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Vitamins and effect of blanching on nutritional and anti-nutritional values of non-conventional leafy vegetables

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The leaves of 14 non-conventional vegetables consumed by rural populace in Michika Local Government Area of Adamawa State Nigeria were assessed for vitamin and effect of blanching on their nutrients and anti-nutrients content. *Ficus asperifolia* has the highest level of vitamins followed by *Adansonia digitata*. These values are higher compared to those of some common Nigerian vegetables. Data obtained for proximate composition showed that the leaves have high carbohydrate, crude protein and crude fiber. The anti-nutritional factors were analyzed; oxalate, hydrogen cyanide (HCN), tannin, alkanoids and phytate, in the vegetables were lower than the range of values reported for most vegetables. Results after blanching showed that, vitamin content, nutrient composition and anti-nutrients decrease. Though the anti-nutrients decrease as a result of blanching, the leaves are best used in diet preparation before blanching as the anti-nutrient content of the leaves before the blanching are below the established toxic level.

Key words: Vitamin, nutritional, anti-nutritional, non-conventional, vegetable.

INTRODUCTION

Vitamins are potent organic compounds found in certain food and perform specific and vital functions in body chemistry (Julie, 2003). Our body needs them for growth, function, energy, tissue repair and waste removal. They are like electric sparks which help to run human motors (Tanu, 1998). Except for a few, they cannot be manufactured or synthesized by organisms and their absence results in specific deficiency disease. The causes of these vitamin deficiencies include poor eating habits, alcoholism, emotional stress, the improper absorption of vitamins usually due to liver or intestinal disorders, and the intake of medicines that interfere with the ingestion of vitamins and of exposure to sunlight (Charlene, 2003).

Vitamins differ from each other in physiological function, in chemical structure and in their distribution in food. They are broadly divided into two categories: water-soluble and fat-soluble vitamins (Julie, 2003; Uswazo and Tanuto, 2006). Vitamins B and C are water soluble. They are dissolved easily in cooking water and some portion of these vitamins may actually be destroyed by heating.

Vitamins A, D, E and K are soluble in fat and fat solvents and therefore known as fat soluble. They are not easily lost by ordinary cooking methods and they can be stored in the body to some extent, mostly in the liver and are measured in international units (Julie, 2003).

Vitamins, used therapeutically, can be of immense help in fighting disease and speeding recovery. They can be used in two ways, namely, correcting eficiencies and treating disease in place of drug. Vitamins therapy has a distinct advantage over drug therapy. While drugs are always toxic and have man undesirable side effects, vitamins, as a rule are non-toxic and safe (Uswazo and Tanuto, 2006). The various functions of these vitamins, for example vitamin A helps to regulate cell development, promotes bone and teeth development, and boosts the body immune system. It is needed particularly for good vision and healthy skin. It also improves the body's healing ability. Vitamin A can be found in liver, kidneys, butter, eggs, fish oils, and the beta-carotene of green and yellow fruit and vegetables. Vitamin B complexes are necessary for converting blood sugar to energy keeping the nervous system healthy; it promotes growth (B_1), helps the body to produce energy, keeps the mucous membranes healthy and protects the nervous system,

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eye and skin (B_2), and also essential in keeping the skin, nerve system and digestive system healthy (B_3), aids the body fight infections, heals wounds and builds cells (B_5), helps in the production of cells, maintains the health of the nervous and immune systems (B_6), aids in growth and cell development particularly in the production of erythrocytes (red blood cells) (Julie, 2003).

Sources of these vitamins B complex include wheat germ, peanuts, sunflower, beans, pork, cereals and peas, eggs, fish oils, meat, liver, kidney, rice, chicken, bread and vegetables.

Vitamin C is required for healthy skin, bones, and muscles. It plays an important role in the manufacture of collagen, which is the connective tissue that holds bones together. Vitamin C can be obtained from fresh fruits, berries, tomatoes, broccoli, green peppers, vegetables and potatoes.

Vitamin D is important for the growth and development of strong bones and teeth. It assists in the absorption of calcium (Julie, 2003). Vitamin D can be obtained from milk products, eggs, herring, salmon, sardines and fish oil. Sun exposure is a source of vitamin D. Ultraviolet rays from the sunlight can trigger vitamin D synthesis in the skin.

Vitamin E is essential for absorption of iron, slowing of the ageing process, and fertility. It is a powerful antioxidant which helps protect cells from damage by free radicals. The main sources of vitamin E include vegetable oils, nuts, sunflower seeds, eggs, wheat germ and green leafy vegetables.

Vitamin K helps in clothing of blood and the healing of wounds. Most of these vitamins are found in vegetables. This vitamin can be obtained from green vegetables, milk products, cod-liver oil, apricots and whole grains.

