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

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Abstract

In tropical Africa, leafy vegetables are traditionally cooked and eaten as a relish together with a starchy staple food. To contribute to their wider utilization and valorization in food sector, five leafy vegetables consumed in Western Côte d'Ivoire were investigated for their amino acids composition. The leaves of *Abelmoschus esculentus*, *Celosia argentea*, *Ipomea batatas*, *Manihot esculenta* and *Myrianthus arboreus* were the five leafy vegetables studied. The samples of these five leafy vegetables in this study were collected at maturity in cultivated farmlands located at Dabou (Southern Côte d'Ivoire). Then, they were washed and oven dried at 60 °C during three days before ground. The amino acid content of the ground samples were analyzed by high performance liquid chromatography (HPLC) technical. The results were showed a significantly different ($p < 0.05$) between amino acids contents of the five leafy vegetables. For a non-essential amino acids, all the five leaves studied were contained only proline with concentrations varying from 563.6 ± 1.08 to 1562.9 ± 1.88 mg/100 g. The two(2) other non-essential amino acids, arginine and tyrosine were detected only in leaves of *C. argentea* (1370.6 mg/100mg) and *A. esculentus* (1.70 mg/100mg) respectively. Concerning essential amino acids, only leucine was contained in all leafy vegetables with contents between 175.9 ± 0.56 and 9685.9 ± 5.14 mg/100 g. For the other essential amino acids, lysine was contained in leaves of *C. argentea*, *I. batatas* and *M. arboreus* with respectives concentrations of 266.7 ± 0.89 mg/100 g, 7225.9 ± 2.56 mg/100 g and 182.4 ± 0.66 mg/100 g. Tryptophane was quantified in leaves of *A. esculentus* and *I. batatas* with respectives levels of 1205.4 ± 1.86 mg/100g and 175.4 ± 0.84 mg/100g. Valine was detected in leaves of *C. argentea* and *M. esculenta* with respectives contents of 1069.4 ± 1.21 mg/100g and 1639.1 ± 1.39 mg/100g. Methionine was contained in leaf of *C. argentea* with level of 165.1 ± 0.61 mg/100g. The important concentration of amino acids revealed in leaves studied clearly would justify their consumption by Western Côte d'Ivoire populations. Therefore, exploitation of leafy vegetables could contribute food security of ivorian population.

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

1. Introduction

Rural populations use African leafy vegetable as valuable sources of nutrients (Nesamvuni et *al*., 2001). Indeed, these leafy vegetables are a source of proteins, minerals, vitamins, fibers and other nutrients essential in daily diets (Mohammed and Sharif, 2011). Thus, for their nutritional potential, leafy vegetables contribute consequently to food security in sub-Saharan Africa where people's diets based on rice, potato and cassava are high in calories but poor in proteins (Yiridoe and Anchirinah, 2005). The proteins are polypeotides, polymers of amino acids sequences which synthesized from genetic code (INRA, 2012).

It is, indeed, primary education products of the assimilation of nitrogen and precursors of proteins and the nucleic acids (Stewart and Lahrer, 1980). On 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 with the cicatrization and the repair of fabrics, the muscles and the bones (Couplan,2012).

Protein deficiency in the diets of children in developing countries manifests by protein-energy malnutrition, the diseases of which are as kwashiorkor, marasmus and mental retardation (Bresssani, 1975; UNICEF, 2012). Access to proteins of animal origin is very expensive for these populations. One of the solutions is to promote traditional plant resources that are generally easy to produce, short cycle and inexpensive to purchase (Mabossy-Mobouna, 2017; Randriatoandro, 2010; Maseko et *al*., 2017).

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Ethno-botanical studies have showed that most people in Western Côte d'Ivoire consume mainly indigenous green leafy vegetables such as Abelmoschus esculentus"gombo",Celosia argentea "soko", Ipomea batatas"patate",Manihot esculenta "manioc" and Myrianthus arboreus"tikliti" through soups (N'dri et *al*., 2008). Leafy vegetables consumed mainly 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 under-taken to evaluate the amino acid profile 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. He knows how to dry this leafy vegetable in the oven and determine the amino acid profile.

