NUTRIENT AND PHYTOCHEMICAL COMPONENTS OF DRIED AND FRESH FORMS OF *TALINUM TRIANGULARE* INVESTIGATED FOR POSSIBLE USE AS NUTRACEUTICAL IN POULTRY AND LIVESTOCK PRODUCTION

C. J. Aronu[1]*, E. U. Onwurafor[2] and C. G. C. Aronu[3]
[1]Departments of Animal Health and Production, Faculty of Veterinary Medicine; [2]Department of Food Science and Technology, Faculty of Agriculture; [3]Department of Biochemistry, Faculty of Biological Sciences, University of Nigeria, Nsukka
*Corresponding author, chinwe.aronu@unn.edu.ng, +2347030627496

Abstract
This study serves as a prerequisite to proposed use of *Talinum triangulare* as a nutraceutical in poultry and livestock production. Nutrient and phytochemical compositions from freshly harvested and dried-pulverised *T. triangulare* were determined using standard methods. Proximate analysis of *T. triangulare* revealed very high moisture content of 94.5 ± 0.10 % in the freshly harvested sample; and 6.1± 0.20 % in the dried. High levels of ash, protein, and fibre; moderate carbohydrate; and low lipid contents were observed in both samples. Minerals and vitamins studied occurred in appreciable quantities in both samples. Drying concentrated the nutrients and phytochemical components in *T. triangulare* Vitamin E was however completely destroyed during the drying process. Quantitative phytochemical analyses of *T. triangulare* revealed the presence of alkaloids, cyanogenic glycosides, flavonoids, oxalates, phenols, saponins, and tannins, in aerial shoot of freshly harvested plant. However, cyanogenic glycoside was reduced from 0.31± 0.02µg/g in the freshly harvested to 0.00 µg/g in the dried samples. Tannin constituted 1.6 % of the *T. triangulare* for the freshly harvested sample and 0.1 % in the dried sample. High nutrient and bioactive components in *T. triangulare* as observed in the study supports possible use as an ethno-medicinal protein/mineral-vitamin supplement. Fortification of *T. triangulare* - leaf meal from dried sample with Vitamin E is advocated. Anti-nutritional factors, as found in cyanogenic glycosides and tannins respectively, were either eliminated or drastically reduced with drying, making the dried sample safer for use in supplements.

Key words: Quantitative analysis, *Talinum triangulare*, vitamin E, cyanogenic glucoside, ethno-medicinal.

Introduction
Humans and animals may be able to determine edible plant species by instinct and by trial and error. Yet, research is needed to determine the value of plants being considered for processing and packaging as nutraceutical preparation or for inclusion in compounded feeds. It is also important to evaluate potential plant sources for anti-nutritional factors and toxins (WHO, 2003). Moreover, component ingredients in phytobiotics are known to differ distinctly due to climatic conditions, soil, species, time of harvest, degree of maturation, including the part of the plant under consideration (Grashorn, 2010). It was based on the discrepancies in nutrient components of different presentations of same plant that comparison between dried and freshly harvested forms of *T. triangulare* cultivated in Nsukka in Enugu State, South-East of Nigeria became necessary.
In a previous study we had identified *T. triangulare* as having potential to promote healthy productive life in pullets and to possess anti-lipidemic property (Aronu et al., 2018). It becomes important to further investigate the phytochemical, nutrient and anti-nutritional properties of the plant for possible packaging as a nutraceutical product for poultry and livestock production. This is in view of the fact that there is much pressure on livestock and poultry farmers to increase the availability of healthy meat to cope with the ever-increasing demand on meat and meat products. Moreover, public health concerns about coronary heart diseases and its relationship with dietary cholesterol which comes primarily from animal sources need to be responded to.

Materials and methods

Experimental design: The study involved quantitative nutrient and phytochemical analyses of aqueous extract from freshly harvested samples and from dried samples of *T. triangulare*. Each sample collected and parameter investigated was done in three replicates.

Plant collection, identification and preparation: Succulent parts of *Talinum triangulare* (waterleaf) plant were harvested weekly from a vegetable garden planted near the student's demonstration poultry house of the Department of Animal Health and Production University of Nigeria, Nsukka, Enugu State, Nigeria. Identification of *T. triangulare* was done by a taxonomist at the herbarium of the Department of Plant Science and Biotechnology, University of Nigeria, Nsukka.

The leaves and succulent shoots of *T. triangulare* were washed after harvesting and drained; for the dried sample this was further shade-dried at room temperature on the laboratory table with frequent turning. The dried leaves were pulverized using harmer grinding machine to obtain a powdered form of the sample which was stored in the refrigerator at 4^{o}C until needed.

