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Impact of Some Organic Mulch Materials on Weed Dynamic, Proximate Composition and Nutrient uptake of Celosia (*Celosia argentea* L.) in Southeastern Nigeria

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Abstract **Original Research Article**

Field experiment was conducted at the Teaching and Research Farm of University of Port Harcourt, Choba, Port Harcourt, Rivers State, Nigeria to the evaluate the impact of some organic mulch materials on weed dynamic, proximate composition and nutrient uptake of celosia. The experiment consisted of six treatments namely: calopo mulch at 10 t/ha, guinea grass mulch at 10 t/ha, sawdust mulch at 10 t/ha, wood shavings mulch at 10 t/ha , Two hoe weeding at 3 and7 WAP and weedy check laid out in a randomized complete block design (RCBD) with four replicates. Result showed that there were changes in weed species composition due to mulching. Weedy check plot had the highest weed score and weed dry weight than other treatments. Among the organic mulch materials, wood shavings and sawdust had the lowest weed score and dry weight. Plot mulched with calapo had the highest dry moisture content (16.00%), crude protein (10.51%) crude fibre (11.75%), carbohydrate (33.33%) fat (0.03%) and ash (34.25%). Weedy plot had lowest dry moisture content (7.63%), crude protein (4.75%) crude fibre (5.25 %), carbohydrate (16.50%), fat (0.01%) and ash (16.53%). In addition, calopo mulched plot had the highest uptake of N (22.54 kg/ha), P (33.35 kg/ha), K (14.70 kg/ha), Ca (3.29 kg/ha) , Mg (31.38 kg/ha) and Fe (32.52 kg/ha). The weedy check had the lowest uptake of N (2.61 kg/ha), P (3.61kg/ha) K (2.40 kg/ha), Ca (0.42 kg/ha), Mg (2.99 kg/ha) and Fe (1.57 kg/ha). The Mulch Technology could be of benefit to farmers for controlling weeds growth, improving the nutritional quality and nutrient uptake of celosia without depending on herbicide usage, which may constitute threat to the environment. Since, calopo was the most effective mulch material for enhancing proximate composition and nutrient uptake; it is thus, recommendable to celosia growers.

Keywords: Celosia, Some Organic Mulch Materials, Proximate Composition, Nutrient uptake, Weed Dynamic.

INTRODUCTION

Celosia (*Celosia argentea* L.) is an annual herb vegetable belonging to the family of Amaranthaceae. It is cultivated in West Africa countries including Nigeria. Although the vegetable appears grown in all states in Nigeria but it is mostly grown in Southwestern States. The average Nigerian diet is derived from starchy food agricultural products like: yam, cassava and rice. Celosia serves as a cheap source of mineral, vitamins and protein and it is use in the preparation of soup and stew to supplement the starchy foods. Proximate studies of celosia showed that it contains 15.6% dry moisture content, 9.35% crude protein, 11.7% crude fibre, 0.21% fat and 32.40% crude ash [1]. The vegetable is also good source of minerals because it contains higher amount of Ca – 0.18%, P – 0.04%, K – 0.06%, Na – 0.0 4%, Mg – 0.04% , Fe – 0.02%, Zn – 0.07% and Cu – 0.04% ,trace amount of Cr, Mn, Ni, and Pb [2, 3]. Noted that different stages of growth and environmental factors influenced the nutritional composition of the vegetable. Weed infestation is one of the major obstacles to the production of this vegetable despite its importance to man [4, 5], had reported losses in yield due to weed infestation in this vegetable. Generally, vegetable farms are small and weeding frequency is high. Mulching is a common weed control practice among vegetable farmers in Nigeria [6]. Mulching reduced the frequency of hand weeding hence it is being practiced by several vegetable farmers in Nigeria. Some examples of organic mulch materials are wood shaving, sawdust, debris, grasses and straw. Although the effect of organic mulch materials on celosia growth and yield are documented in literature [4; 5]; however, their impact on weed dynamic, proximate composition and nutrient uptake have not be fully investigated. Hence, the objective of the study was to evaluate the effect of organic mulch materials on weed dynamic, proximate composition and nutrient uptake of *Celosia argentea*

