until used for various chemical analysis. The unpulverized samples (whole) were used to prepare traditional soup meals for both chemical analysis and organoleptic evaluation.

Both dried and fresh vegetables were analyzed on dry matter basis for various nutrients and antinutrients using standard method (AOAC, 1995). The soup meals based on these vegetables were prepared using traditional recipe for each soup meal with similar consistency. The soups were also analyzed for their chemical composition prior to their organoleptic evaluation.

Analytical methods

Moisture content of each sample was determined as described by AOAC (1995) methods. Crude protein was determined by the micro-kjeldahl method using 6.25 as the conversion factor. Ash, crude fibre, fat, tannins and phytate were also determined as described by AOAC (1995). Carbohydrate was obtained by difference. Minerals were determined using atomic absorption spectrophotometer.

Statistical analysis

The data generated were subjected to various statistical analysis such as means, standard deviation. Least significant difference (LSD) was adopted to separate and compare means.

RESULTS

Table 1 presents the effect of processing on proximate composition and caloric value of three green leafy vegetables. The proximate values were based on dry weight. The caused increases in values more than one would expect in vegetables.

The protein content of *V. doniana* ranged from 6.35 to 25.91%. As one would expect the fresh sample that high moisture had higher protein relative to those of sun and shade dried samples (25.91 vs 11.32 and 6.35% ($p<0.05$). The sun dried samples had higher protein than the shade dried samples (11.32 vs 6.35%). The difference was significant ($p<0.05$).The sun dried sample had 4.97% protein more than the shade dried sample (11.32 vs. 6.35%). The ash content of *V. doniana* ranged from 12.99 to 20.53%. The fresh sample had the least (12.99%). Both the sun and the shade dried samples had high and comparable values (20.51 and 20.53%, respectively) ($p>0.05$).

The fat values for *V. donian* varied. The variation was from 1.66 to 2.36%. The fresh had the least (1.66%). The sun dried sample had the highest (2.36%) and the shade dried had 1.85%. Both the sun and the shade dried samples had higher values than the fresh sample (2.36, 1.85 vs. 1.66%, each) ($p<0.05$). Sun and shade drying influenced the fibre content of *V. doniana* vegetable. The fresh (FVD) had the least fibre (12.39%). The value for the sun dried sample was 20.48% and that of the shade dried was 21.16%. Shade drying had slight edge over sun drying (21.16 vs. 20.48%). The value for both the sun and the shade dried samples were higher than that of the fresh (12.39%) ($p<0.05$) (20.48 and 21.16 vs. 12.39%).

The carbohydrate (CHO) content of *V. doniana* had varied values dissimilar to that of fibre. The sun and the shade dried samples had 29.95 and 37.14% CHO, each. The fresh sample had higher value (47.38%) relative to those of sun and shade dried samples (29.95 and 37.14%) ($p<0.05$). The difference in CHO between these two samples was 7.19%.This was significant ($p<0.05$). The caloric values for three samples of *V. donina* differed widely ($p<0.05$). The fresh sample (FVD) had the highest (194.30Kcal).The sun dried sample had 472.18Kj. However, the value for the sun and shade dried sample were 122.6 and 152.28 Kcal, each. The shade dried samples surprisingly had much more calorie than the sun

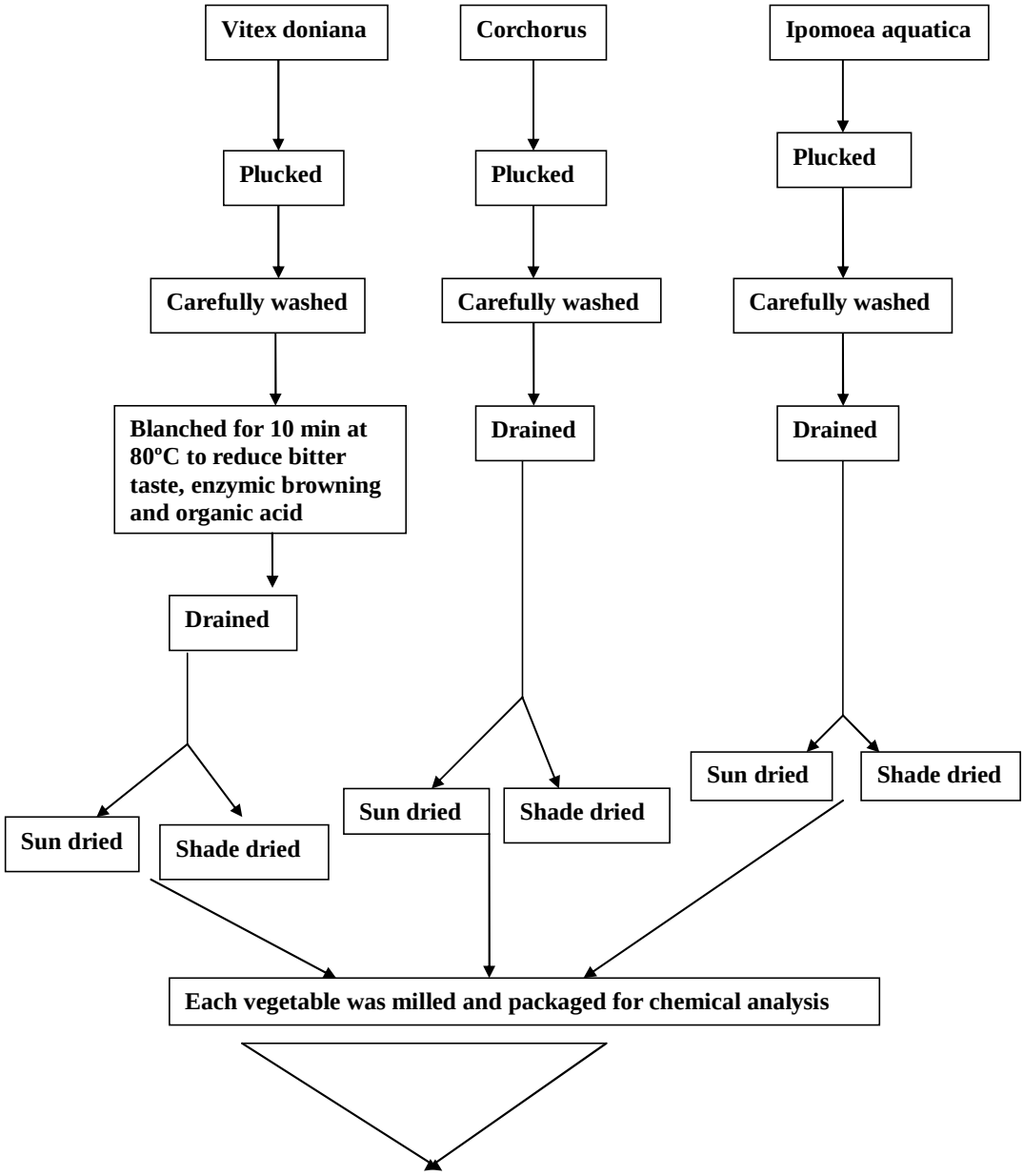

Figure 1. Processing procedures for each vegetable.

dried.