Nutrient analyses: comprised of proximate, vitamins, and mineral analyses carried out in three replicates. Proximate analysis: moisture, crude fibre and ash contents were determined using the method described by AOAC (2010). The method of John and Bernard (1990) was employed for determination of protein content. Lipid content was carried out using the method of Jensen et al. (2003). And the percentage carbohydrate in the sample was obtained by summing up the percentage of moisture, protein, fat, ash and crude fibre and subtracting from 100% (AOAC, 2010). The method of Plumber (1978) was used for vitamin A. Vitamins B1 and B2 (Riboflavin) determinations were done following the method of Nwankpa et al. (2015). Vitamin C was evaluated using the method described by Russel (2004); and Vitamin E using the method described by Harold (1981). Mineral analysis: Precisely iodine, selenium, lead, calcium, manganese, and iron were determined using Atomic Absorption Spectroscopy (AACC, 2000). Nitrate was determined by the method of Rump and Krist (1988).

Phytochemical analysis: The flavonoid content was determined by the use of a slightly modified colorimetry method as reported by Geetha (2014). Phenol was determined by the Folin Ciocateau method as reported by Pekal and Pyrzynska (2014). For tannin the method of FAO/IAEA (2000) was employed, while alkaloid employed the method described by Adeniyi et al. (2009) and Eleazu et al. (2012), saponin, the method described by Algfri et al. (2014) and cyanogenic glycoside, the method described by Indira and Sinha, (1969). The method described by Adeniyi et al. (2009) was employed in the determination of oxalate component.

Data analysis

Excel was used to calculate means of replicate samples of *T. triangulare* used for the proximate and mineral analyses.

Results and discussion

Talinum triangulare was air dried under shade to avoid photolysis and thermal degradation (Swarna and Ravindhran, 2013). Drying reduced the water content in freshly harvested *T. triangulare* from 94.5 % to 6.1 % in the dried sample. The alarm water content of dried vegetables is within the range of 14-20% moisture content at 72% relative humidity and 20^{o}C (Okaka, 2005). The nutrient composition of *T. triangulare* from this study shows that it has high content of total ash, protein, crude fibre, individual mineral and vitamin (Table 1). This result is in agreement with the reports of other researchers (Aja et al., 2010; Ogbonnaya and Chinedum, 2013). The protein value of 18.52% is low when compared to 29.4 % reported by Akachukwu and Fawusi (1995). The high dietary fibre (16.80 ± 0.10) presents waterleaf as a good option for the treatment of some degenerate diseases (WHO, 2003). The low total lipid and carbohydrate content of *T. triangulare* is in agreement with the report of several other researchers (Aja et al., 2010; Swarna and Ravindhran, 2013).

Vitamins and minerals studied occurred in appreciable quantities in both samples of *T. triangulare* (Tables 2 and 3, respectively). However, Vitamin E was destroyed during the drying process. Vitamin E is the only chain breaking lipid soluble antioxidant, which protects the cells from damage caused by free radicals and peroxides (Lobo et al., 2010); incidentally this important nutrient was lost completely during drying. The implication of this finding is that in producing leaf meal from dried *T. triangulare*, as protein and/or vitamin and mineral supplement for animals and human use, fortification with vitamin E is important and therefore is recommended.

Table 1 Proximate composition of *T. triangulare*

Nutrient components of	Fresh water leaf (%)	Dried water leaf (%)
Moisture content	94.5 ± 0.10	6.1 ± 0.20
Protein	0.84 ± 0.04	18.52 ± 0.10
Fibre	0.95 ± 0.08	16.80 ± 0.10
Ash	2.75 ± 0.10	25.34 ± 0.05
Lipid	0.12 ± 0.02	1.5 ± 0.15
Carbohydrate	0.84	31.74

Table 2 Quantitative Analysis of Some Vitamins for the freshly harvested and dried samples of *Talinum triangulare*

Vitamin	**Freshly harvested sample of *T. triangulare***	**Dry sample of *T. triangulare***
Vit A	12.65±0.1µg/g (Re)	85.41±0.08µg/g
Vit B1	21±0.002mg/g	189±0.5mg/g
Vit B2	0.084±0.2mg/g	1.74±0.02mg/g
Vit C	0.34±0.5mg/g	2.46±0.08mg/g
Vit E	0.44±0.003mg/g	0.00mg/g

Table 3 Quantitative Analysis of some Minerals for the freshly harvested and dried samples of *Talinum triangulare*