MATERIALS AND METHODS

Experimental site

The experiment was conducted at the Teaching and Research Farm of the University of Port Harcourt, Choba, Port Harcourt, and Rivers State. The experimental site is located on latitude 04° 54' 538″N and longitude 006° 55' 329″ E with an elevation of 17metres above sea level. The area experiences distinct wet (April to November) and dry (December to March) seasons. The experimental site remained fallow for two years before the beginning of the study. The dominant weed species found in the experimental site and their level of occurrence is presented in Table 1. The soil of the experimental site was sandy loam with sand particle of 66.2%, silt (27.8%) and clay (6%). The soil was slightly acidic with a pH of 5.6, N (0.15%), P (15.6mg/kg), K (0.24 cmol/kg) and Om (2.82%).

Source of planting material

Seeds of Celosia were obtained from the National Institute for Horticultural Research (NIHORT), Ibadan, Nigeria.

Source of mulch materials and chemical composition

Prior to experimentation, calopo (*Calopogonium mucunoide*s Desv.) and guinea grass (*Panicum maximum* were cut from the base of the shoot at young stage before flowering from Teaching and Research Farm, University of Port Harcourt. Wood shaving and saw dust materials were obtained from mixed log at a sawmill factory around University of Port Harcourt environment. The four mulch materials were dried under the sun for two weeks to constant weight. Some quantities from each of the mulch materials were analyzed for their mineral composition by using the procedure of AOAC [7].

Experimental Design and Treatment

The experiment was a randomized complete block design (RCBD) with six (6) treatments and four replicates. The treatments were:

- Calopo mulch at 10 t/ha
- Guinea grass mulch at 10 t/ha
- Sawdust mulch at 10 t/ha
- Wood shavings mulch at 10 t/ha
- Two hoe weeding at 3 and 7WAP
- Weedy check

Cultural Details

An experimental area of dimension 14m x 15 m (210m^2) approximately 0.02 ha was cleared with cutlass. The debris were gathered and packed out of the experimental area. The experimental area was and divided into four blocks. Each block consisted of 6 treatments with an alley way of 1m apart. Each plot measured 1.5m x 2.4m and rose to a bed of 30cm height with alleyways of 1m each between plots and replicates. Celosia seeds were sown at spacing of 60 cm x 15cm at two seeds per hole and the mulch materials were spread per plot leaving a little opening for seed germination. The seedlings were later thinned to one per stand at two weeks after planting (2WAP) giving a population density of 222,222.22 plants/ha. Weeding was done twice with hoes on the plots that needed weeding at three and seven weeks after planting (3 and7 WAP), while the weedy plot was left without weeding throughout duration of the experiment.

Weed data collection

Common weed species before and end of experiment

Common weed species present before and at the end of the experiment done by visual rating. The weed species were identified using weed album [8].

Weed score

This was visually assessed at 6 WAP using a scale of 1 to 10, where 1 = no weed score and 10 = complete cover.

Weed dry weight

All weed biomass was harvested at ground level from each plot at 6 WAP and sun dried to constant weight for two weeks before weighing. The values were expressed in t/ha.

Celosia data collection

Dry shoot weight

This was obtained by cutting six (6) plants with sharp knife at ground level from the middle row of each plot at 6WAP. The fresh shoots were oven dried at 110ºC for 24 hours and weighed with Hana weighing balance.

Mineral and proximate composition

The dry shoots were analyzed for mineral and proximate composition by [7] method.

Nutrient uptake

The nutrient uptake was done by taking the product of shoot dry weight and concentration of nutrient elements in the shoot i.e., Nutrient uptake = concentration (%) of dry tissue x dry weight of tissue.

Statistical analysis

Data generated were subjected to statistical analysis of variance (ANOVA) and significant treatment means were compared using least significant difference (LSD) at 5% probability level.