The protein value for corchorus varied. The variation was influenced by sun and shade drying. The fresh sample (FCR) had the highest (25.62%). On the other hand, the sun (SDCR) and the shade (SHDCR) dried samples had comparable protein (6.46 and 6.76%, each) regardless of treatments ($p>0.05$).

The ash values differed. The value ranged from 14.36 to 20.48%. The sun dried sample had 18.98% as against 20.48% for the shade dried sample. Both sun and shade drying increased ash, however, shade drying had an edge over sun drying (20.48% vs. 18.99%). The difference was not significant ($p>0.05$). The fat content of corchorus ranged from 1.55 to 2.38%. As one would expect, the fresh sample (FCR) had the least (1.55%). The sun and the shade dried samples had each 2.08 and 2.38%.

The shade dried sample had more fat than the sun dried sample (2.38 vs 2.08%).There was a slight difference of 0.30% which was not different ($p<0.05$).

The fibre values differed. The range was from 12.74 to 20.70%. The fresh (FCR) sample had much lower value

Table 1. Effect of processing on proximate composition and caloric value of three green leafy vegetables (%) dry matter basis.

Sample	Protein	Ash	Fat	Fibre	CHO	Caloric value (Kcal/g)
FVD	25.91±0.01^{a}	12.99±0.04^{d}	1.66±0.04^{c}	12.39±0.05^{c}	47.38±0.13^{d}	194. 03^{d}
SDVD	6.68±0.13^{a}	20.51±0.03 ^{a}	2.36±0.05 ^{a}	20.48±0.03 ^{a}	29.95±0.04 ^{a}	122.64^{e}
SHVD	6.35±0.04^{c}	20.53±0.04^{a}	1.85±0.04^{b}	21.16±0.04^{a}	37.14±0.06^{e}	152.29^{de}
FCR	25.62±0.01^{a}	14.36±0.14^{c}	1.55±0.30^{c}	12.74±0.05^{c}	45.04±0.58^{c}	184.69^{d}
SDCR	6.46±0.04^{a}	18.98±0.05^{b}	2.08±0.03^{b}	19.98±0.04^{b}	53.41±0.15^{a}	84.72^{f}
SHDCR	6.76±0.14^{c}	20.48±0.04^{a}	2.38±0.05^{a}	20.70±0.03^{a}	51.16±0.03^{c}	209.74^{c}
FIP	22.83±0.16^{b}	11.84±0.04^{d}	1.23±0.02^{c}	12.09±0.04^{c}	52.87±0.05^{b}	216.78^{a}
SIPA	5.95±0.06^{d}	18.77±0.05^{b}	2.63±0.05^{a}	21.06±0.05^{a}	52. 93±0.04^{b}	214.81^{a}
SHIP	5.93±0.07^{d}	19.81±1.91^{a}	2.50±0.05^{a}	21.15±0.03^{a}	52.04±0.03^{b}	213.15^{b}

Mean ±SD of three determinations. Samples within the same column with the same superscript are not significantly different (p> 0.05). *Dry weight basis. FVD = Fresh *Vitex doniana*, SDVD = sun dried Vitex doniana, SHVD = Shade dried *V. doniana,* FCR = Fresh Corchorus, SDCR = Sun dried Corchorus, SHDCR = Shade dried Corchorus, FIP = Fresh *I. aquatica*, SIPA =Sun dried *I. aquatica*, SHIP, = Shade dried *I. aquatica.*

12.74% than those of the sun and the shade dried values (19.98 and 20.70 vs. 12.74% (p<0.05). The shade dried sample had 0.72% more fibre than the sun dried sample (20.70 vs. 19.98%).The difference in fibre between the two samples was significant. The CHO content of *Corchorus* samples ranged from 45.04 to 53.41% (p<0.05). The fresh *Corchorus* had 45.04% CHO, on the other hand, the sun and the shade dried samples had 53.41% and 51.16%, Even if Sun drying increased CHO much more in *Corchorus* than shade drying, the increase was comparable (p<0.05) (53.41 vs. 51.16%).The caloric values for *Corchorus* sample were a function of treatments. The values ranged from 122.6 to 194.30 Kcal. The fresh corchorus had the highest energy (194.30 Kcal). The sun dried sample had the least 122.64 Kcal and the shade dried had 152.28 Kcal. Sun drying decreased energy relative to the higher value for shade dried samples (152.28 vs. 122.64 Kcal (p<0.05).

The protein content of *I. aquatica* ranged from 5.93 to 22.83%. The fresh sample (FIP) had more than trice protein of both the sun and the shade dried samples 22.83 vs. 5.95 and 5.93%, each (p<0.05). On the other hand, the sun and shade dried samples had comparable values (5.95 and 5.93%) (p>0.05). The ash values for *I. aquatica* samples ranged from 11.84 to 19.81%. The fresh sample had the least 11.84%. The shade dried (SHIP) sample had the highest ash (19.81%) and the sun dried sample (SIPA) had the second highest (18.77%). Both the sun and shade dried samples had similar values (p<0.05). The fat values for *I. aquatica* samples ranged from 1.23 to 2.63%. The fresh sample (FIP) had the least fat (1.23%). On the other hand, both the sun and the shade dried samples had each 2.63 and 2.50% fat.

The fibre content of *I. aquatica* samples varied. The range was from 12.90 to 21.15%. The sun (SIPA) and the shade dried (SHIP) samples had comparable values (21.06and 21.15%, each). The fresh (FIP) sample had the least fibre (12.09%) CHO values for *I. aquatica* differed. The differences were associated with sun and shade drying of the samples. The range for CHO was from 52.04 to 52.87%. The sun and the shade dried samples had higher and comparable values (52.39 and 52.04%) and the fresh sample had the highest CHO (52.87%). The caloric values of *I. aquatica* varied. The range was from 213.15 to 216.78 Kcal. The fresh sample (FIP) had the highest energy (216.78 Kcal). The sun and the shade dried samples had comparable values (214.81, and 213.15 Kcal).

Table 2 presents the effect of processing on micro-nutrient content of three green leafy vegetables (mg/100g). The calcium (Ca) content of *V. doniana* samples varied. The fresh (FVD) had the highest Ca (12.86 mg). The sun and the shade dried samples had values that were very much lower than that of the fresh sample (0.16 and 0.13 vs. 12.86 mg, respectively) (p>0.05). On the other hand, shade drying (SHVD) reduced calcium more than sun drying (0.13 vs. 0.16mg). The iron (Fe) content of *V. doniana* samples differed. The differences ranged from 0.07 to 1.33 mg. The fresh (FVD) sample had the highest Fe (1.33 mg). Both sun and shade drying decreased Fe value from 1.33 to 0.07mg. Sun drying decreased Fe in *V. doniana* much more than shade drying (0.07 vs. 0.10 mg).