The non-conventional leaves assessed are found in Northern Nigeriaespecially in Borno and Adamawa States. Some grow fresh new shoots in wet and dry seasons (Kubmarawa et al., 2008). The new shoots are commonly used as animal forage but in periods of food storage, people in Michika Local Area of Adamawa State cut the newly growing succulent shoots with the leaves, cook and eat them (Okoli et al., 1988; Kubmarawa et al., 2008). In Nigeria and other developing countries, as a result of food shortage and high cost of cultivated green leafy vegetables, wild and semi-wild food resources are frequently consumed as a dominant source of leafy vegetables especially in rural communities (Barminas et al., 1998; Kubmarawa et al., 2008). These non-conventional leafy vegetables play an important role in every day cooking especially in the rural areas. Researchers have provided data on these non-conventional leaves in respect of their mineral composition (Barminas et al., 1998), amino acid profile (Kubmarawa et al., 2008), but no data on the vitamins and effect of blanching on the nutritional and anti-nutritional values/factor (i.e values/factors that interfere with nutrients utilization) of these non-conventional leafy vegetable.

By learning more about their vitamins and the effect of blanching on the nutritive and anti-nutritional values, one can better assess their importance in the well being of the communities that consume them. This work is designed to examine the leaves of edible non-conventional vegetables for vitamins and the effect of blanching on their nutritional and anti- nutritional values. This will help to adequately establish their importance in human nutrition and provide basis for maximum utilization of the plants.

MATERIALS AND METHODS

Collection and treatment of samples

The 14 non-conventional leaves were sampled randomly from farmlands in Michika Local Government Area of Adamawa State Nigeria. The leaves were plucked and air- dried in a closed room, that is, away from sunlight. They were then ground into fine powder using pestle and mortar (stainless steel) and stored in screw-capped containers. All the chemicals used were of analytical grade and were not subjected to further purification.

Blanching

All determinations were carried out before and after blanching. For blanched samples, the blanching was carried out according to standard method described by Badifu and Okeke (1992).

Determination of vitamins

The vitamin contents of the 14 non-conventional leaves were determined by standard methods described by Paul (1967), Paul and Pearson (2005), Nkafamiya et al. (2006) and Nkafamiya et al. (2007a).

Analysis of nutritional and anti-nutritional values

Nutritional values for the non-conventional leafy vegetables were determined before and after blanching. The methods adopted by Maragoni and Ali (1987), Nielson (1994), Cocks and Pede (1996) and Nkafamiya et al. (2007b) were used. The anti-nutrients content was estimated by standard procedures described by Price and Butler (1977), Ukpadi and Ejidon (1989), Reddy and Love (1999) and Nkafamiya et al. (2006). All analysis was carried out in triplicate and data were analyzed by Analysis of Variance (ANOVA). Duncan's multiple Range Test was used to compare mean variance. Significance was accepted at 5% level of probability following Steel and Torric (1980) procedures.

RESULTS AND DISCUSSIONS

The vitamin content of the 14 non-conventional leaves is listed in Table 1. Before blanching *F. asperifolia* had the highest vitamins followed by *A. digitata*. Vitamin A, C, E and K of the leaves are far above the values of *Telferic occidentalis* and *Cocohorus olitoris* as reported by Fatunso and Bassir (1977) and Ifon and Bassir (1979).

In general the leaves have considerable amount of Vitamin levels after blanching were also presented in Table 1. The results show that vitamin B complex (B_1, B_2,

Table 1. Vitamin content of non-conventional leafy vegetables before and after blanching (mg/100g).