RESULTS AND DISCUSSION

Weed dynamic

Table 1 shows weed species found before planting and under different organic mulch materials at 6 WAP. Thirteen (13) weeds species were found in the experimental site before planting. Out of 13 weed species, 9 species (53.8%) were broad leaf weeds, grasses and sedges (3) 23.1% each. The high increase of broad leaf weeds indicates that it is more prevalent than

grasses and sedges. Since, the experimental site was located in Southern Nigeria, broad leaved is bound to be prevalent as result of high rainfall. Low rainfall and high temperature give rise to the growth of grasses. About 28.57% of all the weed species belonged to the Asteraceae (4), 30.8 %, Cyperaceae (3) and 23.1% Poaceae (3) 23.1%. Others were Rubiaceae (2) 15.4%, and Malvaceae (1) 7.69. The most dominant weed species found at the experimental site were: *Euphorbia heterophylla*, Digitaria *horizontalis, Eleusine indica* and *Panicum maximum.*

The weed flora observed at the experimental site and their level of infestation under the each treatment 6WAP are presented in Table 1. Out of 16 weed species found across all treatment at 6 WAP, 8 species (50%) were broad leaved, grasses 4 (25%), sedges 3 (18.8%) spiderwort 1 (6.3%). The organic mulched materials were able to reduced weed growth of sedges and grasses than broadleaved weeds hence, the high percentage of broad leaf weeds were noticed after treatment application at 6 WAP. The probable reason could be that broadleaved weeds were more tolerant to ground cover provided by the mulch materials than grasses and sedges. Some of the weeds species that appeared before planting and after treatments application could be regarded as persistent weeds.

About (4) 25% of all the weed species at end of the experiment belonged to each of the family of Asteraceae, Cyperaceae and Poaceae respectively. Others were Rubiacee (2) 12.5%, and 1 (6.2%) each of Amaranthecee and Commelinacee respectively. The most common weed species across the treatments were *Amaranthus spinosus, Aspilia africana, Mitracapus villosus,* Three new weed species were found at harvest namely: *Amaranthus spinosus Echinochloa colona,* and C*ommelina benghalensis.* Weed occurrences were higher in weedy check than in mulch and hoe weeded plots.

Table-1: Weed species found before planting and under different organic mulch materials at 6 WAP

Weed species	Plant family		After treatment application at 6 WAP					
		Bf	CA	GG	SD	WS	HW	WC
Broad Leaves								
Amaranthus spinosus	Amaranthaceae	–	+	++	+	+	+	+++
Ageratum conyzoides	Asteraceae	++	–	–	–	–		+++
Aspilia africana	Asteraceae	++	+	++	+	+	+	+++
Chromoleana odorata	Asteraceae	+	+	+	+	+	–	++
Euphorbia heterphylla	Asteraceae	+++	+	+	+	+	–	+++
Mitracapus villosus	Rubiaceae	++	+	+	+	+	+	+++
Oldenlandia corymbosa	Rubiaceae	++	+	+	+	–	–	+++
Sida acuta	Malvaceae	++	++	++	++	+	–	+++
Grasses								
Digitaria horizontalis	Poaceae	+++	+	+	+	+	–	+++
Echinochloa colona	Poaceae	–	+	+	+	+	–	+++
Eleusine indica .	Poaceae	+++	+	+	+	+	–	+++
Panicum maximum	Poaceae	+++	+	+	+	+	–	+++
Sedges								
Cyperus esculentus .	Cyperaceae	++	+	+	–	–	–	++
Cyperus rotundus .	Cyperaceae	++	+	+	–	–	–	++
Mariscus alternifolius	Cyperaceae	++	+	+	–	–	–	++
Spiderwort								
C*ommelina benghalensis*	Commelinaceae	–	+	+	–	–	–	++