Zinc values followed a different trend as against that of iron. The values ranged from 0.08 to 0.4mg. The Fe value for the fresh (FVD) was the highest (0.40 mg). On the other hand, sun and shade drying caused insignificant and comparable increase in Fe (p>0.05). The values for both processed samples were from 0.08 to 0.40 mg. Both processes had equal effect on Fe content of the samples (0.08 mg).

The iodine values differed for *V. doniana* samples. The range was from 22.07 to 31.74 mg. Both sun and shade drying increased iodine in *V. doniana*. Shade drying increased iodine much more than sun drying (27.72 and 22.07 mg) (p>0.05). The increase was 5.65 mg. The fresh sample had the highest iodine (31.74 mg). The pro-vitamin A (B-corotene) values for *V. doniana* reacted

Table 2. The effects of processing on micronutrient composition of three green leafy vegetables dry weight basis (mg/100g, dry matter basis).

Samples	Ca	Fe	Zn	I	B-carotene	Ascorbic Acid
FVD	12.86±0.01^{b}	1.33±0.05^{b}	0.40±0.06^{a}	31.74±0.01^{b}	322.60±0.32^{a}	225.31±0.33^{c}
SDVD	0.16±0.05^{c}	0.07±0.04^{c}	0.08±0.06^{c}	22.07±0.50^{b}	9.64±0.32^{e}	1.73±0.32^{f}
SHVD	0.13±0.05^{c}	0.10±0.05^{c}	0.08±0.06^{c}	27.72±0.00^{c}	8.52±0.32^{e}	1.75±0.32^{f}
FCR	14.77±0.03^{a}	4.05±0.05^{a}	0.40±0.06^{a}	30.95±0.01^{b}	179.34±0.09^{c}	465.94±0.32^{a}
SDCR	0.14±0.03^{b}	0.10±0.06^{c}	0.00±0.00^{d}	26.41±0.00^{d}	0.20±0.27^{f}	2.75±0.00^{e}
SHDCR	0.12±0.12^{b}	0.08±0.04^{b}	0.07±0.06^{d}	25.30±0.00^{d}	0.20±0.56^{f}	3.24±0.00^{d}
FIP	13.14±0.05^{b}	1.05±0.05^{b}	0.00±0.00^{d}	54.90±0.20^{a}	314.62±0.32^{b}	302.28±0.32^{b}
SIPA	0.13±0.04^{c}	0.07±0.04^{c}	0.00±0.00^{d}	27.75±0.01^{c}	25.93±0.32^{d}	2.07±0.00^{d}
SHIP	0.10±0.05^{d}	0.10±0.03^{c}	0.11±0.06^{b}	24.71±0.46^{e}	27.65±0.32^{d}	2.41±0.36^{d}

Means±SD of three determinations. **dry matter basis Samples with the same superscript in the sae column are not significantly different (p>0.05). FVD = Fresh *V. doniana*, SDVD = Sun dried *V. doniana*, SHVP =Shade dried *V. doniana*. FCR = Fresh *Corchorus*, SDCR = Sun dried *Corchorus*, SHDCR = Shade dried *Corchorus*, FIP = Fresh *I. aquatica*, SIPA = Sun dried *I. aquatic* SHIP = Shade dried *I. aquatica*.

differently to both sun and drying. These processes decreased the value from 322.60 to 8.52 mg. Shade drying caused much more decrease (9.64 mg) than sun drying (8.52 mg). The fresh sample had the highest value (322.6 mg). The ascorbate content of *V. doniana* varied. The range was from 1.73 to 225.31 mg. The fresh (FVD) sample had the highest ascorbate (225.31 mg). On the other hand, the sun and the shade dried samples had the least and comparable value (1.73 and 1.75 mg each). Both processing methods had equal effect on ascorbate value.

The calcium (Ca) content of Corchorus varied. It ranged from 0.12 to 14.77 mg. The shade dried (SHDCR) sample had the least Ca (0.12 mg). The fresh (FCR) had the highest value (225.31 mg) and differed from the processed samples (p<0.05). Sun drying slightly reduced calcium more than shade drying (0.14 vs. 0.12 mg). The Fe values for *Corchorus* differed. The differences were controlled by processing methods. The fresh (FCR) sample had 4.05 mg Fe. On the other hand, the sun and the shade dried samples had 0.10 and 0.08 mg each, Shade drying slightly reduced Fe (0.08 mg) more than sun drying (0.10 mg). The zinc values differed. The range was from 0.00 to 0.40 mg. Sun drying adversely reduced Zinc to zero (0.00 mg). On the other hand, shade drying increased Zinc content of *Corchorus* from 0.00 to 0.07 mg. Both fresh (FCR) and shade dried (SHDCR) samples had varied values (0.40 and 0.07 mg each). The iodine value for *Corchorus* varied. The variation was from 30.95 to 26.41 and 25.30 mg, each). The values for both processed samples were comparable and differed from that of the fresh sample (26.41 and 25.30 vs. 30.95 mg) (p<0.05). Shade drying increased iodine (26.41 mg) more than sun drying (25.30 mg), However the difference was insignificant (p>0.05). Iodine for *I. aquatica* (FIP) fresh was 54.90 mg and those of sun and shade dried were 27.75 and 24.71 mg, each. Fresh sample had higher value than those of the processed (54.90 vs 27.75 and 24.71 mg each (p<0.05).

The pro-vitamin A (B-Carotene) content of *Corchorus* samples differed. It ranged from 8.52 to 322.60 mg. Both the sun and the shade dried samples had lower and equal values (9.64 and 8.52 mg). The fresh (FCR) had extremely higher value than those of the processed samples (322.60 vs. 9.64 and 8.52 mg (p<0.05). The ascorbate values followed the same trend as provitamin A. Both sun and shade drying drastically reduced the value from 225.31 to 1.73mg. Sun drying caused slight decrease in ascorbate more than shade drying (1.73 vs. 1.75 mg) the difference was not significant (p>0.05). The fresh sample had much ascorbate concentration than the processed samples (225.31 vs. 1.73 and 1.75 mg, each) (p<0.05).

The calcium content of *I. aquatica* ranged from 0.10 to 13.14 mg. The fresh (FIP) had the highest value (13.14 mg). The sun and the shade dried samples had each 0.13 and 0.10 mg. The shade dried (SHIP) sample had the least as against those of the fresh and sun dried samples (0.10 vs 0.13 and 13.14 mg, each). The Fe content of *I. aquatica* varied. It ranged from 0.07 to 0.13 mg. The sun dried sample had 0.07 mg which was lower than that of the shade dried sample (0.10 mg). However, the fresh (FIP) had the highest (1.05 mg). This value was higher than those of the sun and shade dried samples (1.05 vs 0.10 and 0.07 mg) (p>0.05).

The zinc content of *I. aquatica* varied. It ranged from 0.00 to 0.11 mg. Both the fresh (FIP) and the sun dried (SIPA) sample values for zinc was (0.00 and 0.00 mg). On the other hand, the shade dried (SHIP) sample had 0.11 mg zinc.

