Amino Acids Profile of Leafy Vegetables Consumed in Western Côte d'Ivoire

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Doi: 10.19044/esipreprint.7.2022.p289

Approved: 12 July 2022
Posted: 14 July 2022

Cite As:
Zoro A.F., Toure A., Kouassi K.A. (2022). *Amino Acids Profile of Leafy Vegetables Consumed in Western Côte d'Ivoire*. ESI Preprints.
https://doi.org/10.19044/esipreprint.7.2022.p289

Abstract

Leafy vegetables are an important source of essential components of rural people diet in tropical Africa. This study aimed to characterize the free amino acids of five leafy vegetables consumed in Western Côte d 'Ivoire. The leaves of *Abelmoschus esculentus*, *Celosia argentea*, *Ipomea batatas*, *Manihot esculenta*, and *Myrianthus arboreus* were collected at maturity from cultivated farmlands located at Dabou (Abidjan District). These five leaves were washed and oven-dried at 60 °C for 3 days. The dried leaves were then ground and the powdered samples of each leaf were analysis for its amino acid contents using HPLC. The results showed that the amino acid contents of each leaf vegetable were significantly different ($p < 0.05$). The proline which is a non-essential amino acid was found in all the leaves with contents varying from 563.6 ± 1.08 to 1562.9 ± 1.88 mg/100 g. For essential amino acids, leucine contents of the leaves ranged from 175.9 ± 0.56 to 9685.9 ± 5.14 mg/100 g. Among the five leafy vegetable, lysine was quantified in leaves of *C. argentea* (266.7 ± 0.89 mg/100 g), *I. batatas* (7225.9 ± 2.56 mg/100 g) and *M. arboreus* (182.4 ± 0.66 mg/100 g).

Tryptophan could not be detected in *C. argentea*, *M. esculenta* and *M. arboreus*. *M. esculenta* recorded the highest content of valine (1639.1 ± 1.39 mg / 100 g) compared to *C. argentea* (1069.4 ± 1.2 mg / 100g). Methionine is the only sulfur amino acid detected in *C. argentea* (165.1 ± 0.61 mg / 100g). These results show that leafy vegetables consumed in Western Côte d'Ivoire are an important source of amino acids. Therefore, they can contribute to improving the nutritional quality of food and ensure food security.

Keywords: Leafy vegetable, amino acids, nutritional quality, food security, Côte d'Ivoire

1. Introduction

African Leafy Vegetable (ALV) are considered as valuable sources of nutrients (Nesamvuni et *al*., 2001). Indeed, these plants are valuable sources of nutrients, especially in rural areas. They are substantially a source of proteins, minerals, vitamins, fibers, and other nutrients which are usually in short supply in daily diets (Mohammed and Sharif, 2011).

In view to their nutritive potential, leafy vegetables contribute substantially to food security in sub-Saharan Africa where people's diets based on rice, potato, and cassava are high in calories but deficient in proteins (Yiridoe and Anchirinah, 2005). The proteins are macromolecules made up of a sequence of amino acids whose sequence is dictated by the genetic code for each one of them (INRA, 2012).

It is, indeed, a primary education product of the assimilation of nitrogen and precursors of proteins and nucleic acids (Stewart and Lahrer, 1980). One knows that more than 200 amino acids and simple peptides intervene in the constitution of the plants (Fowden, 1978), but only twenty amino acids form part of proteins normally. The amino acids are thus essential for the cicatrization and the repair of fabrics, muscles and bones (Couplan,2012).

Ethno-botanical studies have stated that most people in Western Côte d'Ivoire consume indigenous green leafy vegetables such as Abelmoschus esculentus"gombo",Celosia argentea "soko", Ipomea batatas"patate",Manihot esculenta "manioc" and Myrianthus arboreus"tikliti" through confectionary soups (Kouamé, 2000; N'dri et *al*., 2008). Leafy vegetables consumed in Western Côte d'Ivoire (*Abelmoschus esculentus*, *Celosia argentea*, *Ipomea batatas*, *Manihot esculenta* and *Myrianthus arboreus*) are good source of proteins (Zoro et *al*., 2013).