Bf=before planting, CM= calopo mulch; GM = guinea grass mulch; SD = Sawdust mulch; WS= Wood shavings mulch; HW = Two hoe weedings at 3 and 7 WAP; WC = Weedy check, +++ = Higher Infestation (60 – 90% occurrence), ++ = Moderate Infestation (30 – 59% Occurrence), + = Low Infestation (1 – 29% occurrence)

Weed score and Weed dry weight

The effect of organic mulch materials on weed cover score and weed dry weight at 6 WAP is presented in Table 2 .There were significant differences ($P < 0.05$) among the treatments on weed score and weed dry weight. Plots hoe weeded twice at 3 and7 WAP produced the lowest weed score and weed dry weight while weedy plot had the highest weed score and weed dry weight. Among the organic mulch materials, wood shavings had the lowest weed score and dry weight but statistically at *par* with sawdust.

Table-2: Effect of organic mulch materials on weed cover score and weed dry weight of *Celosia argentea* at 6 WAP

Treatment	Weed score	Weed dry weight (t/ha)
Calopo mulch	5.33	0.13
Guinea grass mulch	5.67	0.13
Sawdust mulch	3.33	0.09
Wood shavings	2.67	0.09
Two hoe weeding at 3and 7WAP	1.33	0.01
Weedy check	9.33	2.01
LSD (P=0.05)	0.92	0.04

Proximate composition

Dry moisture content

The effect of organic mulch materials on dry moisture content of *Celosia argentea* is presnted in Table 3. The moisture content differed significantly among the various treatments. Plot mulch with calopo produced the highest moisture content though at *par* with two hoe weeding. The lowest moisture content was produced from weedy checks. Plot treated with calopo mulch had higher dry moisture content probable as result of better moisture conservation in the soil than other organic mulch materials. The probable reason for weedy check having lower dry moisture content could be attributable to strong weed competition with vegetable for water, nutrients space, light and carbon dioxide. The dry moisture content, which ranged between 7.63 % and 16 % obtained in this vegetable from this study, fell within the comparable range, obtained in some Nigerian vegetables between 10.0-12.08 % [9]. High moisture content in vegetables determines their quality [10]. The food values of leafy vegetables including celosia are low because of the large volume of water they contain [11].

Crude protein

The effect of organic mulch materials on crude protein content of *Celosia argentea* is presnted in Table 3. The treatment differed significantly on crude protein content. The highest amount of crude protein was recorded in plots treated with calopo mulch, which was at *par* with that of guinea grass mulch and hoe weeded plots. The weedy plot had the lowest crude protein content. Plot mulched with calopo and guinea grass had slightly higher values of crude protein than other treatments probable because of their high nitrogen levels present in the two materials as indicated from the result of the chemical composition (Table 4).Nitrogen is essential for protein formation [12] noted that availability of adequate nitrogen and moisture in the soil for plants could influence greater chlorophyll formation and photosynthesis that could produce crops with greater protein content. The protein content ranged from 4.75 % to 10.51%, which is higher than the standard reference value of 3.3% [13]. Since the value of crude protein is above the reference standard of 3.3%, it implies that the vegetable is a good source of protein.

Crude fiber

The effect of organic mulch materials on crude fibre content of *Celosia argentea* is presnted in Table 3. The treatment differed significantly on crude fibre content. Calopo mulch had the highest value of crude fibre but the value was comparable to that of guinea grass mulch, two hoes weeding at 3 and 7 WAP and wood shavings. The least crude fibre content was obtained in weedy check. The high content of crude fibre might be attributable to high organic matter present in the three treatments (Table 4) [14]. Noted that the use of organic mulch could decrease fibre content of crops, which could serves as benefit for human health and animal feed production. The crude fiber range between 5.25 % and 11.75 % obtained in this study fell within the range obtained in some Nigerian vegetables, which is between 8.50% and 20.90% [15]. A diet that is rich in crude fibre helps to prevent constipation, bowel problems and piles [10].