The iodine content of *I. aquatica* ranged from 24.71 to 54.90 mg. The fresh (FIP) sample had 54.90 mg as against those of the sun and the shade dried samples (54.90 vs. 27.75 and 24.71 mg). The sun dried value was the second highest (mg) followed by that of the shade dried (24.71 mg). Based on the result, sun drying

Table 3. Effect of processing on Chemical content of soup meals based on *Vitex doniana*, Corchorus and *I. aquatica* vegetables (%), and dry matter basis.

Sample	Protein	Ash	Fat	Fibre	CHO	Cal. Value (Kcal/g)
FVDS	16.51±0.04^{c}	12.60±0.03^{a}	7.15±0.05^{d}	12.38±0.05^{a}	51.28±0.20^{b}	210.24^{c}
SDVDS	18.64±0.02^{a}	12.76±0.08^{a}	8.26±0.05^{a}	11.36±0.05^{c}	48.662±0.06^{b}	199.52^{e}
SHVS	16.27±0.04^{c}	12.13±0.03^{b}	7.81±0.04^{d}	13.37±0.03^{a}	50.69±0.05^{b}	207.70^{a}
FCRS	14.06±0.04^{d}	12.93±0.05^{a}	8.06±0.06^{c}	12.80±0.61^{a}	54.41±0.06^{a}	222.89^{a}
SDCRS	15.07±0.04^{d}	12.18±0.04^{b}	7.26±0.09^{d}	13.38±O.O4^{a}	52.41±0.04^{b}	214.87^{c}
SHCRS	16.52±0.03^{c}	12.53±0.06^{a}	10.18±1.36^{a}	11.48±0.05^{b}	52.03±0.04^{b}	217.70^{b}
FIPS	16.14±0.18^{c}	13.76±0.03^{a}	7.82±0.01^{b}	12.83±0.04^{a}	46.65±0.10^{d}	191.26^{e}
SIPS	18.58±0.05^{a}	11.50±0.06^{b}	9.35±0.05^{b}	12.56±0.61^{a}	48.85±0.08^{c}	200.30^{d}
SHIS	17.67±0.04^{b}	1152±0.05^{c}	9.10±0.05^{b}	12.36±0.08^{b}	49.68±0.03^{c}	203.67^{d}

Mean±SD of three determinations. Sample within the same column with the same superscript are not significantly different (p>0.05). FVDS = Fresh *V. doniana* Soup, SDVDS = Sun dried *V. doniana* soup. SHVS = Shade dried *V. doniana* soup. FCRS = Fresh Corchorus Soup. SDCRS = Sun dried *Corchorus* soup. SHCRS = Shade dried *Corchorus* soup. FIPS = Fresh *I. aquatica* soup. SIPS = Sun dried *I. aquatica* soup. SHIS = Shade dried *I. aquatica* soup.

appears to be a better method of processing *Ipomoea aquatica* vegetable to increase and retain its iodine concentration. The pro-vitamin A (B- carotene) content of *I. aquatica* differed. It ranged from 25.93 to 314.62 mg. The fresh sample had the highest (314.62 mg). Shade drying had an edge over sun drying (27.65 vs. 25.93 mg). The ascorbate content of *I. aquatic* samples differed. It ranged from 2.07 to 302.28 mg. The fresh sample had the highest ascorbate (302.28 mg). Both sun and shade drying drastically reduced ascorbate from 302.28 to 2.41 and 2.07 mg, each. However, sun drying reduced ascorbate (2.07), much more than shade drying (2.41 mg) as against that of the fresh (302.28 mg)

Table 3 presents the effect of processing on chemical content of soup meals based on *V. doniana*, *Corchorus* and *I. aquatica* vegetables. The protein content of soup meal based on *V. doniana* vegetable varied. The range was from 16.27 to 18.64%. Again, the soup based on sun dried *V. doniana* (SDVS) vegetable had the highest protein (18.64%). The protein values for the soup based on fresh (FVDS) and the shade dried (SHVS) vegetables had comparable protein (16.51 and 16.27%). The ash values differed. It ranged from 12.13 to 12.76%. The soup based on shade dried (SHVS) vegetable had the least ash (12.13%). The soup based on sun dried (SDVS) vegetable had value that was higher than that of the fresh (FVDS) soup 12.13 and comparable to that of fresh (12.76 vs. 12.60%. The fat for *V. doniana* soup varied. It ranged from 7.15 to 8.26%. The soup based on sun dried (SDVS) vegetable had increased fat (8.26%). However, it was comparable to that of the fresh (FVDS) soup (7.81 vs. 7.15%). The latter soup had the least fat (7.15%).

The fibre content of *V. doniana* soup meals varied. The range was from 11.36 to 13.37%. The sun dried (SDVS) soup had the least fibre (11.36%). The soup based on fresh (FVDS) vegetable had 12.88% fibre. The soup meal based on shade dried (SHVS) vegetable had the highest value which might be similar to that of the fresh (FVDS) soup (13.37%). The CHO content of *V. doniana* based soups varied. The variations were insignificant (51.28, 48.60 and 50.69%, each). The energy content of *V. doniana* based soup meals varied. The range was from 199.52 to 210.24 Kcal. The soup based on fresh (FVDS) vegetable had the highest value (210.24 Kcal) followed by that based on shade dried (SHVS) vegetable (207.70 Kcal). The soup based on sun dried (SDVS) vegetable had the least energy (199.52 Kcal).

Protein for *Corchorus* soups varied. The variation was from 14.06 to 16.52%. The shade dried (SHCRS) soup had the highest protein 16.52% followed by that of the sun dried (SDCRS) vegetable soup (15.02%). Both the sun and the shade dried soups had more protein than that of the fresh (FCRS) soup meal (15.07 and 16.52 vs. 14.00%, each).The ash value for the sun and the shade dried (SDCRS and SHCRS) soups were lower than that of the fresh (FCRS) soup (12.48 and 12.53 vs. 12.93%). The sun and shade dried (SDCRS and SHCRS) based soups had comparable values (12.48 and 12.53%) The fat values for the *Corchorus* soups varied. The soup based on fresh corchorus (FCRS) had 8.06% fat. The sun dried (SDCRS) soup had the least (7.26%). On the other hand, the shade dried (SHCRS) based soup had the highest fat (10.12%).

The fibre values for all soups based on *Corchorus* were high and varied. The range was from 11.48 to 11.46%. The sun dried (SDCRS) based soup had the least (11.48%). The sun dried (SDCRS) soup had the highest fibre (13.46%) which was slightly higher than that of the fresh (FCRS) vegetable based soup (12.38%). The CHO values for soups based on *V. doniana* vegetable varied. The soup based on fresh (FVDS) vegetable had highest (51.28%) followed by that of the soup based on shade dried (SHVS) vegetable (50.69%). The sun dried (SDVS) soup had the least (48.66%). The values for the fresh and

Table 4. Minerals and antinutrients content of soups based on fresh, sun and shade dried green leafy vegetables (mg/100 g).