This study was, therefore, undertaken to evaluate the amino acids of leafy vegetables consumed in Western Côte d'Ivoire in order to provide

necessary information for their wider utilization and contribution to food security of Ivorian populations

2 - Materials and Methods

2 -1 Plant materials

Leafy vegetables were collected at maturity from cultivated farmlands located at Dabou (Abidjan District). These plants were authenticated by National Floristic Center (University Félix Houphouët Boigny, Abidjan-Côte d'Ivoire). The collected plants were destalked, washed with distilled water, drained at ambient temperature, and oven-dried (Memmert, Germany) at 60°C for 72 h (Chinma and Igyor, 2007). The dried materials obtained were ground with a laboratory crusher (Culatti, France) equipped with a 10 µm mesh sieve. The dried powdered samples obtained were stored in polythene bags at 4°C until further analyses.

2 -2 Chemicals

All solvents (Methanol et Chlorhydric acid) were purchased from Merck. Standards used (Lysine, Valine, Tryptophane, Methionine, Tyrosine, Leucine, Proline et Arginine) were purchased from Sigma-Aldrich. All chemicals used in the study were of analytical grade.

2 -3 HPLC analysis

One (1) g of dried powdered sample was dissolved into 20 mL of hydrochloric acid 1N. The mixture was filtered through a 0,45 µm corning syringe filter prior to 20 µL injection into the HPLC system (Waters, USA). The column used for amino acid separation was a C18 Sunfire (4.6 x 250 mm, 5 µm). The HPLC solvent gradient included water/methanol (v/v). Samples were analyzed at 1.2 mL/min with a 20 min. Lysine, Valine, Tryptophane, Methionine, Tyrosine, Leucine, Proline et Arginine were identified and quantified using HPLC-purified standards. Chromatograms were generated at 254 nm.

$$T = \frac{\text{Aire E} * \text{PE} * 100}{\text{Aire T} * \text{PT}}$$

Aire T : surface of the witness
Aire E : surface test
PE : mass test
PT : mass of the witness

2 -4 Statistical Analysis

All analyses were carried out in triplicates and data expressed as means ± standard deviation. One-way analysis of variance (ANOVA) and Duncan's multiple range test (DMRT) were carried out to assess significant differences between means ($p<0.05$) using XLStat 2017 software.

3 - RESULTS AND DISCUSSION

The table below shows the (8) free amino acids detected in the leafy vegetables studied. Proline is the non-essential amino acid present in all leaves. The highest tenors are recorded in the leaves of cassava (1562.9 mg), potato (1460.9 mg), soko (1396.9 mg) and tikliti (1061.4 mg), respectively. The lowest content is detected in the degombo leaves. These results are similar to those of Miele et *al.* (2000) in Cabernet Sauvignon grapevine leaves (1760 mg) and higher than those of Aida et *al.* (2006) in baobab leaves. This high proline content may be explained by the fact that the plants are under water stress (HSIAO, 1973). This confirms that these plants would be grown in bunkers. Leafy vegetables could cover the daily needs which are estimated at between 500 and 3000 mg. It must be remembered that proline is involved in the healing and in the robustness of the skin and hair (Arnould, 2010). As for the other 2 non-essential amino acids, arginine and tyrosine were detected only in soko (1370.6 mg) and okra (1.70 mg) leaves, respectively. The arginine content is higher than those identified by Foidl et *al.* (2001) and Aida et *al.* (2006) in *Moringa olifiera* (692 mg) and baobab (900 mg). That of tyrosine (1.70 mg) is much lower than that of Zarkadas et *al.* (1995) in the leaves of *Moringa olifiera* (1880 mg). This high arginine content in soko leaves may be explained by its increase during maturation and at the end of the cycle (Hernandez-Orte et *al*., 1999; Mielé et *al*., 1996; Sauvage et *al*., 1993). The low tyrosine content in okra leaves may be explained by the destruction of this compound during acid hydrolysis and its instability in hydrochloric acid (Mossé, 1990). Soko leaf could be used in supplementation as arginine would reduce the risk of hypertension, atherosclerosis and protect the intestinal mucosa (Suliburska et *al*., 2014; Boisseau, 2005; Cynober, 2001; Woo et *al*., 1998).

All amino acids are essential nutrients but some are called essential when they are not produced by the body. They must therefore be present in the diet. Five of these amino acids were detected in the vegetable leaves studied. Leucine is present in all five leaf vegetables. The contents range from 9685.9 mg to 175.9 mg. The tikliti has the highest content while the lowest is recorded in the potato. The leaves of okra, soko and cassava have contents of 1307.2, 3466.3 and 2607.2 mg respectively. These values are higher than that of Fuglie (2002) and Aida (2006) respectively in leaves of