Samples	A*	B_1	B_2	B_3	B_5	B_6	B_{12}	C	E	K
B.cosatum	15.04 ± 0.51 (13.51 ± 0.12)^{a}	1.08 ± 0.11 (0.08 ±0.23)^{a}	2.05 ± 0.56 (0.28 ±0.18)^{a}	0.85 ±0.14 (0.02 ±0.45)^{a}	0.75 ± 0.55 (0.01 ± 0.28)^{a}	0.95 ± 0.14 (0.04±0.23)^{a}	0.81 ± 0.22 (0.03 ±0.15)^{a}	18.02 ± 0.22 (9.45 ±0.34)^{a}	24 .52 ± 0.18 (21.97 ±0.23)^{a}	22.05 ±0.27 (20.67 ± 0.76)^{a}
B. aegyptiaca	14.07 ± 0.12 (11.27 ± 0.32)^{a}	1.59 ± 0.89 (0.97 ±0.45)^{a}	2.00 ± 0.28 (0.37 ± 0.94)^{a}	0.76 ± 0.18 (0.03 ± 0.88)^{a}	0.78 ± 0.45 (0.03 ± 0.76)^{a}	0.86 ± 0.11 (0.41 ±0.65)^{a}	0.86 ± 0.14 (0.04 ±0.68)^{a}	17.02 ± 0.72 (8.55 ±0.91)^{a}	21.02 ± 0.11 (19.97 ± 0.76)^{a}	22.98 ±0.27 (21.09 ± 0.32)^{a}
C. tora	13.35 ± 0.78 (11.25 ± 0.21)^{a}	1.98 ± 0.24 (0.92 ±0.23)^{a}	2.12 ± 0.58 (0.96 ± 0.21)^{a}	0.85± 0.44 (0.04 ± 0.76)^{a}	0.85 ± 0.27 (0.04 ± 0.74)^{a}	0.79 ± 0.35 (0.38 ±0.18)^{a}	0.94 ± 0.28 (0.34 ±0.43)^{a}	16 .35 ± 0.79 (8.14 ± 0.69)^{a}	23.07 ± 0.26 (21.44 ± 0.37)^{a}	20.38 ± 0.61 (18.23 ± 0.59)^{a}
F. trihopoda	10 .21 ± 0.23 (8.92 ± 0.39)^{a}	1.46 ± 0.67 (0.91 ±0.58)^{a}	1.69 ± 0.26 (1.01 ± 0.71)^{a}	0.76 ± 0.81 (0.23 ± 0.92)^{a}	0.93 ± 0.18 (0.26 ± 0.28)^{a}	0.86 ± 0.25 0.41 ± 0.95)^{a}	0.97 ± 0.56 (0.47 ±0.26)^{a}	15.23 ± 0.74 (7.12 ±0.76)^{a}	10.74 ± 0.48 (8.45 ± 0.61)^{a}	9.21 ± 0.78 (7.09 ± 0.34)^{a}
G.senegalensis	11.01 ± 0.23 (9.27 ± 0.77)^{a}	0.78 ± 0.72 (0.09 ±0.11)^{a}	1.28 ± 0.84 (0.89 ± 0.73)^{a}	0.89 ± 0.56 (0.07 ± 0.29)^{a}	0.77 ± 0.82 (0.12 ± 0.58)^{a}	0.61 ± 0.42 (0.02 ±0.22)^{a}	0.45 ± 0.97 (0.01 ±0.37)^{a}	9.74 ± 0.93 (4.32 ±0.78)^{a}	8.27 ± 0.71 (6.98 ± 0.26)^{a}	11 .01 ± 0.36 (9.56 ± 0.46)^{a}
M. oleifera	8.23 ± 0.67 (7.01 ± 0.83)^{a}	0.97 ± 0.33 (0.24 ±0.71)^{a}	2.11 ± 0.58 (1.01 ± 0.67)^{a}	0.91 ± 0.85 (0.37 ± 0.43)^{a}	0.67 ± 0.69 (0.08 ± 0.38)^{a}	0.77 ± 0.19 (0.12 ±0.45)^{a}	0.65 ± 0.36 (0.13 ±0.35)^{a}	7.28 ± 0.55 (3.52 ±0.28)^{a}	8.97 ± 0.25 (6.91 ± 0.26)^{a}	23.07 ± 0.21 (7.23 ± 0.71)^{a}
A.digitata	15.98 ± 0.36 (13.61 ± 0.56)^{a}	1.99 ± 0.28 (0.98 ±0.58)^{a}	2.44 ± 0.24 (1.04 ± 0.43)^{a}	0.93 ± 0.41 (0.43 ± 0.16)^{a}	0.94 ± 0.24 (0.12 ± 0.44)^{a}	0.96 ± 0.29 (0.26 ±0.16)^{a}	0.98 ± 0.37 (0.31 ±0.93)^{a}	18. 25 ± 0.85 (9.11 ± 0.48)^{a}	24.53 ± 0.27 (5.01 ± 0.47)^{a}	7.24 ± 0.56 (5.87 ± 0.79)^{a}