2. Material and methods

2.1. Plant materials

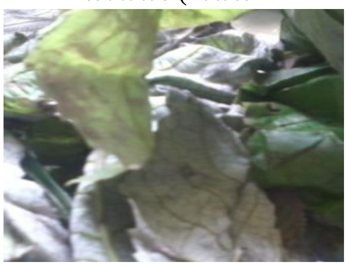
Leafy vegetables were collected at maturity on plots located at Dabou (Southern Côte d'Ivoire). These plants were authenticated by National Floristic Center (University Félix Houphouët Boigny, Abidjan-Côte d'Ivoire). The collected leaves were washed with distilled water and primary dried at laboratory temperature (25°C) for 24 hours. Then, 250 g of these leaves were dried in oven (MEMMERT) at 60°C for 72 hours (Chinma and Igyor, 2007). The dried materials obtained were ground with a laboratory crusher (Culatti, France) equipped with a 10 µm mesh sieve. The powdered samples were stored in polyethylene container at 4°C until further analyses.

A.esculentus (Gombo)

M.esculenta (Manioc)

I.batatas (Patate

M.arboreus (Tikliti)



C.argentea (Sôkô)

Figure 1. Leafy vegetable studied

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2.2. Chemicals

Methanol and chlorhydric acid were purchased from Merck. Standards amino acids (lysine, valine, tryptophane, methionine, tyrosine, leucine, proline and arginine) were purchased from Sigma-Aldrich. All these chemicals were of analytical grade.

2.3. High performancy liquid chromatography (HPLC) analysis

For analysis of each leaf, one (1) g of powdered sample was dissolved in to 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. These differents amino acids, lysine, valine, tryptophane, methionine, tyrosine, leucine, proline and arginine were identified and quantified using HPLC-purified standards at 254 nm. Amino acid concentration in each sample was determined by following formula (1) :

$$CT = \frac{Aera\ E * CE}{Aera\ T} * 100 \qquad (1)$$

with
CT : amino acid concentration in sample,
Aera E : sample peak area,
Aera T : witness peak area,
CE : amino acid concentration in 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 figures 2, 3, 4, 5 and 6 show the respectives amino acids chromatograms of *A.esculentus*, *I. batatas*, *C. argentea*, *M. esculenta* and *M. arboreus* leaves. These chromatograms were allowed to calculate concentrations of the differents free amino acids detected in leafy vegetables using the above formula (1). These concentrations were summarized in table 1. The results were showed a significantly different ($p < 0.05$) between amino

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acids contents of the five leafy vegetables. For a non-essential amino acids, all the five leaves studied were contained proline with concentrations varying from 563.6 ± 1.08 to 1562.9 ± 1.88 mg/100 g. The highest content of proline was recorded in leaves of *M. esculenta* (1562.9 ± 1.88 mg/100 g), *I. batatas* (1460.9 ± 1.15 mg/100g), *C. argentea* (1396.9 ± 1.56 mg/100g), *M. arboreus* and the lowest in leaves of *A. esculentus* (563.6 ± 1.08 mg/100g). These results are similar to those of Miele et *al.* (2000) in *Cabernet sauvignon* grape vine leaves (1760 mg/100g) and higher than those of Aida et *al.* (2006) in *Adansonia digitata* (baobab) leaves. This high proline content may be explained by the fact that the plants are under water stress (HSIAO, 1973). These leafy vegetables could cover the daily needs which are estimated at between 500 and 3000 mg. The presence proline content in differents these leafy vegetables is very interesting because of proline intervenes in healing and in the robustness of skin and hair (Arnould, 2010).