Moringa olifiera (1950 mg) and baobab (900 mg). The presence of leucine in the five leaves may be explained by its stability during acid hydrolysis (Mossé, 1990). Tryptophan was identified in okra leaves (1205.4 mg) and potato leaves (175.4 mg) while lysine was recorded in soko leaves (266.7 mg), potato (7225.9 mg) and tikliti (182.4 mg). Since lysine is the first limiting amino acid and tryptophan the third for pork (Pierre, 2019), potato and okra leaves could be used as a dietary supplement in pork and poultry farming. These leaves may be used as a dietary supplement in the production of bread, pasta, biscuits and in infant flours as cereals are low in lysine and tryptophan (Laleg et *al*., 2016). Methionine is the sulfur amino acid that has been identified only in soko leaves (165.1 mg). The presence of methionine in small quantities may be due to its destruction during hydrolysis (Mossé, 1990). Regarding valine, it was detected in the leaves of Cassioc (1639.1 mg) and Soko (1069.4 mg). These values are higher than those of Fuglie (2002) and Aida et *al*. (2006) respectively in Moringa and baobab leaves. It should be remembered that valine allows a drastic reduction of dietary protein levels and the achievement of a perfect balance of essential amino acids (Pierre, 2019). Cassava and soko leaves could be used in the diets of children under 5 years of age as well as in breeding.

4 - Conclusion

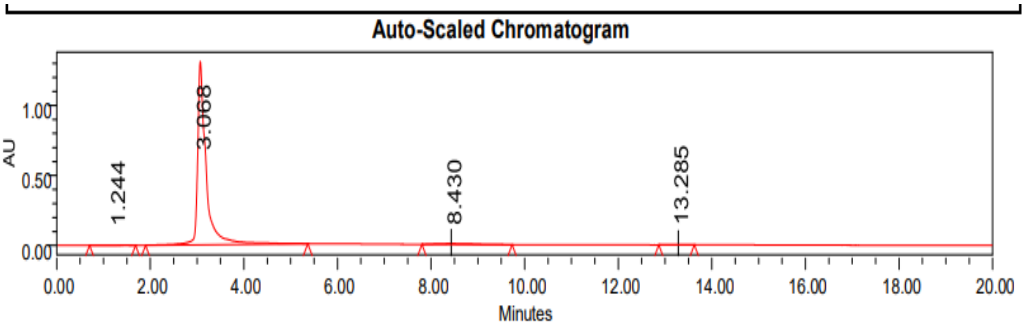
The results obtained in this study show that selected leafy vegetables contain an appreciable amount of free amino acids. Thus they can be considered important sources of essential amino acids. Leafy vegetables consumed in Western Côte d'Ivoire could thus contribute to the food security of the population. However, it is necessary to evaluate the bioavailability of these amino acids and the effects of technological treatments on these leafy vegetables.

References:

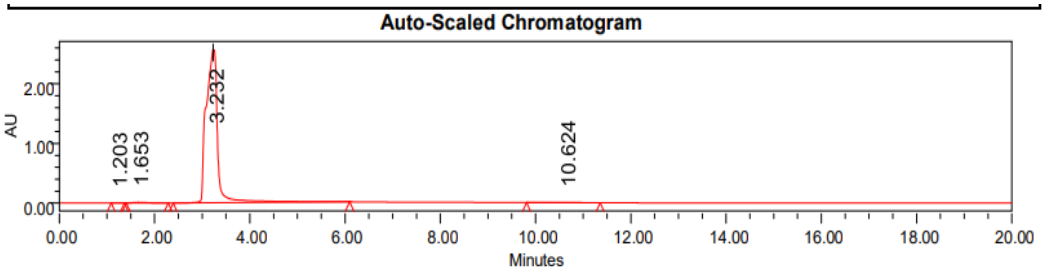
1. Aïda Diop, Mama Sakho, Manuel Dornier, Mady Cisse, Max Reynes (2006). Le baobab africain (Adansonia digitataL.) : principales caractéristiques et utilisations. Fruits, 61 (1), pp.55-69.
2. Boisseau. N. (2005). Nutrition et bioénergétique du sportif. Ed Masson. p 9 – 148.
3. Chinma, C.E. and M.A. Igyor, (2007). Micro-nutriments and anti-nutritional content of select tropical vegetables grown in south-east, Nigeria. Nig. Food J., 25: 111-115.
4. Couplan F. (2012). Lettre d'information n°8. 10p.
5. Cynober L. (2001). Les pharmaconutriments azotés : du laboratoire au lit du malade. Nutr. Clin. Metabol.. ; 15 :131-143