Carbohydrate

The effect of organic mulch materials on carbohydrate content of *Celosia argentea* is presnted in Table 3. The highest amount of carbohydrate was produced in calopo mulch plots but it was comparable to that of guinea grass mulch and two hoe weeding at 3 and 7WAP. The lowest amount was from weedy plots. The high amount of carbohydrate content in calopo and guinea grass mulch could be attributable to high organic matter and low C/N ratio when compared to other mulched materials (Table 4). Hoe weeded plots had comparable value with that of calopo and guinea grass mulch probable because of it less weed population. The carbohydrate content recorded range between 16.50% to 33. 33%. The value was lower than 46.7%-79.5% obtained in twelve edible vegetables in Nigeria [16].This implies that the vegetable cannot be the right source of carbohydrate.

Fat

The effect of organic mulch materials on fat content of *Celosia argentea* is presnted in Table 3. There were no significant differences among the treatments. The probable reason could be due to lack treatment effect. Fat contents ranged between 0.01 and 0.03%, which is lower than 1.5 - 4.1 % noted by [2]. With this high value, the vegetable can be the right source of phosphorous.

Ash

The effect of organic mulch materials on ash content of *Celosia argentea* is presnted in Table 3. The ash content differed significantly among the treatments. Plot mulched with calopo material gave the highest ash content while the weedy check plot gave the lowest. The ash content ranged from 16.53 to 34.25% and these values were above 16.30% - 17.31% for some vegetables [17]. Leaf vegetables with ash content higher than 8.8% are of health benefit to human [18]. The high content of ash in leafy vegetables is an impression of the quantity of mineral elements present in them [19]. This vegetable can serve as good source of ash, which provides minerals that are important for proper growth, and development of the body.

Table-3: Effect of organic mulch materials on proximate composition of Celosia *argentea*

Treatment	DMC (%)	CP (%)	CF (%)	CHO (%)	Fat (%)	Ash (%)
Calopo mulch	16.00	10.51	11.75	33.33	0.03	34.25
Guinea grass mulch	14.75	10.50	11.00	33.30	0.02	33.50
Sawdust mulch	14.58	8.25	10.75	30.50	0.02	31.00
Wood shavings	14.73	8.50	11.03	30.75	0.02	31.50
Two hoe weeding at3 and 7 WAP	15.25	10.25	11.25	33.00	0.02	33.00
Weedy check	7.63	4.75	5.25	16.50	0.01	16.53
LSD (P=0.05)	0.51	0.56	0.87	1.15	NS	0.68

DMC= Dry moisture content, CP= Crude protein, CF= Crude fibre, CHO = Carbohydrate,

Chemical composition of organic mulch materials

Table 4 shows the chemical composition of the organic mulch materials used for the experiment. The chemical composition of the organic mulch materials showed that calopo mulch had the highest level of organic carbon (OC), Organic matter (OM), total nitrogen (N), Potassium (K) and the lowest C/N when compared to other organic mulch materials. Wood shavings had the highest level of Phosphorous (P) while guinea grass had the lowest level of P**.**

Table-4: Chemical composition of the organic mulch materials used in the experiment

Organic mulch materials	OC(%)	OM (%)	Total N (%)	C/N	P (mg/kg)	K (cmol/kg
Calopo	39.8.	68.62	2.00	19.90	1.00	0.11
Guinea grass	36.1	62.23	1.14	31.67	0.99	0.15
Saw dust	35.6	61.37	0.11	323.63	2.05	2.95
Wood shavings	35.8	61.72	0.10	358.00	2.07	2.98

Mineral composition

The effect of organic organic mulch materials on mineral composition of *Celosia argentea* is shown in Table 5. There were no significant differences among the treatments on the various mineral elements except on phosphorus (P). The non-significant differences on the various treatments might be attributable to lack of treatment effects. The values of Ca – 0.04% to 0.06 %, P – 0.36% to 0.70%, K – 0.21% to 0.29%, Mg – 0.15% to 0.60%, Fe – 0.27 to 0.57%, were above the values of Ca – 0.18%, P – 0.04%, K – 0.06%, Mg – 0.04% , Fe – 0.02% reported by [2]. The high values showed that the vegetable is good source of mineral elements.