C. esculentus	4.25 ± 0.67 (3.01 ± 0.35)^{a}	0.98 ± 0.74 (0.45 ±0.25)^{a}	2.14 ± 0.47 (1.04 ± 0.73)^{a}	0.68 ± 0.65 (0.35 ± 0.33)^{a}	0.52 ± 0.86 (0.21 ± 0.99)^{a}	0.78 ± 0.21 (0.41 ±0.29)^{a}	0.52 ± 0.45 (0.28 ±0.73)^{a}	7.04 ± 0.74 (3.57 ± 0.38)	4.22 ± 0.24 (3.02 ± 0.76)^{a}	6.98 ± 0.73 (5.01 ± 0.15)^{a}
C. tridens	2.71 ± 0.47 (1.97 ± 0.74)^{a}	0.78 ± 0.45 (0.21 ±0.55)^{a}	1.99 ± 0.78 (1.00 ± 0.27)^{a}	0.47 ± 0.65 (0.09 ± 0.23)^{a}	0.42 ± 0.35 (0.08 ± 0.38)^{a}	0.66 ± 0.76 (0.21 ±0.44)^{a}	0.67 ± 0.73 (0.23 ±0.39)^{a}	10.02 ± 0.07 (4.98 ±0.25)^{a}	5.26 ± 0.78 (3.87 ± 0.36)^{a}	3.44 ± 0.41 (2.01 ± 0.76)^{a}
A. spinosus	2.75 ± 0.78 (1.89 ± 0.27)^{a}	0.87 ± 0.45 (0.36 ±0.13)^{a}	2.01 ± 0.21 (0.97 ± 0.24)^{a}	0.58 ± 0.34 (0.26 ± 0.16)^{a}	0.68 ± 0.91 (0.34 ± 0.22)^{a}	0.71 ± 0.86 (0.37 ±0.28)^{a}	0.42 ± 0.26 (0.22 ±0.08)^{a}	4.12 ± 0.58 (2.25 ± 0.12)^{a}	6.67 ± 0.14 (4.79 ± 0.47)^{a}	0.98 ± 0.27 (0.79 ± 0.66)^{a}
S.indium	3.55 ± 0.27 (2.71 ± 0.23)^{a}	0.84 ± 0.23 (0.45 ±0.65)^{a}	1.87 ± 0.72 (0.96 ± 0.74)^{a}	0.76 ± 0.01 (0.34 ± 0.08)^{a}	0.75 ± 0.89 (0.42 ± 0.48)^{a}	0.72 ± 0.39 (0.44 ±0.37)^{a}	0.52 ± 0.26 (0.29 ±0.54)^{a}	5.27 ± 0.88 (2.29 ± 0.22)^{a}	3.25 ± 0.68 (2.21 ± 0.27)^{a}	0.66 ± 0.48 (0.49 ± 0.26)^{a}
F. asperifolia	16.01 ± 0.26 (14.06 ± 0.23)^{a}	2.01 ± 0.74 (0.98 ±0.38)^{a}	2.47 ± 0.26 (1.05 ± 0.37)^{a}	0.95 ± 0.03 (0.47 ± 0.85)^{a}	0.97 ± 0.54 (0.48 ± 0.29)^{a}	0.98 ± 0.08 (0.51 ±0.01)^{a}	0.99 ± 0.09 (0.54 ±0.03)^{a}	19.6 ± 0.97 (9.01 ± 0.08)^{a}	24.98 ± 0.08 (22. 71 ±0.05)^{a}	23.71 ± 0.03 (21. 09± 0.07)^{a}
C.pepo	4.21 ± 0.23 (3.01 ± 0.25)^{a}	0.95 ± 0.08 (0.45 ±0.07)^{a}	1.97 ± 0.04 (0.98 ± 0.01)^{a}	0.78 ± 0.12 (0.34 ±0.06)^{a}	0.65 ± 0.05 (0.33 ±0.07)^{a}	0.89 ± 0.08 (0.47 ±0.33)^{a}	0.95 ± 0.09 (0.45 ±0.03)^{a}	8.67 ± 0.22 (4.67 ± 0.12)^{a}	5.57 ± 0.33 (4.01 ± 0.21)^{a}	2.57 ± 0.07 (1.35 ± 0.04)^{a}
F. sycomorus	5.51 ± 0.34 (3.98 ± 0.07)^{a}	0.97 ± 0.06 (0.46 ± 0.04	1.89 ± 0.03 (0.89 ±0.07)^{a}	0.71 ± 0.21 (0.35 ±0.02)^{a}	0.72 ± 0.04 (0.36 ±0.08)^{a}	0.78 ± 0.06 (0.37 ±0.11)^{a}	0.97 ± 0.05 (0.50 ±0.04)^{a}	7.54 ± 0.09 (3.60 ± 0.23)^{a}	4.57 ± 0.08 (3.53 ± 0.01)^{a}	6.65 ± 0.02 (5.05 ± 0.01)^{a}
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Table 1. Contd.