6. Foidl N., Makkar H.P.S. et Becker K.(2001). Potentiel de développement des produits du Moringa 29 octobre - 2 novembre 2001, Dar es Salaam, Tanzanie. 20p.
7. Fowden L.(1978). Non-protein nitrogen compounds : toxicity and antagonistic action in relation to amino protein synthesis. In : NORTON G., ed. Plant proteins. London, Butterworths, 109-115.
8. Fuglie L.J. (2002). Le Moringa dans la médecine traditionnelle (141-148) In: L'arbre de la vie, Les multiples usages du Moringa.- Wageningen : CTA; Dakar: CWS.-177p.
9. Hernández-orte P., Guitart A. et Cacho J.(1999). Changes in the concentration of amino acids during the ripening of Vitis viniferaTempranillo variety from the Denomination d'Origine Somontano (Spain). Am. J. Enol. Vitic., 50, 144-154.
10. HSIAO T.C., (1973). Plant responses to water stress. Annu. Rev. Plant Physiol., 24, 519-570.
11. INRA,(2012). L'avenir des légumineuses dans l'alimentation humaine. 22p.
12. Laleg . K, Barron . C, Santé-Lhoutellier . V, Walrand . S and Micard. V. (2016). Protein enriched pasta: structure and digestibility of its protein Food & Function. 31p.
13. Miele A., Carbonneau A. et Bouard J., (1996). Évolution des teneurs en proline et en arginine et du total des acides aminés libres au cours de la maturation des baies du Cabernet Sauvignon. J. Int. Sci. Vigne Vin, Nº hors série, 71-74.
14. Miele. A , Carbonneau A et Bouard. J (2000). Composition en acides aminés libres des feuilles et des baies du cépage cabernet sauvignon. J. Int. Sci. Vigne Vin, 34, n°1, 19-26
15. Mohammed M. I. and N. Sharif, (2011). Mineral composition of some leafy vegetables consumed in Kano, Nigeria. Nig. J. Basic Appl. Sci., 19: 208-211.
16. Mossé J. (1990). Acides aminés de 16 céréales et protéagineux : variations et clés du calcul de la composition en fonction du taux d'azote des grain(e)s. Conséquences nutritionnelles. INRA Productions Animales, Paris: INRA,3 (2), pp.103-119.
17. N'Dri, M.T., G.M. Kouamé, E. Konan and D. Traoré(2008). Plantes alimentaires spontanées de la région du Fromager (Centre-Ouest de la Côte d'Ivoire) : flore, habitats et organes consommés. Sci. Nat., 1: 61-70.
18. Nesamvuni,C., N.P. Steyn and M.J. Potgieter, (2001). Nutritional value of wild, leafy plants consumed by the Vhavenda. S. Afr. J. Sci., 97: 51-54.

19. Pierre T. (2019). Les acides aminés, des nutriments essentiels au cœur de notre métier. Ajinomoto Animal Nutrition.
20. Sauvage F.X., Nicol M.Z., Verries C., Sarries J., Pradal M. et Robin J.P.(1993). Acides aminés libres et quelques activités enzimatiques de moûts de raisins mûrs. Analyses statistiques de l'effet variétal. Sci. Alim., 13, 443-462.
21. Stewart G.R. et Lahrer F1(980). Accumulation of amino acids and related compounds in relation to environmental stress.In : Stumpf P.K. et Conn E.E., eds. The biochemistry of plants. New York, Academic Press, v.4, 609-635.
22. Suliburska. J et Coll. (2014). Changes in mineral status are associated with improvements in insulin sensitivity in obese patients following L-arginine supplementation. Eur J Nutr. 53(2) :387-93
23. Woo. A et Coll. (1998). Arginine metabolism : nitric oxide and beyon, Biochem J, 336 : 1-17
24. Yiridoe E.K. and V.M. Anchirinah, (2005). Garden production systems and food security in Ghana:Characteristics of traditional knowledge and management systems. Renew. Agric. Food Syst.,20: 168-180.
25. Zarkadas, C.G., Yu, Z. & Burrows, V.D. (1995). Protein quality of three new Canadian-developed naked oat cultivars using amino acid compositional data. Journal of Agricultural and Food Chemistry 43, 415-421.
26. Zoro A.F., Zoue L.T., Kra A.K., Yepie A.E., Niamke S.L(2013). An Overview of Nutritive Potential of Leafy Vegetables Consumed in Western Côte d'Ivoire. Pak. J. Nutr. 12. p. 949.956.