Sample	Ca	Fe	Zn	I	Phytate	Tannins
FVDS	0.12±0.03	0.08±0.04	0.06±0.05	22.47±0.10	7.17± 0.61	0.13±0.04
SDVS	0.11±0.04	0.07±0.03	0.07±0.04	21.61±0.01	6.19± 0.03	0.13±0.04
SHVS	0.08±0.03	0.12±0.04	0.07±0.04	23.00±0.01	7.65± 0.04	0.11±0.03
FCRS	0.10±0.04	0.08±0.05	0.00±0.00	23.80±0.00	6.92± 0.04	0.17±0.04
SDCRS	0.11±0.04	0.10±0.04	0.00±0.00	11.51±0.00	6.60 ±0.04	0.12±0.04
SHCRS	0.12±0.04	0.13±0.04	0.00±0.00	12.04±0.00	6.66 ±0.04	0.14±0.04
FIPS	0.10±0.05	0.08±0.05	0.00±0.00	29.39±0.00	6.56± 0.05	0.11±0.05
SIPS	0.11±0.04	0.07±0.03	0.00±0.00	22.13±0.01	7.03± 0.04	0.15±0.04
SHIPS	0.11±0.04	0.010±0.27	0.00±0.00	22.41±0.01	6.8 1±0.04	0.08±0.0

Mean± SD of three determinations *** Dry matter basis. FVDS = Fresh *V. doniana* soup. SDVS = Sun dried *V. doniana* soup. SHVS = Shade dried *v. doniana* soup. FCRS = Fresh *Corchorus* soup. SDCRS = Sun dried *Corchorus* soup. SHCRS = Shade dried *Corchorus* soup. FIPS = Fresh *I. aquatica* soup. SIPS = Sun dried *I. acquatica* soup. SHIPS = Shade dried *I. aquatica* soup.

the shade dried based soups were comparable (51.28 vs. 50.69%). The energy content of the soups varied. The range was from 199.52 to 210.24 kcal. The sun dried vegetable soup had the least 199.52 Kcal. The soup based on fresh (FVDS) and shade dried (SHVS) vegetables were 210.24 and 207.70 Kcal, respectively.

The protein values for *I. aquatica* also deferred. The soup based on sun dried (SIPS) had the highest protein (18.58%) followed very closely by that of the shade dried (SHIS) (17.67%). The soup based on fresh (FIPS) had the least protein (16.14%). Both treatments of the vegetables influenced protein content. However, sun drying increased protein more than shade drying. The difference in protein was less than 1.0% (0.91%) (18.58 to 17.67%). The ash values established an interesting trend. The range was from 11.52 to 13.76%. The soups containing the sun and the shade dried Ipomoea vegetable had similar values (11.52 and 11.50%). The soup based on fresh (FIPS) had more ash than any of the soups based on either sun or shade dried vegetable (13.76 vs. 11.52 and 11.50%). The fat values for the soups differed. The range was from 7.82 to 8.40%. On the other hand, the soups based on the sun or the shade dried vegetable had comparable fat (9.35 and 9.10%) which was higher than that of the fresh (FIPS) (7.82%).

The fibre values for the three soups based on fresh, sun and shade dried vegetables (FIPS, SIPS and SHIS) had comparable values (12.83, 12.56 and 12.33%, respectively). The CHO content of these soups had a similar trend as that of fibre. The fresh (FIPS), the sun dried (SIPS) and the shade dried (SHIS) soup had each 46.65, 48.85 and 49.68%, CHO). The soup based on fresh (FIPS) had the least CHO (46.65%). The CHO content of the soup based on shade dried vegetable (SHIS) soup had an edge over that of the sun dried (SIPS) soup (49.68 vs. 48.85%). The difference was only 0.83% (49.68 to 48.85%). The energy content of the soups based on fresh, sun and shade dried *I. aquatica* leaves varied. The range was from 191.26 to 203.67 Kcal. The soup prepared with fresh (FIPS) vegetable had the least energy (191.26 Kcal) followed by that of the soup prepared with sun dried (SIPS) vegetable (200.30 Kcal). On the other hand, the soup prepared with shade dried (SHIS) vegetable had the highest energy (203.67 Kcal).

Table 4 presents the effect of processing on minerals and anti-nutrients content of soups based on three green leafy vegetables (mg/100g). The calcium, iron, zinc, iodine, plytate and tannins content of the soup meals whether or not the vegetable was fresh, sun or shade dried were comparable ($p>0.05$). (Table 4). Zinc content of both *Corchorus* and *I. aquatica* soups were in traces or zero values. The iodine values for *V. doniana* soup meals differed. The ranged was from 21.61 to 23.00 mg. The SHVS soup had little edge over the FVDS and the SDVS soups (23.00 vs 22.47 and 21.61 mg). The difference was not significant ($p>0.05$). The soup prepared with fresh (FIPS) had the highest iodine (29.39 mg). On the other hand, the soups prepared with the sum (SDCRS) or the shade dried (SHCRS) *Corchorus* had each 11.51 and 12.04 mg). The difference in Iodine between the two soups was only 0.60 mg. The phytate and tannins content of the soups were high and comparable (phytate 6.60 to 6.92 and tannins 0.12 to 0.17 mg, each.

The calcium, iron, zinc, iodine and tannins, content of the soups based on fresh (FIPS) sun dried (SIPS) and shade dried (SHIPS) had similar values. On the other hand, these soups had varying values for iodine and phytate. The values for iodine ranged from 22.13 to 29.39 mg and that of phytate ranged from 6.56 to 7.03 mg, respectively,

DISCUSSION

Moisture content is an index of stability of food. The amount of moisture in a food affects its keeping quality, the nutrients provided, type and rate of microbial spoilage (Bollin and Stafford, 1974). The general increases in

protein, ash, fat, fibre, carbohydrate and energy were due to loss of moisture. (The values were expressed on dry matter basis to allow for necessary comparisons). Moisture loss is associated with increase in dry matter of which these nutrients are among. The lower fat for all the processed vegetables based on dry matter have some nutrition implications. Lower moisture increases both nutrients and shelf life. Lower fat in any given food reduces chances of rancidity- a commonly observed fact (Oguntona, 1988). Thus, increase in consumption of vegetables (*V. doniana, I. aquatica* and *Corcohorus*) would naturally lower the percentage of total fat intake. More importantly, no cholesterol is found in fruits and vegetables (Akubo et al., 2009), vegetables are known to contain very small amount of fat to maintain cell wall integrity.