A. digitata	15.98 ± 0.36 (13.61 ± 0.56)[a]	1.99 ± 0.28 (0.98 ±0.58)[a]	2.44 ± 0.24 (1.04 ± 0.43)[a]	0.93 ± 0.41 (0.43 ± 0.16)[a]	0.94 ± 0.24 (0.12 ± 0.44)[a]	0.96 ± 0.29 (0.26 ±0.16)[a]	0.98 ± 0.37 (0.31 ±0.93)[a]	18. 25 ± 0.85 (9.11 ± 0.48)[a]	24.53 ± 0.27 (5.01 ± 0.47)[a]	7.24 ± 0.56 (5.87 ± 0.79)[a]
C. esculentus	4.25 ± 0.67 (3.01 ± 0.35)[a]	0.98 ± 0.74 (0.45 ±0.25)[a]	2.14 ± 0.47 (1.04 ± 0.73)[a]	0.68 ± 0.65 (0.35 ± 0.33)[a]	0.52 ± 0.86 (0.21 ± 0.99)[a]	0.78 ± 0.21 (0.41 ±0.29)[a]	0.52 ± 0.45 (0.28 ±0.73)[a]	7.04 ± 0.74 (3.57 ± 0.38)	4.22 ± 0.24 (3.02 ± 0.76)[a]	6.98 ± 0.73 (5.01 ± 0.15)[a]
C. tridens	2.71 ± 0.47 (1.97 ± 0.74)[a]	0.78 ± 0.45 (0.21 ±0.55)[a]	1.99 ± 0.78 (1.00 ± 0.27)[a]	0.47 ± 0.65 (0.09 ± 0.23)[a]	0.42 ± 0.35 (0.08 ± 0.38)[a]	0.66 ± 0.76 (0.21 ±0.44)[a]	0.67 ± 0.73 (0.23 ±0.39)[a]	10.02 ± 0.07 (4.98 ± 0.25)[a]	5.26 ± 0.78 (3.87 ± 0.36)[a]	3.44 ± 0.41 (2.01 ± 0.76)[a]
A.spinosus	2.75 ± 0.78 (1.89 ± 0.27)[a]	0.87 ± 0.45 (0.36 ±0.13)[a]	2.01 ± 0.21 (0.97 ± 0.24)[a]	0.58 ± 0.34 (0.26 ± 0.16)[a]	0.68 ± 0.91 (0.34 ± 0.22)[a]	0.71 ± 0.86 (0.37 ±0.28)[a]	0.42 ± 0.26 (0.22 ±0.08)[a]	4.12 ± 0.58 (2.25 ± 0.12)[a]	6.67 ± 0.14 (4.79 ± 0.47)[a]	0.98 ± 0.27 (0.79 ± 0.66)[a]
S. indium	3.55 ± 0.27 (2.71 ± 0.23)[a]	0.84 ± 0.23 (0.45 ±0.65)[a]	1.87 ± 0.72 (0.96 ± 0.74)[a]	0.76 ± 0.01 (0.34 ± 0.08)[a]	0.75 ± 0.89 (0.42 ± 0.48)[a]	0.72 ± 0.39 (0.44 ±0.37)[a]	0.52 ± 0.26 (0.29 ±0.54)[a]	5.27 ± 0.88 (2.29 ± 0.22)[a]	3.25 ± 0.68 (2.21 ± 0.27)[a]	0.66 ± 0.48 (0.49 ± 0.26)[a]
F. asperifolia	16.01 ± 0.26 (14.06 ± 0.23)[a]	2.01 ± 0.74 (0.98 ±0.38)[a]	2.47 ± 0.26 (1.05 ± 0.37)[a]	0.95 ± 0.03 (0.47 ± 0.85)[a]	0.97 ± 0.54 (0.48 ± 0.29)[a]	0.98 ± 0.08 (0.51 ±0.01)[a]	0.99 ± 0.09 (0.54 ±0.03)[a]	19.6 ± 0.97 (9.01 ± 0.08)[a]	24.98 ± 0.08 (22. 71 ±0.05)[a]	23.71 ± 0.03 (21. 09± 0.07)[a]
C. pepo	4.21 ± 0.23 (3.01 ± 0.25)[a]	0.95 ± 0.08 (0.45 ±0.07)[a]	1.97 ± 0.04 (0.98 ± 0.01)[a]	0.78 ± 0.12 (0.34 ±0.06)[a]	0.65 ± 0.05 (0.33 ±0.07)[a]	0.89 ± 0.08 (0.47 ±0.33)[a]	0.95 ± 0.09 (0.45 ±0.03)[a]	8.67 ± 0.22 (4.67 ± 0.12)[a]	5.57 ± 0.33 (4.01 ± 0.21)[a]	2.57 ± 0.07 (1.35 ± 0.04)[a]
F. sycomorus	5.51 ± 0.34 (3.98 ± 0.07)[a]	0.97 ± 0.06 (0.46 ± 0.04	1.89 ± 0.03 (0.89 ±0.07)[a]	0.71 ± 0.21 (0.35 ±0.02)[a]	0.72 ± 0.04 (0.36 ±0.08)[a]	0.78 ± 0.06 (0.37 ±0.11)[a]	0.97 ± 0.05 (0.50 ±0.04)[a]	7.54 ± 0.09 (3.60 ± 0.23)[a]	4.57 ± 0.08 (3.53 ± 0.01)[a]	6.65 ± 0.02 (5.05 ± 0.01)[a]