A.esculentus



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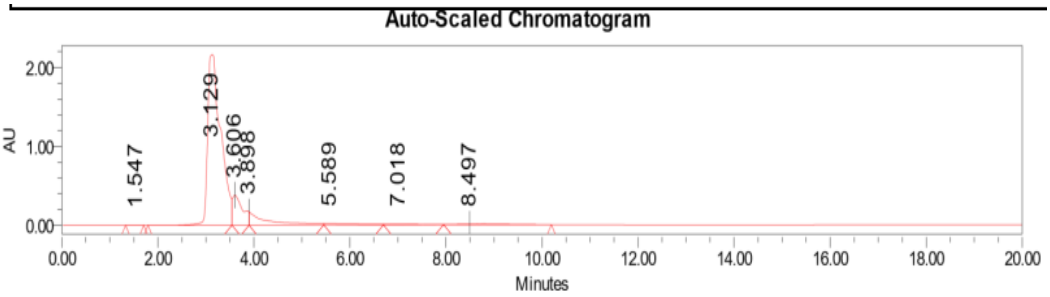
I.batatas



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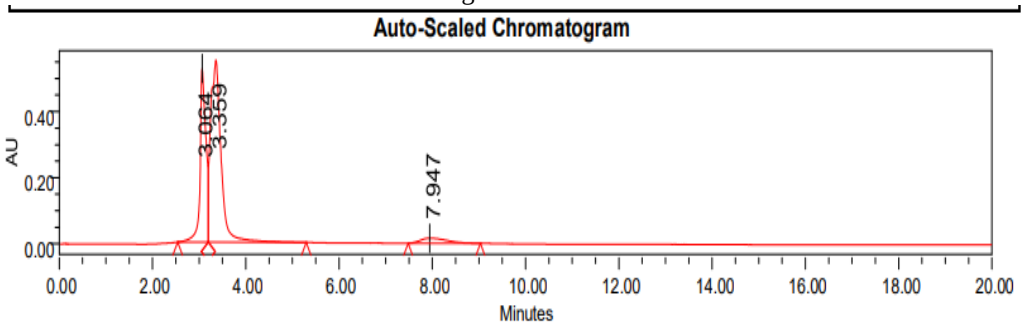
C.argentea



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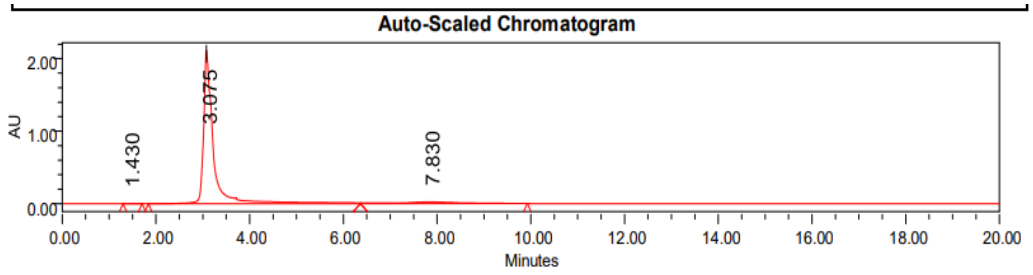
M. esculenta



Sample Name essai 5 acide aminé; Vial 101; Injection 1; Channel 2998 Ch1 254nm@1.2nm; Date

M.arboreus

Table : Amino acid profile leaf vegetables consumed in Western Côte d'Ivoire (mg/100 g)

	A. esculentus	***C. argentea***	***I. batatas***	***M. esculenta***	***M. arboreus***
Proline	563.6 ± 1.08^{e}	1396.9 ± 1.56^{c}	1460.9 ± 1.15^{b}	1562.9 ± 1.88^{a}	1061.4 ± 1.03^{d}
Tyrosine	1.70 ± 0.07^{a}	nd	nd	nd	nd
Arginine	nd	1370.6 ± 1,55^{a}	nd	nd	nd
Tryptophane	1205.4 ± 1.86^{a}	nd	175.4 ± 0.84^{a}	nd	nd
Lysine	nd	266.7 ± 0.89^{b}	7225.9 ± 2.56^{a}	nd	182.4 ± 0,66^{c}
Leucine	1307.2 ± 1.68e	3466.3 ± 2.67^{b}	175.9 ± 0.56^{d}	2607.2 ± 2.07c	9685.9 ± 5.14^{a}
Methionine	nd	165.1 ± 0.61^{a}	nd	nd	nd
Valine	nd	1069.4 ± 1.21^{b}	nd	1639.1 ± 1.39^{a}	nd

Data are expressed as Means±SD (n = 3). Means in the lines with no common superscript differ significantly ($p<0.05$)