The highest content of P was observed on wood shavings mulched though the value was comparable to that of calopo mulch, guinea grass mulch, sawdust mulch, and two-hoe weeding @ 3&7WAP (control). The lowest mineral content was obtained from weedy check. The high level of P in wood shaving mulch could be attributable to high P content present in the material (Table 3) [20]. Noted that different organic mulch materials with variable chemical composition have diverse effects on the soil food web, as well as the mineralization of the elements especially phosphorous.

Table-5: Effect of organic mulch materials on mineral composition of Celosia *argentea*

Treatment	N (%)	P (%)	K (%)	Ca (%)	Mg (%)	Fe (%)
Calopo mulch	0.41	0.61	0.27	0.06	0.60	0.57
Guinea grass mulch	0.38	0.68	0.22	0.05	0.58	0.43
Sawdust mulch	0.36	0.68	0.22	0.06	0.58	0.31
Wood shavings	0.34	0.70	0.23	0.06	0.58	0.31
Two hoe weeding at 3and 7WAP	0.37	0.60	0.29	0.05	0.59	0.49
Weedy check	0.24	0.36	0.21	0.04	0.15	0.27
LSD (P=0.05)	NS	0.15	NS	NS	NS	NS

Shoot dry weight and Nutrient uptake

The effect of organic mulch materials on shoot dry weight is presented in Table 6. There were significant differences ($p<0.05$) among the treatments. Plot treated with calopo mulch produced the highest shoot dry weight while the weedy check had the lowest weed dry weight. Plot treated with calopo mulch gave the highest shoot dry weight probable because it was richer in nutrients elements than other treatments. The reduced weed dry weight observed in mulched plots and hoe weeded plots could be responsible for the higher uptake of nutrient when compared to weedy check. Plot treated with calopo mulch had the highest uptake of nutrients (N, P, K, Ca, Mg and Fe) when compared to other treatments probable because of it low C/N which facilitated its faster decomposition, released of more nutrient to soil and coupled with reduced weed competition. High uptake of nutrients due to reduce weed competition has also been noted by [21].

Table-6: Effect of organic mulch materials on shoot dry weight (kg/ha) and nutrient uptake (kg/ha) of Celosia *argentea*

Treatment	SDW	N	P	K	Ca	Mg	Fe
Calopo mulch	5500.00	22.54	33.35	14.70	3.29	31.38	32.52
Guinea grass mulch	4111.11	15.62	29.70	9.05	2.18	17.74	23.79
Sawdust mulch	2333.33	8.29	15.70	4.98	1.33	7.26	16.62
Wood shavings	2944.44	9.87	20.61	6.54	1.60	9.26	17.01
Two-hoe weeding @ 3&7 WAP	4000.00	14.61	24.01	11.38	1.87	19.45	23.56
Weedy check	1111.11	2.61	3.61	2.40	0.42	2.99	1.57
LSD (P=0.05)	280.00	1.04	3.92	1.17	0.34	2.24	1.51

SDW = Shoot dry weight

CONCLUSION

The present study revealed that organic mulch materials enhanced the proximate composition and nutrient uptake of celosia by promoting weed change and reducing weed infestation. The Mulch Technology could be of benefit to farmers for controlling weed growth and improving the nutritional quality of celosia without depending on herbicide, which may constitute threat to environment. Among the mulch materials, calopo was the most effective in enhancing proximate composition and nutrient uptake of celosia. With its effectiveness, it is thus, recommendable to celosia growers.