*Valuesinµg/100g.
[a]Valuesafterblanching
Values are means ± SD for 3 determinations.

B_3, B_5, B_6, and B_{12}) and C were reduced drastically, for example vitamin C of *Bambox cosatum* was reduced from 18.02 ± 0.22 mg/100 g to 9.42 ± 0.34 mg/100 g. This is because they dissolve easily in cooking water and as a result some portions of these vitamins may actually be destroyed by heating (Julie, 2003). The change in values for vitamin A, E, and K was very small compared to vitamin B complex and C, for example the value for vitamin A for *B. cosatum* changes from 15.04 ± 0.51 mg/100 g to 13.51 ± 0.12. This is because they are not easily lost by ordinary cooking methods (Julie, 2003). Though vitamin contents of these leaves may vary from place to place due to geographical factors, these leafy vegetables when consumed would alleviate the symptoms of these vitamins and perform their specific and vital functions in the body chemistry. It will interest Higgi Community in Michika Local Government Area of Adamawa State to know that *F. asperifolia* has the highest of all the vitamins. This is because they use the leaf to facilitate breast feeding traditionally immediately after delivery.

Table 2 presents the nutritional status of the leaves before and after blanching. Before blanching, *F. sycomorus* has the highest value for moisture and carbohydrate (14.12 ± 0.22 g/100 g, 39.32 ± 0.38 g/100 g). *F. asperifolia* has the highest value for ash (11.25 ± 0.11g/100 g). Crude fibre and lipid (fats) are higher in *Cassia tora* (32.06 ± 0.11 g/100 g, 3.56 ± 0.14g/100 g) and *B. cosatum* has the highest protein (20.82 ± 0.65 g/100 g). Lipids, ash and carbohydrate contents of the leaves were within the range expected for dry leaf vegetables (Osagie and Offiong, 1998). All the non-conventional leafy vegetables have relatively high crude fibre. This implies that in the diet, the 14 vegetables will perform the important role of promoting softer stools with increased frequency and regularity of elimination as it is characteristic of fibre-rich will perform the important role of promoting softerstools with increased frequency and regularity of elimi-nation as it is characteristic of fibre-rich diets (Okaka et al., 2000; Kubmarawa et al., 2008). Results after blanching show that there is remarkable decrease in crude fibre and carbohydrate for *B. cosatum* reduce from 32.02 ± 0.57 g/100 g to 16.05 ± 0.18 g/100 g and 28.28 ± 0.10 g/100 g to 14.75 ± 0.21 g/100 g. Other values (moisture, ash, lipid and crude protein) were also affected but less compared to crude fibre and carbohydrate. Though some of the values were reduced to almost half, these vegetables have high nutrient content and can serve as a good substitute for conventional leaves.

Table 2. Nutrient content of non-conventional leafy vegetables before and after blanching (g/100g dry weight).

Samples	Moisture	Ash	Lipid (fats)	Crude fibre	Crude protein	carbohydrate
B. cosatum	8.75 ± 0.85 (6.56 ± 0.54)[a]	8.12 ± 0.25 (5.85 ± 0.55)[a]	3.12 ± 0.52 (2.10 ± 0.15)[a]	32.02 ± 0.57 (16.05 ± 0.18)[a]	20.82 ±0.65 (15.28 ± 0.15)[a]	28.28 ± 0.10 (14.75 ± 0.21)[a]
B. aegyptiaca	13.11 ± 0.50 (11.04 ± 0.14)[a]	9.26 ± 0.47 (6.62 ± 0.67)[a]	2.90 ± 0.07 (1.34 ± 0.55)[a]	30.75 ± 0.81 (15.25 ± 0.12)[a]	15.89 ± 0.56 (12.10 ± 0.28)[a]	32.38 ± 0.20 (16.98 ± 0.28)[a]
C. tora	10.58 ± 0.28 (8.55 ± 0.85)[a]	10.59 ± 0.66 (7.08 ± 0.28)[a]	3.56 ± 0.14 (2.76 ± 0.24)[a]	32.06 ± 0.11 (16.97 ± 0.51)[a]	18.26 ± 0.68 (13.62 ± 0.14)[a]	34.28 ± 0.25 (17.14 ± 0.18)[a]
F. trihopoda	8.22 ± 0.51 (6.42 ± 0.52)[a]	8.01 ± 0.18 (5.28 ± 0.94)[a]	2.91 ± 0.12 (0.85 ± 0.22)[a]	28.78 ± 0.88 (14.75 ± 0.17)[a]	19.78 ± 0.16 (14.39 ± 0.10)[a]	31.78 ± 0.81 (16.39 ± 0.04)[a]
G.senegalensis	9.78 ± 0.12 (7.34 ±0.21)[a]	8.75 ± 0.18 (5.01 ± 0.14)[a]	1.97 ± 0.71 (1.01 ± 0.18)[a]	31.08 ± 0.81 (16.21 ± 0.85)[a]	17.25 ± 0.75 (12.75 ± 0.22)[a]	28.72 ± 0.22 (14.85 ±0.38)[a]
M. oleifera	11.28 ± 0.52 (8.84 ± 0.27)[a]	8.29 ± 0.98 (5.07 ± 0.42)[a]	2.98 ± 0.29 (1.42 ± 0.25)[a]	27.78 ± 0.72 (14.22 ± 0.51)[a]	16.72 ± 0.62 (12.11 ± 0.28)[a]	29.25 ± 0.55 (14.99 ± 0.27)[a]
A. digitata	12.68 ± 0.15 (9.26 ± 0.45)[a]	10.72 ± 0.17 (6.28 ± 0.86)[a]	2.38 ± 0.52 (1.27 ± 0.17)[a]	28.26 ± 0.72 (14.94 ±0.28)[a]	14.67 ± 0.67 (10.48 ± 0.28)[a]	30.61 ± 0.78 (15.37 ± 0.37)[a]
C. esculentus	8.98 ± 0.86 (5.37 ± 0.24)[a]	8.71 ± 0.14 (5.34 ± 0.45)[a]	2.67 ± 0.28 (1.34 ± 0.27)[a]	32.98 ± 0.27 (17.42 ± 0.23)[a]	21.28 ± 0.18 (16.78 ± 0.71)[a]	31.16 ± 0.85 (16.81 ± 0.28)[a]
C. tridens	7.98 ± 0.15 (5.84 ± 0.24)[a]	9.03 ± 0.93 (5.56 ± 0.65)[a]	1.78 ±0.24 (0.98 ± 0.13)[a]	28.85 ± 0.13 (15.00 ± 0.02)[a]	15.89 ± 0.16 (10.25 ± 0.18)[a]	33.43 ± 0.34 (17.28 ± 0.14)[a]
A. spinosus	10.65 ± 0.95 (8.25 ± 0.58)[a]	11.08 ± 0.65 (6.98 ± 0.71)[a]	1.98 ± 0.42 (1.02 ± 0.21)[a]	29.85 ± 0.12 (15.48 ± 0.45)[a]	17.75 ± 0.13 (12.71 ± 0.21)[a]	35.28 ± 0.81 (18.25 ± 0.28)[a]
S.indium	7.83 ± 0.12 (5.38 ± 0.23)[a]	10.30 ± 0.08 (6.28 ± 0.14)[a]	1.66 ± 0.24 (0.87 ± 0.14)[a]	27.58 ± 0.50 (14.54 ± 0.44)[a]	18.59 ± 0.82 (13.95 ± 0.79)[a]	34.04 ± 0.43 (17.54 ± 0.15)[a]
F. asperifolia	9.01 ± 0.58 (6.19 ± 0.96)[a]	11.25 ± 0.11 (6.27 ± 0.16)[a]	2.78 ± 0.34 (1.85 ± 0.12)[a]	28.68 ± 0.57 (14.98 ± 0.94)[a]	20.27 ± 0.17 (15.98 ± 0.210[a]	37.02 ± 0.34 (19.45 ± 0.19)[a]
C. pepo	8.34 ± O.61 (5.37 ± 0.62)[a]	10.78 ± 0.25 (5.28 ± 0.14)[a]	2.98 ± 0.67 (1.95 ± 0.19)[a]	31.05 ± 0.68 (16.27 ± 0.76)[a]	19.00 ± 0.21 (13.02 ± 0.29)[a]	33.08 ± 0.71 (16.25 ± 0.11)[a]
F. sycomorus	14.12 ± 0.22 (10.42 ± 0.24)[a]	10.24 ± 0.68 (5.42 ± 0.25)[a]	3.00 ± 0.52 (2.14 ± 0.37)[a]	31.54 ± 0.11 (16.38 ± 0.86)[a]	17.24 ± 0.71 (12.74 ± 0.15)[a]	39.32 ± 0.38 (20.27 ± 0.76)[a]