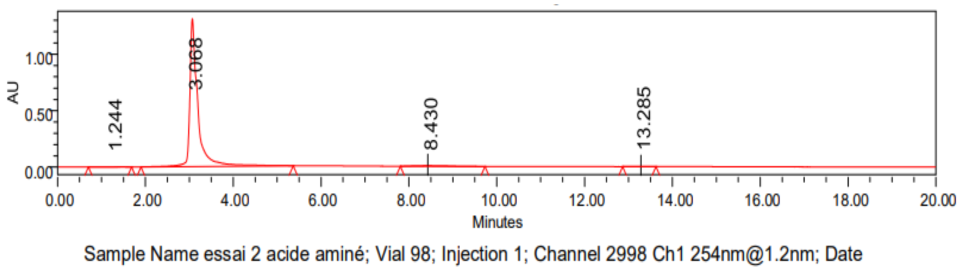

Figure 2. Amino acids chromatogram of *A.esculentus*

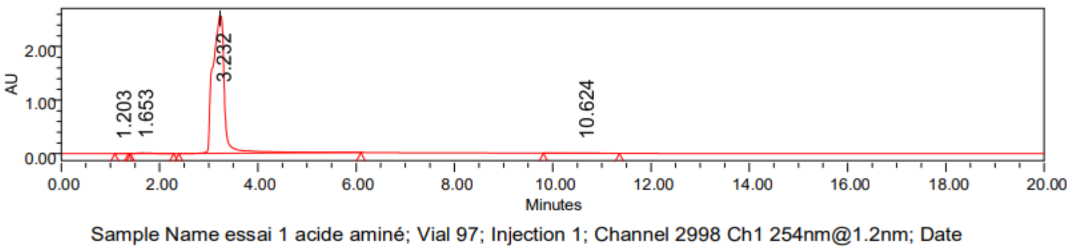

Figure 3. Amino acids chromatogram of *I.batatas*

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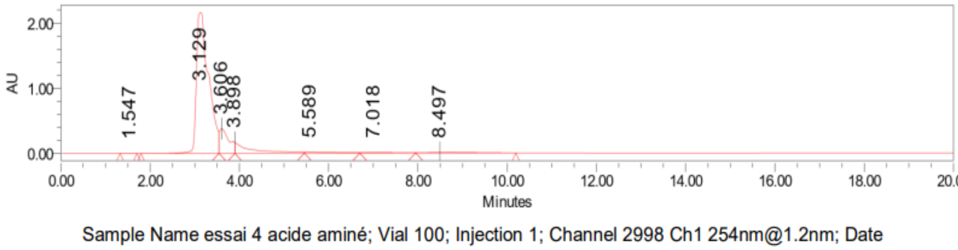

Figure 4. Amino acids chromatogram of *C.argentea*

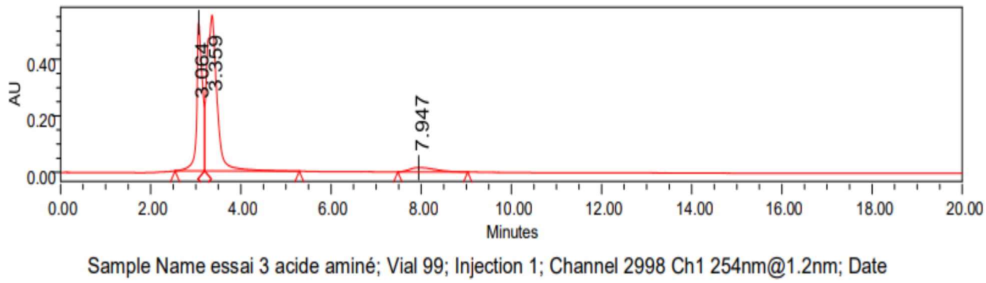

Figure 5. Amino acids chromatogram of *M. esculenta*

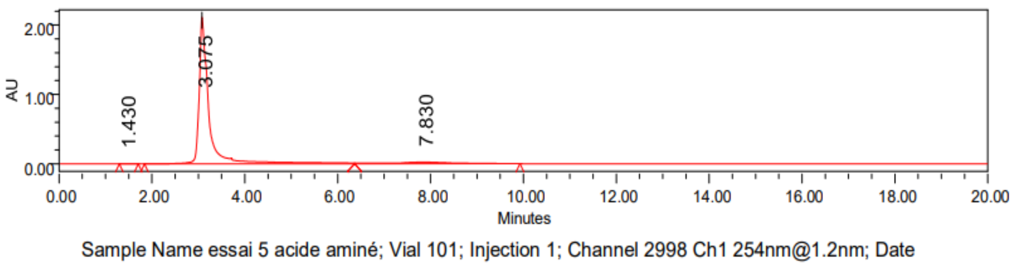

Figure 6. Amino acids chromatogram of *M. arboreus*

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Table 1. Amino acid profile of 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 ($p<0.05$)