The much lower protein (6.35%) for the shade dried SHVD) *V. doniana* than that of the sun dried (SDVD) 11.32mg sample appeared to indicate the superiority of sun drying to increase and retain more protein than shade drying (11.32 vs. 6.35%). ($p<0.05$) The higher ash (20.53%) for the shade dried (SHVD) sample than that of the sun dried (SDVD) (20.51%) showed that sun drying slightly increased ash in *V. doniana* sample than shade drying, however the difference was comparable ($p>0.05$). The lower fat for fresh (FVD) samples (12.99%) showed that fresh (FVD) samples had better chance of longer keeping quality and free of rancidity – a commonly observed phenomenon (Xiao et al., 2000). The higher fibre for the sun and the shade dried samples was not a surprise. Loss of moisture increases dry matter of which fibre is one. This value was based on free moisture. High fibre content of foods is good for quick bowl evacuation. The high fibre consumption is known to reduce the risk of colon cancer (Afarm, 2003). The lower value (12.39%) for fresh (FVD) sample further showed that fresh vegetables are not better sources of dietary fibre than those of the processed samples (12.39 vs. 20.45 and 21.16%, each) ($p<0.05$). The lower carbohydrate and energy (47.38% and 194.30 Kcal) for fresh *V. doniana* (Table 1) was expected. This is because vegetables in general are poor sources of carbohydrate and energy. On the other hand, the two food processing techniques increased the values as against their controls (29.95% and 122.64 Kcal and 37.14% and 152.28 Kcal vs. 47.38% and 194.30 Kcal (Table 1).

The higher protein for fresh *Corchorus* 25.62% was not surprising. Fresh vegetables contains more moisture, however, when based on moisture free, their dry matter is increased of which protein is among. The lower value for the fresh sample (6.46 and 6.76%) (Table 1) for the two processed samples relative to higher value (25.62%) for the fresh sample demonstrated that any of the processing methods would decrease the nutrients in these vegetables. On the other hand, the lower ash, fat, fibre, carbohydrate and energy for fresh *Corchorus* and *I. aquatica* (14.36, 1.55, 12.74, 45.04% and 184.69 Kcal as well as 11.84, 1.23, 12.09, 52.87% and 216.78 Kcal, respectively) showed that fresh vegetables are not good sources of these nutrients and energy.

The higher calcium, iron, zinc, iodine, B-carotene and ascorbate for all the three vegetables (Table 2) showed that these micronutrients are much more concentrated in fresh vegetables relative to their processed counterparts. The decreases in sun and shade dried samples particularly in Beta carotene and ascorbate were due to loss during heat treatment for fresh vegetables than dried because they are volatile in nature. The higher calcium (2.19, 2.13 and 1.94 mg) for the three vegetables showed that they are good sources of calcium. The lower values for the dried samples indicated that none of the drying method had the potential to increase calcium in these vegetables.

The higher B-carotene (322.60, 179.34 and 314.62 mg) for fresh samples, against dried (27.65, 8.52 and 0.20) demonstrated that the nutrient (pro-vitamin A) was much more concentrated in fresh samples than in dried. The lower B-carotene was not a surprise, because B-carotene and its relative derivatives are known to be volatile when exposed to mild heat. Base on this, drying might have led to the loss of B-carotene during processes (Udofia and Obizoba, 2005; Wachap, 2005) had experienced the same phenomenon in various fresh green leafy vegetable they investigated.

The lower ascorbate for the three dried vegetable samples relative to their fresh (controls) was soley attributable to the treatments. Ascrobate is water soluble and volatile when heated. It might be that the heat generated during drying caused the loss. Ascorbic acid assists iron absorption while B-carotene promotes human eyesight. Udofia and Obizoba (2005) and Zimmermann et al. (2003) reported similar observations. On the other hand, the low zinc (0.40 mg) content of the fresh *V. doniana* (FVD) showed that the vegetable contains little or traces of zinc minerals. The lower values for iodine for the sun and the shade dried samples (Table 2) 22.07 and 27.72 mg against 31.74 mg for *V. doniana*; 21.41 and 25.30 mg against 30.95 mg for *Corchorus* and 27.75 and 24.71 mg against 54.43 mg for *I. aquatica*, showed that iodine would be high in diets that contain these vegetables in their dry forms.

The higher protein (18.64%) content of the soup prepared with sun dried vegetable was because of heat lower moisture (Table 1) relative to its control (fresh) prior to its use for soup preparation. The soups prepared with the sun and the shade dried *I. aquatica* (SIPS and SHIS) vegetables had lower and comparable ash (11.50 and 11.52) (Table 3) than the other soups prepared with the sun or the shade dried samples. The higher fat content of soups prepared with traditional recipes that called for addition of palm oil, led to the increase in fat of each soup meal.

The high fiber content of all the soup meals was because the dried vegetables had increased fibre due to

loss of moisture. In addition, the food condiments contained extra fibre in addition to those in vegetables. The less than 50% carbohydrate content of the soups is simple to explain. Naturally, vegetables are not good sources of carbohydrate. The values contained in these soups might be those from soup thickeners. The fair levels of energy content of the soups might be associated with the added soup thickener and palm oil based on carbohydrate foods such as yam or cocoyam as the case may require.

The general low calcium, iron and zinc content of the soup meals (Table 4) was because the vegetables used for these soups preparation had low values for these minerals. The food condiments also did not contain these minerals as to add to those in vegetables. On the other hand, the high iodine values for the soups were because the vegetables prior to their use for soup preparation had high levels of this nutrient. The slightly high levels of phytate and tannins in these soups have some nutrition and health implications. Formally, these plant chemicals were regarded as anti-nutrients because they chelate some macro-elements to precipitate their un-bioavailability. However, recent information regards these as phytochemicals. They are now involved in series of reactions to lower serum cholesterol levels. Not only this, they may participate in the processes of reducing or lowering cancer risks (Vainio and Bianchini, 2003).

Indigenous vegetables constitute very important sources of minerals and vitamins in Nigeria diet. The high fibre content of the analyzed vegetables suggests that they can provide excellent sources of roughage which help to promote digestion of food. Therefore, vegetables provide significant percent of minerals and vitamins, for the average Nigerian's nutrient requirement which could be met through consumption of *V. doniana, Corchorus* and *I. aquaticas* for eradication of malnutrition.

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Full Length Research Paper

Chemical composition of an ecotype tilapia of Epe lagoon commonly called '"Wesafu"'

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The chemical composition of wild and domesticated "Wesafu", an ecotype cichlid found abundantly in Epe Lagoon fisheries in Lagos, south-western coast of Nigeria and a private fish farm in Badagry, Lagos, was investigated for proximate, mineral, fatty acid and amino acid compositions. The proximate compositions of the two specimens were found to be similar except for crude protein contents of 16.80 and 19.51% for the wild and farmed specimens, respectively. Seventeen different amino acids, twelve fatty acids and ten minerals were obtained in the tissues of the fish. The amino acids compositions of both the wild and farmed specimen were essentially similar and no wide variation in the amino acids compositions. Palmitic and oleic acids were the main saturated and monounsaturated fatty acids respectively. The principal oil in the polyunsaturated group was linoleic acid. Ten minerals were determined, including iron; 30.73 and 18.39, cobalt; 0.47 and 0.32, manganese; 13.64 and 2.75, zinc; 35.35 and 33.17 in mg/kg, respectively for the wild and farm raised specimens. This ecotype cichlid of Epe Lagoon, Nigeria "Wesafu" is thus a nutrient dense food fish being rich in quality protein, polyunsaturated fatty acids and having an array of essential minerals. It is recommended for culture and introduction to the bodies of water across the country to further guarantee food fish security, especially in the poor coastal communities of the country.