Mineral	**Freshly harvested sample of *T. triangulare***	**Dry sample of *T. triangulare***
Iodine	0.016mg/g	0.178mg/g
Selenium	0.002mg/g	0.023mg/g
Lead	0.004mg/g	0.015mg/g
Calcium	0.023mg/g	0.181mg/g
Manganese	0.002mg/g	0.055mg/g
Iron	0.017mg/g	0.159mg/g
Nitrate	1.78mg/g	5.92mg/g

The presence of alkaloid, cyanogenic glycoside, flavonoid, phenol, saponin, and tannin in *T. triangulare* support possible medicinal and dietary relevance of the plant which view is upheld by other authors like Oloyed (2005), Aja et al., (2010), and Ogbonnaya and Chinedum (2013). Cyanogenic glycoside occurred in a very low (safe) level in the fresh sample and was absent in the dried sample (Table 4). Cynogenic glycosides are plant toxicants (Chandra et al., 2012). Processing like crushing of foods before soaking in water and shade drying of plant, as observed in this study, detoxifies the cyanogenic glycoside; thus making these plant foods healthier for animal and human consumption (Essers, 1995). Tannin constituted 1.6 % of the *T. triangulare* for the freshly harvested sample and 0.1 % in the dried sample. Aja et al. (2010) reported the level of tannin in *T. triangulare* to be 1.44 mg/100 g and 1.09 mg/100 g for dry and wet samples respectively. According to Adebayo et al., (2000) the lethal value of tannin in animal nutrition is above 5 %.

The outcome of this study therefore supports proposed use of succulent parts (aerial parts) of *T. triangulare* plant as a phytobiotic based supplement for livestock and poultry production.

Table 4 Quantitative analysis of Some Phytochemicals for the freshly harvested and dried samples of *Talinum triangulare*

Phytochemicals	Freshly harvested sample of *T. triangulare*	Dry sample of *T. triangulare*
Saponin	3.85±0.1mg/g	17.68±0.41mg/g
Alkaloid	1.08±0.2mg/g	29.06±0.5mg/g
Tannin	0.12±0.02mg/g	0.96±0.01mg/g
Phenol	0.26±0.006mg/g	2.55±0.08mg/g
Flavanoid	0.73±0.03mg/g	8.91±0.38mg/g
Oxalate	1.29±0.1mg/g	21.24±0.24mg/g
Cyanogenic glycoside	0.0003±0.02mg/g	0.00mg/g

Conclusion: High nutrient and bioactive components in *T. triangulare* as observed in the study supports possible use as an ethno-medicinal protein/mineral-vitamin supplement. Drying concentrated the nutrients and phytochemical components in *T. triangulare*. Vitamin E and cyanogenic glycoside were destroyed in the process of drying.

Recommendation: Fortification of *T. Triangulare* - leaf meal from dried sample with Vitamin E is advocated. Drying, packaging and transportation of plant protein sources from rural to urban settlements and for export is a viable business venture for women and teeming unemployed youth population in a developing nation like Nigeria.

6.0 REFERENCES

Adebayo, A. S., Gbadamosi, I. A., Adewunmi, C. O. 2000. Formation of antimicrobial dried powdered herb in soap bases, in: phytomedicines in malaria and sexually transmitted diseases; challenges for the new millennium. Adewunmi, C. O. and Adesina, S. K. (editors); Obafemi Awolowo University, Ile-Ife, 97.

Adeniyi, S. A., Orjiekwe, C. L., Ehiagbonare, J. E. 2009. Determination of alkaloids and oxalates in some selected food samples in Nigeria. *African J. Biotechnol.* 8 (1), 110-112.

Aja, P. M., Okaka, A. N. C., Onu, P. N., Ibiam, U., Urako, A. J., 2010. Phytochemical composition of *Talinum triangulare* (waterleaf) leaves. *Pakistan J. Nutr.* 9 (6), 527-530.

Akachukwu, C. O., Fawusi M. A. O., 1995. Growth Characteristics, Yield and Nutritional Value of Waterleaf, *Talinum triangulare* (Jacq) Wild in a Semi-Wild Environment, Discovery and Innovation, 7, 163-172.

Algfri, S. K., Alshakka, M. A., Munaiem, R. T. 2014. Study of Saponins in Methanol Extract of the Leaves of *Acacia etbaica* subspecies etbaica. *Res. J. Pharma Biol. Chem. Sci.* (5)3:803-810

American Association of Cereal Chemists (AACC). 2000. *AACC* Approved Methods of Analysis, tenth ed. St. Paul, MN.

Aronu, C. J., Okoye, J. O. A., Ihedioha, J. I., Marire, B. N., Anika, S. M. 2018. The eeffects of aqueous extracts of dried –pulverised or the freshly form of Talinum triangulare on the haematology and serum biochemistry of layers. *Vet. Arh.* 88, 687-707.