[a]Values after blanching . Values are means ± SD for 3 determinations.

The results for anti-nutritional factors for the leaves before and after blanching are presented in Table 3. The anti-nutritional factors are the major factors limiting the wide use of many plants as they are present in the plants naturally and capable of eliciting deleterious effects in man and animals (Kubmarawa et al., 2008). The anti-nutritional factors; oxalate, HCN, tannin, alkanoids and phytate were present in varying amounts in all the vegetables. Phytate has been reported to reduce the bioavailability of trace element and minerals (Apata and Ologhobo, 1989; Kubmarawa et al., 2008). The phytate contents of all the plants were, however, below the range reported for most vegetables. Tannin, HCN, alkanoids and oxalate were low and therefore would not cause the deleterious effects, for example tannin will not reduce digestibility of nutrients. Though the levels of oxalate in *B. aegyptiaca* and *S. indium* are high, they are still lower than those associated with renal problems, as high oxalate diet can increase the risk of renal calcium absorption (Marshal et al., 1967; Kubmarawa et al., 2008). The levels of the anti-nutritional factors generally reduced after blanching, though their level before the blanching were low to significantly interfere with the nutrients utilization (Nkafamiya et al., 2006).

Conclusion

The non-conventional leafy vegetables assessed (are used before and after blanching in preparing diet) contain considerable amount of vitamins and nutrients.

From this work it is evident that blanching has an effect on their contents. Since the anti-nutrients effect on their contents. Since the anti-nutrients were reduced after blanching, preparing diet with these leaves before blanching would be of more advantage than after blanching. This is because the nutrient contents before the blanching were higher than after blanching and the levels of the anti-nutrients before blanching were below the established toxic levels. Considerable levels of vitamin and nutrients in these leaves and the low anti-nutrient levels make them compete with some of the conventional leaves as source of vitamins and nutrients. This study therefore, will help to adequately establish the importance of these leaves in human nutrition and provide basis for their maximum utilization as studies have

Table 3. Anti-nutrient content of non-conventional leafy vegetables before and after blanching (%).