REFERENCES

1. Onwordi CT, Ogungbade AM, Wusu AD. The proximate and mineral composition of three leafy vegetables commonly consumed in Lagos, Nigeria. Africa Journal of Pure Applied Chemistry. 2009; 3: 102-107.
2. Bapu RT. Review on *Celosia argentea* L. Plant Research Journal of Pharmacognosy and Phytochemistry. 2018; 10 (1): 109-119.
3. Grubben GJH. Tropical Vegetables and Their Genetic Resources IBPC, Rome, Italy, 1977; 197.
4. Akobundu I.O. Weed Science in the Tropics. Principles and Practices. John Wiley and Sons. N.Y. 1987; 522.
5. Okhira JI, Ogunyemi S, Omueti S. Evaluation of dry mulches for weed suppression in. *Celosia argenta production*. Nigerian Journal of Weed Science. 1992; 5: 63-66
6. Kushwaha HS, Tripathi ML, Singh VB. Weed management in coriander (*Coriandrum sativum*). In: Proceeding of Second International Agronomy Congress on Balancing Food and Environment Security: a Continuing Challenge (Eds.), Singh Panjab, IPS Ahlawat and Gautam RC. Indian Society of Agronomy, IARI, New Delhi: 2002; 985-987.
7. AOAC. Official methods of analysis. 21st Edition, Association of official analytical chemists. Washington D. C. USA. 1999
8. Akobundu IO, Agyakwa CW. A Handbook of West African Weeds. IITA, Ibadan. 1987
9. Asaolu SS, Adefemi, OS, Oyakilome IG, Ajibulu KE, Asaolu MF. Proximate and mineral composition of Nigerian leafy vegetables. Journal of Food Research. 2012; (1): 214- 218.
10. Okwu DE, Morah FNI. Mineral and nutritive value of Dennettia tripetala fruits. Fruits. 2004; 59: 437 – 442.
11. Remison SU. Arable and Vegetative Crops of the Tropics. Gift Prints Associates, Benin City. 2005; 4-18.
12. Boomsma CR, Santini JB, Tollenaar M, Vyn TJ. Maize morph physiological response to intense crowing and low nitrogen availability: an analysis and review. Agronomy of Journal. 2009; 101: 1426-1452.
13. Hall R. Kale, *Brassica oleraceae* (Acephala Group). USDA Database for Standard Reference, Release 12 (March, 1998). Nutrition guide. http://www.nutrition.about.com. Accessed 10/4/2009.
14. Brunilda NMD. Fiber http://www.webmd.com/diet/fiber-health-benefits-11/insoluble-soluble-fiber, 2010.
15. Freiberger CE, Vanderjagt DJ, Pastuszyn A, Glew RS, Mounkaila G, Millson M, Glew RH. Nutrient content of the edible leaves of seven wild plants

from Niger. Plant foods for Human nutrition. 1998 Mar 1;53(1):57-69.
16. Udousoro I, Ekanem P. Assessment of proximate compositions of twelve edible vegetables in Nigeria. International Journal of Modern Chemistry. 2013; 4(2): 79 -89.
17. Dairo FAS, Adanlawo IG. Nutritional quality of *Crassocephalum crepidioides* and *Senecio biafrae*. *Pakistan Journal of Nutrition*. 2007; 6(1):35-3
18. Ifon ET, Bassir O. The nutritive value of some Nigerian leafy vegetables- part 2: The distribution of proteins, Carbohydrates (including ethanol-soluble simple sugars), Crude fat, Fibre and Ash. Food Chemistry. 1980; 5: 231-235.
19. Fagbohun ED, Lawal OU, Ore ME. The proximate, mineral and phytochemical analysis of the leaves of Ocimum gratissimum, Melanthera scandens and Leea guineensis and their medicinal values. International Journal of Applied Biology and Pharmaceutical Technology. 2012; 3(1):15-22.
20. Forge TA, Hogue NG, Neilsen D. Effects of organic mulches on soil microfauna in the root zone of apple: Implications for nutrient fluxes and functional diversity of the soil food web. Applied Soil Ecology. 2003**;** 22:39–54.
21. Shrinivas CS, Channabasavanna AS, Mallikarjun SR. Evaluation of sequential application of herbicides on nutrient uptake and yield of maize (*Zea mays* L) under irrigated condition. Research Journal of Agricultural Sciences. 2014; 5 (5): 924-926.