Association of Official Analytical Chemists, International, A.O.A.C. 2010. Official Methods of Analysis, 18th ed. Washington D.C., U.S.A.

Chandra, S. J., Sandhya, S., Vinod, K. R., David, B., Sudhakar, K., Chatanya, R., 2012. Plant toxins – useful and harmful effects. *J. Drugs Med.*, 4(1), 79-90.

Eleazu, C. O., Eleazu, K. C., Awa, E., Chukwuma, S. C., 2012. Comparative study of the phytochemical composition of the leaves of five Nigerian medicinal plants. *J. Biotechnol. Pharm. Res.* 3(2), 42-46.

Esers, A. J. A. 1995. Removal of cyanogens from cassava roots: studies on domestic sun drying and solid substrate fermentation in rural Africa. Ph.D Thesis at Wageningen Agricultural University, The Netherlands, together with the Unit for International Child Health, Uppsala University Sweden.

F.A.O./I.A.E.A. Working Document IAEA, Vienna, 2000. Quantification of Tannins in Tree Foliage A laboratory manual for the FAO/IAEA Co-ordinated Research Project on 'Use of Nuclear and Related Techniques to Develop Simple Tannin Assays for Predicting and Improving the Safety and Efficiency of Feeding Ruminants on Tanniniferous Tree Foliage', I, 5-6.

Geetha, T. S., Geetha, Net., 2014. Phytochemical screening, Quantitative Analusis of primary and secondary metabolites of cymbopogan citrates leaves from kodaokanalhill, Tamilnadu. *Inter. J. Pharmtech. Res.* 6(2),521-529.

Grashorn, M. A., 2010. Use of phytobiotics in broiler nutrition- an alternative to infeed antibiotics? *J. Animal Feed Sci*. 19, 338-347.

Harold, E. 1981. Pearson's chemical analysis of food. Churchil living stone, New York.

Indira, P., and Sinha, S. K., 1969. Calorimetric method for determination of HCN in tubers and leaves of cassava. *Indian J. Agric. Sci*. 39, 1021-1023.

Jensen, S., Häggberg, L., Jörundsdóttir, H., Odham, G., 2003. A quantitative lipid extraction method for residue analysis of fish involving nonhalogenated solvents. *J. Agric. and Food Chem.* 51, 5607-5611.

John, F. R., Bernard, J. W., 1990. Biochemical techniques: theory and practical, Waveland press, Inc.232 Verlagsgeseillschaft.

Lobo, V., Patil, A., Phatak, A., and Chandra, N., 2010. Free radicals, antioxidants, and functional foods: impact on human health. *Pharma. Rev.* 4(8), 118-126.

Jensen, S., Häggberg, L., Jörundsdóttir, H., Odham, G., 2003. A quantitative lipid extraction method for residue analysis of fish involving nonhalogenated solvents. *J. Agric. and Food Chem*. 51, 5607-5611.

Ogbonnaya, E. C. Chinedum, E. K., 2013. Bioactive constituents and *in vitro* antioxidant capacity of waterleaf (*Talinum triangulare*) as affected by domestic cooking. *Bioch. Pharm.* 2, 115.

Okaka, C. J., 2005. Storage of grains, cereals and legumes. In: Handling, Storage and Processing of Plant Foods. OCJ Academic Publishers, Independence Layout Enugu, Enugu State, Nigeria, pp. 16-29.

Oloyed, O. I., 2005. Chemical profile of unripe pulp of *Carica papaya. Pakistan J. Nutr.* 4, 379-381.

Pękal, A., Pyrzynska, K., 2014. Evaluation of aluminium complexation reaction for flavonoid content assay. *Food Anal. Methods* 7, 1776–1782.

Plummer, T. D., 1978. An Introduction to Practical Biochemistry, second ed. McGraw-Hill Book Company (UK) limited.

Rump, H. H., Krist, H., 1988. Laboratory Manual for the Examination of Water, Waste Water and Soil, VCH.

Russel, F., 2004. Water Soluble Vitamins. Handbook of food analysis, second ed. Nollet Marcel Delelear Inc. New York.

Swarna, J., Ravindhran, R., 2013. Pharmacognostical and phytochemical evaluation of *Talinum triangulare* (jacq) willd; *Inter. J. Pharm. Pharmaceutical Sci.* 5, (2).

World Health Organisation (WHO), Geneva 2003. Diet Nutrition and the prevention of chronic disease. Report of a Joint WHO/FAO Expert Consultation, WHO Technical Report; 916.