Key words: Ecotype cichlid, "Wesafu", chemical composition, amino acids, fatty acids, minerals.

INTRODUCTION

Fish constitute a very important component of the diet for many people and often provides the much needed nutrients that are not provided in cereal based African diets (Clucas and Sutchiffe, 1981). Saisithi (1994) reported that fish provides between 30 and 80% of the total animal protein intake of the coastal people of West Africa, while Olomu (1995) also reported that fish is rich in protein with amino acid composition very well suited for human dietary requirements and compare favorably well with egg, milk and meat. The concentration of dietary essential amino acids is a major factor in determining the nutritional value of food protein. Fish muscle contains an excellent amino acid composition and is a source of nutritive and easily digestible proteins (FAO/WHO, 2001).

Cichlids, commonly called the "*Tilapias*" of the family Cichlidae are perch-like fish and the family is known to have produced an enormous variety of freshwater species in Africa. The problem of precocious sexual maturity and unwanted reproduction has long been accepted as a major constraint to further development and expansion of tilapia culture in Nigeria. However, there exists an ecotype cichlid in Epe lagoon, Nigeria that grows up to 1500 g, and has a broad and deep fleshy body when landed from the wild in Epe where they are endemic in Nigeria (Fashina-Bombata et al., 2008). "Wesafu" is therefore a candidate for culture and introduction to water bodies as stock replenishment to reduce fishing efforts of artisanal fisher folks. Sex reversal is more successful and has been adopted in many commercial hatcheries, but has yet to be widely adopted in Nigeria until recently with this ecotype with interesting results in an ongoing study (Fashina-Bombata et al., 2008).

"Wesafu" is a vernacular name of a tilapia that is very prominent in Epe lagoon of Lagos State. This species is highly prized (Fashina-Bombata et al., 2004). The huge size of this species makes it a desirable food fish for culture.

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Table 1. Proximate composition of wild and domesticated "Wesafu".

Parameter	Wild "Wesafu" (%)	Farmed "Wesafu" (%)
Moisture content	76.92	76.31
Crude protein	16.80	19.51
Crude fibre	0.03	0.02
Total fat	2.33	2.62
Ash	1.35	1.54

Fashina-Bombatta et al. (2005, 2006) reported "Wesafu" to be highly priced fish in Lagos, Nigeria, for its tasty flesh and large size of over 1,500 g in the wild. At the moment, 1 kg of "Wesafu" is sold for between 7.74 and $9.67 [the exchange rate is N160 to one US Dollar] in Lagos, probably the highest priced fish in Nigeria (Megbowon et al., 2010). The objective of this study was thus to document the chemical composition of this unidentified ecotype cichlid of Epe Lagoon in Lagos, Nigeria.

MATERIALS AND METHODS

Representative samples of 350 g (average of 'Wesafu') were obtained from the wild and a domestic source from a private farm. Each sample was scaled and then filleted on both sides in Fish Laboratory of Lagos State University. Fillets obtained from samples were dried in an oven for two days at 60°C. The dry ti ssue samples were then bulked for analyses.

Proximate analysis

Proximate analyses were carried using the methods of AOAC (2000), which included moisture, ether extractives, crude protein, crude fiber and ash contents. Moisture content was determined by drying samples to a constant weight at 105°C in an oven (Table 1.).

Estimation of protein

Optical density measurements were achieved with a spectrometer to estimate amino acid and protein levels according to the Lowry et al. (1951) method. The values of the optical densities were then recorded. The quantification of proteins was done by tracing the various optical densities relative to the standard proteins, and similarly for amino acids. A standard amino acid, methionine, with known optical density (570 nm) was used to calibrate the spectrometer.

Fatty acids determination

Extraction of the crude oil was carried out at the Analytical laboratory, National Institute for Freshwater Fisheries Research (NIFFR), New Bussa. The extracted oil was stored at ambient temperature before taken to the Central Science laboratory. The fatty acids were converted to their methyl esters according to the method of Christy (1997). About 5 ml of the oil was esterified with acetone (59:41). The mixture in vials was heated at 80°C on hot plate for 30 min, cooled and then diluted with water; it was then extracted with diethyl ether and analyzed by high pressure liquid chromatography (HPLC). Identification and quantification of fatty acids were carried out in HPLC using the methods of Christy (1997). Fatty acids in the samples were identified by relative retention time matched to reference standards. Percentage composition of each fatty acid identified was calculated using peak area as follows:

$$\% \text{ Fatty acid} = \frac{\text{Peak area of sample} \times \text{conc. of std.} \times \text{dilution factor}}{\text{Peak area of standard}}$$

Determination of minerals

The mineral contents of fish flesh samples were determined in triplicate by the acid digestion method involving microwave technology. A 0.5 g sample was placed in a vessel and 6 ml HNO_3 was added. The sealed vessel was heated until digestion was completed, and the digested sample was cooled for 5 min. An inductively coupled argon plasma optical emission spectrometer (Model CIROS, SPECTRO Analytical Instruments) was used to analyze the mineral content.

RESULTS AND DISCUSSION

The results of the analysis on the chemical compositions of "Wesafu" are represented in Tables 1 to 4. Proximate composition of both wild and domesticated "Wesafu" was observed to have close values of 16.80 and 19.31% crude protein (CP), total fat (2.33 and 2.62), ash (1.35 and 1.54) and moisture (76.92 and 76.31), which is as high as the values recorded by Osibona et al. (2009) on *Tilapia zillii* [crude protein (19.0 ± 1.90), total fat (1.1 ± 0. 4), ash (1.2 ± 0.2), moisture (80.4 ± 3.79)]. Moisture content was within previously reported range in other tilapiine fishes (Gallagher et al., 1998).

The range of amino acids in "Wesafu" is reported in Table 1 and shows a generous composition in both the wild and the farmed fish. These values are also similar to those of *T. zillii* reported by Osibona et al. (2009) [http://findarticles.com/p/articles/mi_7400/is_1_9/ai_n32063507/]. "Wesafu" also contain significant amounts of essential amino acids, particularly lysine (10.82%), which is low in cereals and common staples of African diets. "Wesafu" protein can therefore be used to complement the amino acid pattern and the overall protein quality of diets of inhabitants of poor coastal communities in Nigeria. Furthermore, "Wesafu" is a good source of polyunsaturated fatty acid (PUFA) having a high content of arachidonic acid (4.20% for wild and 3.36% for the

Table 2. Amino acid composition of wild and farmed “Wesafu”.

Amino acid	“Wesafu” (Wild) (%)	“Wesafu” (Farmed) (%)
Glysine	5.22	5.22
Alanine	5.79	5.78
Serine	3.59	3.59
Proline	3.08	3.08
Valine	4.05	4.05
Threonine	4.56	4.56
Isoleucine	4.45	4.45
Leucine	8.60	8.60
Aspartate	9.56	9.56
Lysine	10.82	10.82
Glutamate	17.30	17.30
Methionine	5.12	5.12
Phenylalanine	4.70	4.70
Histidine	2.11	2.11
Arginine	5.68	5.68
Tyrosine	4.82	4.82
Cysteine	0.46	0.46

Table 3. Fatty acid composition of wild and farmed “Wesafu”.