Samples	Oxalate	HCN	Tannin	Alkanoids	Phytate
B. cosatum	3.78 ± 0.28 (1.96 ± 0.04)[a]	0.45 ± 0.12 (0.41 ± 0.11)[a]	5.60 ± 0.11 (1.70 ± 0.15)[a]	6.40 ± 0.11 (2.65 ± 0.22)[a]	3.74 ± 0.28 (0.21 ± 0.03)[a]
B. aegyptiaca	75.00 ± 0.08 (2.36 ± 0.04)[a]	0.47 ± 0.07 (0.42 ± 0.03)[a]	11.25 ± 0.08 (0.75 ± 0.12)[a]	9.26 ± 0.03 (5.16 ± 0.08)[a]	0.15 ± 0.04 (0.10 ± 0.05)[a]
C. tora	5.91 ± 0.05 (2.53 ± 0.02)[a]	0.47 ± 0.07 (0.44 ± 0.09)[a]	8.80 ± 0.07 (4.20 ± 0.15)[a]	6.78 ± 0.31 (4.46 ± 0.28)[a]	0.13 ± 0.01 (0.10 ± 0.05)[a]
F. trihopoda	2.27 ± 0.02 (1.89 ± 0.07)[a]	0.48 ± 0.07 (0.45 ± 0.11)[a]	7.80 ± 0.09 (2.95 ± 0.03)[a]	10.78 ± 0.02 (7.94 ± 0.23)[a]	0.21 ± 0.02 (0.11 ± 0.02)[a]
G. senegalensis	2.70 ± 0.06 (1.28 ± 0.05)[a]	0.45 ± 0.05 (0.42 ± 0.11)[a]	6.70 ± 0.12 (2.05 ± 0.04)[a]	9,88 ± 0.03 (6.42 ± 0.08)[a]	0.14 ± 0.23 (0.09 ± 0.01)[a]
M. oleifera	2.38 ± 0.67 (0.28 ± 0.76)[a]	0.52 ± 0.17 (0.42 ± 0.27)[a]	3.57 ± 0.14 (1.26 ± 0.25)[a]	4.28 ± 0.14 (1.21 ± 0.41)[a]	1.75 ± 0.28 (0.97 ± 0.25)[a]
A. digitata	4.28 ± 0.67 (1.65 ± 0.77)[a]	0.42 ± 0.68 (0.38 ± 0.34)[a]	4.56 ± 0.67 (2.00 ± 0.18)[a]	5.26 ± 0.38 (2.38 ± 0.19)[a]	0.78 ± 0.38 (0.32 ± 0.21)[a]
C. esculentus	6.38 ± 0.22 (3.28 ± 0.16)[a]	0.67 ± 0.35 0.42 ± 0.11	1.20 ± 0.88 (0.82 ± 0.42)[a]	7.21 ± 0.12 (4.25 ± 0.14)[a]	0.98 ± 0.18 (0.52 ± 0.14)[a]
C. tridens	3.55 ± 0.28 (1.28 ± 0.36)[a]	0.57 ± 0.28 (0.42 ± 0.14)[a]	7.28 ± 0.38 (3.72 ± 0.32)[a]	6.21 ± 0.56 (4.22 ± 0.16)[a]	5.04 ± 0.12 2.08 ± 0.16
A. spinosus	4.56 ± 0.11 (1.34 ± 0.26)[a]	0.35 ± 0.21 (0.17 ± 0.22)[a]	4.78 ± 0.14 (2.01 ± 0.15)[a]	4.78 ± 0.14 (1.37 ± 0.47)[a]	2.75 ± 0.28 (1.01 ± 0.48)[a]
S. indium	56.5 ± 0.06 (35.06 ± 0.14)[a]	1.94 ± 0.81 (0.41 ± 0.45)[a]	4.80 ± 1.47 (2.74 ± 0.36)[a]	5.56 ± 0.28 (3.47 ± 0.87)[a]	10.90 ± 0.68 5.78 ± 0.96
F. asperifolia	3.78 ± 0.28 (1.38 ± 0.82)[a]	0.45 ± 0.12 (0.41 ± 0.21)[a]	2.67 ± 0.28 (0.95 ± 0.17)[a]	6.40 ± 0.11 (2.24 ± 0.74)[a]	2.01 ± 0.12 (0.98 ± 0.78)[a]
C. pepo	3.5 ± 0.22 (1.37 ± 0.35)[a]	0.98 ± 0.66 (0.45 ± 0.31)[a]	7.56 ± 0.14 (4.26 ± 0.26)[a]	5.57 ± 0.75 (2.75 ± 0.55)[a]	0.85 ± 0.73 (0.48 ± 0.38)[a]
F. sycomorus	2.88 ± 0.37 (1.74 ± 0.56)[a]	3.05 ± 0.51 (1.48 ± 0.35)[A]	1.78 ± 0.11 (0.98 ± 0.24)[a]	5.64 ± 0.41 (2.36 ± 0.14)[a]	1.98 ± 0.78 (0.78 ± 0.87)[a]

[a]Values after blanching. Values are means ± SD for 3 determinations.

been carried out by researchers on their amino acid profile and mineral composition.

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