The two (2) other non-essential amino acids, arginine and tyrosine were detected only in leaves of *C. argentea* (1370.6 mg/100mg) and *A. esculentus* (1.70 mg/100mg) respectively. The arginine content is higher than those identified by Foidl et *al.* (2001) and Aida et *al.* (2006) respectively in leaves of *Moringa olifiera* (692 mg/100g) and baobab (900 mg/100g). The level of tyrosine in *A. esculentus* is much lower than that of Zarkadas et *al.* (1995) in leaves of *Moringa oleifera* (1880 mg/100g). This high arginine content in *C. argentea* leaves may be explained by its level increase during maturation and at the end of its cycle (Hernandez-Orte et *al*., 1999; Mielé et *al*., 1996; Sauvage et *al*., 1993). The low tyrosine content in *A. esculentus* leaves may be explained by the destruction of this compound during acid hydrolysis and its instability in hydrochloric acid (Mossé, 1990). *C. argentea* leaves could be used in supplementation as arginine to reduce the risk of hypertension, atherosclerosis and protect the intestinal mucosa (Suliburska et *al*., 2014; Boisseau, 2005; Cynober, 2001; Wu et *al*., 1998).

Concerning essential amino acids, five of them (leucine, lysine, tryptophane, valine and methionine) were detected in leaf vegetables studied. Only leucine was contained in all leafy vegetables with contents between 175.9 ± 0.56 and 9685.9 ± 5.14 mg/100 g. The leaves of *M. arboreus* recorded the highest content of leucine (9685.9 ± 5.14 mg/100g) while the lowest detected in *I. batatas* leaves. The leaves of *A. esculentus*, *C. argentea* and *M. esculenta* were contained leucine at respectives concentrations of 1307.2, 3466.3 and 2607.2 mg/100g. These values are higher than that of Fuglie (2002) and Aida (2006) respectively in leaves of *Moringa olifiera* (1950 mg/100g) and baobab (900 mg/100g). The presence of leucine in the five leaves may be explained by its stability during acid hydrolysis (Mossé, 1990). For the other essential amino acids, lysine was contained in leaves of *C. argentea*, *I. batatas* and *M. arboreus* with respectives concentrations of 266.7 ± 0.89 mg/100 g, 7225.9 ± 2.56 mg/100 g and 182.4 ± 0.66 mg/100 g. Tryptophane was

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quantified in leaves of *A. esculentus* and *I. batatas* with respectives levels of 1205.4 ± 1.86 mg/100g and 175.4 ± 0.84 mg/100g.

Since lysine is the first limiting amino acid and tryptophan the third for pork (Pierre, 2019), *I. batatas* and *A. esculentus* leaves could be used as a supplement dietary in pork and poultry farming. Also, these leafy vegetables may be used as a ingredients in production of bread, biscuits and infant flours because cereals are poor in lysine and tryptophan (Laleg et *al*., 2016). Methionine was only contained in leaf of *C. argentea* with level of 165.1 ± 0.61 mg/100g. The presence of methionine in small quantities may be due to its destruction during hydrolysis (Mossé, 1990). Valine was detected in leaves of *C. argentea* and *M. esculenta* with respectives contents of 1069.4 ± 1.21 mg/100g and 1639.1 ± 1.39 mg/100g. These values of valine are higher than those of Fuglie (2002) and Aida et *al*. (2006) respectively in *Moringa oleifera* and baobab leaves. These high contents of valine in *C. argentea* and *M. esculenta* leaves are very interesting because valine intervenes drastic reduction of dietary protein allowing a perfect balance of essential amino acids (Pierre, 2019). Therefore *M. esculenta* and *C. argentea* leaves could be used in diets of children under 5 years of age as well as in breeding.

Conclusion

This study on determination of amino acids profile of five leafy vegetables clearly justifies their consumption by Western of Côte d'Ivoire populations. Their abundance in essential amino acids such as leucine, lysine, tryptophane, valine and methionine which body cannot synthesize, these leaves studied could be used to fortify foods as dietary supplement. Therefore, exploitation of leafy vegetables could be contribute to nutritional quality, food security and good health of ivorian population. However, it is necessary to evaluate the bioavailability of these amino acids after technological treatments.

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