Fatty acid	“Wesafu” (Wild) (%)	“Wesafu” (Farmed) (%)
Myristic acid	4.86	5.27
Palmitic acid	23.98	26.81
Palmitoleic acid	6.01	6.70
Stearic acid	4.46	5.057
Oleic acid	19.79	21.43
Linoleic acid	13.92	15.09
Linolenic acid	8.93	8.66
Arachidic acid	0.20	0.11
Arachidonic acid	4.20	3.36
Behenic acid	7.22	4.50
Erucic acid	6.42	2.56
Lignoceric acid	-	0.45

Table 4. Average measurements are listed for the mineral composition of wild and domesticated “Wesafu” (n = 10).

Parameter	Wild “Wesafu” (mg/kg)	Farmed “Wesafu” (mg/kg)
Iron	30.73	18.39
Cobalt	0.47	0.32
Manganese	13.64	2.75
Zinc	35.35	33.17
Phosphorus	24.19	22.11
Copper	2.81	3.62
Sodium	894	853
Magnesium	1349	158
Calcium	1572	892
Potassium	13105	11483

farmed strain), which is known to facilitate the blood clotting process. Other abundant mono-unsaturated fatty acids included palmitoleic acid (6.01 and 6.70), palmitic (23.98 and 26.81), oleic (19.79 and 21.43) in wild and domesticated species respectively, thus making "Wesafu" a good source of essential fatty acids.

In addition, the ecotype cichlid, "Wesafu" appears to be a good source of phosphorus with a level of 22.11 and 24.19 mg/kg for domesticated and wild specimen, respectively. A low calcium intake, coupled with inadequate intake or production of vitamin D, greatly increases the risk of bone fractures in older people. Getting enough calcium and vitamin D every day can decrease the risk. An adequate intake of calcium also may contribute to the taming of high blood pressure and the prevention of (polyps) growths in the colon that sometimes turn cancerous. Calcium content of "Wesafu" is capable of meeting the requirements of a young adult. Like calcium and vitamin D, magnesium is an essential nutrient for bone health. Recommended intake for men of 420 mg a day and women 320 mg a day is easily met with a regular consumption of this fish. Moreover, potassium is present in every cell of the body and plays a vital role in muscle contraction, transmission of nerve impulses and maintenance of fluid balance. Adequate potassium intake is a way to keep blood pressure in check and to promote bone health. Potassium is so important to blood pressure control. The recommended intake for men and women is 4,700 mg a day. With a content of 13105 mg/kg, a kilogram of "Wesafu" will give about 278% of the daily requirement of adult male and female. Thus, wesafu is a good source of potassium.

Zinc is involved in the metabolism of carbohydrates, fats and proteins. It also plays an important role in the production of DNA. Additionally, zinc is also essential for wound healing and for maintaining immunity and sense of taste. Dietary surveys show that about 50% of men and 75 percent of women over the age of 51 do not get enough zinc in their diets, making supplementation a good idea. The recommended intake for men is 11 mg a day; women: 8 mg a day. With a zinc content of 35.35 mg/kg, the regular intake of about a kilogram of "wesafu" can only meet 70 and 47% requirement zinc for men and women, respectively. On the other hand, copper is involved in the absorption, storage and metabolism of iron and the formation of red blood cells. It also helps supply oxygen to the body. The symptoms of a copper deficiency are similar to iron-deficiency anemia. Copper is needed to help body use iron, also important for nerve function, bone growth and help the body use sugar. Many survey studies show that people consume about 1.0 mg or less of copper per day. With a content of 3.62 mg/kg, "Wesafu" is capable of meeting the daily need for copper.

The daily requirement for manganese in man is 2.0 to 5.0 mg/d ay for adults, 2.0 to 3.0 mg for children 7 to 10 years, 1.5 to 2.0 mg for children 4 to 6 years, 1.0 to 1.5 mg for children 1 to 3 years, 0.6 to 1.0 mg for children 6 months to 1 year, and 0.3 to 0.6 mg for infants 0 to 6 months. Manganese content in "Wesafu" is 13.64 mg/kg which is way beyond the daily requirement. Iron deficiency is common in infants, adole-scent girls and pregnant women. Iron deficiency in infants can result in impaired learning ability and behavioural problems. It can also affect the immune system and cause weakness and fatigue. Women and teenage girls need at least 15 mg a day, whereas men can get by on 10 mg per day. It is important that children get about 10 to 12 mg of iron per day, preferably from their diet. "Wesafu" is also a rich source of iron with a content of 30.73 mg/kg.

Current dietary recommendation suggests that we avoid too much sodium, and many individuals have been advised to reduce their sodium intake because of hypertension (high blood pressure) or other disorders. Sodium is always found in pairs of electrolyte with other elements. Electrolytes function in the maintenance of water balance and distribution, kidney and adrenal function, acid-base balance, muscle and nerve cell function, and heart function (FAO/WHO, 2001). Fish in general are low in sodium and even those species with the highest sodium levels contain less than 100 mg per 3 ounce cooked portion, which is less than 5% of the current daily recommended maximum sodium intake. A daily diet intake of 500 mg/day for adults and 120 mg for infants is recommended. "Wesafu" offers 0.894 mg/kg, which is low compared to the daily recommendation and may not be regarded as a good source of sodium. This is good as it does not increase the risk of excessive intake and the effect of the low content in "Wesafu" will not be too pronounced due to the availability of sodium in purified form such as table salt. Furthermore, cobalt was 0.47 and 0.32 mg/kg in the specimens and is an integral component of cyanocobalamin (vitamin B12), essential for red blood cell formation and the maintenance of nerve tissue. Wesafu will rank among other rich dietary sources of cobalt like copra meal (2 mg/kg Co), linseed meal, dried brewers yeast, fish meal, meat meal, cottonseed meal, and soybean meal (0.5 to 0.1 mg/kg).

This study reveals that "Wesafu" is a fish that is high in nutrients. "Wesafu" is rich in leucine (8.60), aspartate (9.60), lysine (10.82) and glutamate (17.30); making it a quality source of protein, although its protein content is low due to its herbivorous feeding habits. The lipid content is, however, encouraging as the fish contains high level of essential poly-unsaturated fatty acid [PUFA] such as arachidonic acid (4.20 and 3.36), mono unsaturated fatty acids such as palmitoleic acid (6.01 in the wild specimen and 6.70 for farmed), palmitic (23.98 and 26.81) and oleic (19.79 and 21.43).

Conclusion

The overall assessment of this fish suggests its nutritional benefits as an important food fish in the coastal community of Epe lagoon, where it is believed to be endemic in

in the State. Hence, there is an urgent need to conserve this wild species by immediately introducing it in the culture systems in the country. This will limit its aggressive fishing to stem stock depletion while efforts are underway to conclude DNA studies for proper naming of this fish for conservation.

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