



Quantitative Determination of Biochemical Constituents of the Wild Food Plant *Talinum triangulare* (Jacqu) Wild (Big Purslane)

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Authors' contributions

This work was carried out in collaboration among all authors. Authors FBM, ANI and FKB designed the study, performed the statistical analysis and wrote the protocol. Authors FBM, PBI, PKM, MNM, KNN and NKN wrote the first draft of the manuscript. Authors FBM, ANI, JBM, PKM, FKB and GNB managed the analyses of the study. Authors MNM, FBM, PBI, JBM, GNB and KNN managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

The Democratic Republic of the Congo is one of the major biodiversity hotspot in the world. Wild edible plants (WEPs) are widely consumed as part of daily diet by the local people and are part of their traditional culture and food habit. The *T. triangulare* species is a non-conventional vegetable crop of the *Talinaceae* family. It is well adapted to the hot and humid climate and the poor quality soil, which makes its cultivation an important economic activity for small growers. However, mere enumeration of such plants is not enough. A thorough assessment of their nutritive values is of paramount importance to find out how to make best use of them. The present work deals with the biochemical analysis of the nutritive values of non-conventional food plant *T. triangulare* with pink and white flowers. Freshly collected seeds, barks, roots leaves samples were first washed with tap water and then distilled water and dried in air, away from the sun till constant weight was recorded. From this moisture percentage was computed and chemical analysis was on dry weight basis. It appears from this study that the leaves of *T. triangulare* have a moisture content of 93%, which is slightly higher than the values given successively (90.8%) for *T. triangulare* (Jacq.). The mineral matter or ash content of leaves is 18.7%. The total protein found by us in the leaves presents a rate (2.4%). The protein rate on dry matter in the leaves is higher (2.27%) than that found in the roots 1.13%, stems 1.75% and seeds 1.44%. This rate varies considerably depending on the season. The fat content found in the leaves is 0.326%, it is lower than that found in the roots 0.366% and that found in the stems 0.38%, the fat content found in the seeds is lower compared to the others. The carbohydrate content analysed in the leaves is 0.07%, lower than that found in roots (2.614%), stems (3.58%) and seeds (3.16%). The present study revealed that *T. triangulare* is excellent sources of protein and minerals with moderate level of crude fibre and excellent sources of crude fibre with good amount of minerals. There is a general misconception that non-conventional leafy vegetables as well as other edible plants are nutritionally poor and hence unimportant.

Keywords: *Mataku mabibi*; protein; fat; ash; fiber; chromatography; reducing sugars.

1. INTRODUCTION

Talinum triangulare (Jacq.) Wild belongs to the family *Talinaceae*, previously *Portulacaceae* [1]. Its common names include Surinam purslane, Ceylon spinach, sweetheart, cariru, Florida spinach, potherb fame flower, lagos bologi, and waterleaf [2-4]. This species has pantropical distribution and adapts well to low fertility soils [2, 5]. Native to tropical Africa, it is cultivated for medicinal [6] and food purposes in South America, Asia, and Africa, especially in Nigeria [7, 8, 2].

The *T. triangulare* species, which is known as “cariru” in Brazil, is a non-conventional vegetable crop of the *Talinaceae* family, is mainly consumed in Northern Brazil, where the soft and highly nutritious leaves are used as a substitute for spinach. It is well adapted to the hot and humid climate and the poor quality soil, which makes its cultivation an important economic activity for small growers. This species is used in traditional medicine as a tonic and enhance the cognitive ability; however, few studies have investigated its biochemical composition [9,10].

The Democratic Republic of the Congo (DRC) is one of the major biodiversity hotspot in the world.

Wild edible plants (WEPs) are widely consumed as part of daily diet by the local people and are part of their traditional culture and food habit. WEPs are critical for the sustenance of ethnic communities and also as a source of income. However, WEPs received little attention in research activities, economic development, biodiversity conservation and sustainable management [11].

Majority of the non-conventional food plants are neglected which grow naturally in the wild and need no input, maintenance or care [12]. Non-conventional food plants have always played a pivotal role as supplement to major food plants in the food security system since time immemorial. In almost all countries of the world which are rich in floral biodiversity and have abundance of vegetation, there are established practices of using Non- conventional food plants as stand-by source of food at times of famine, natural calamity and at times when major crops fail due to local climatic aberrations etc. For example, in Assam (India) where flood is common during the rainy season; since time immemorial people have been using tender shoot of banana, corms of *Colocasia*, tender fronds of Fern as staple and scarcity food to survive during unfavourable time.

Non-conventional food plants are defined as those wild and semi-wild species that grow naturally in forest, forest margins, community land, degraded and discarded lands etc; but invariably come from sources other than organized cultivation [13]. Such plants are routinely used as supplement to major food and are part of traditional knowledge and culture of various ethnic groups elsewhere and particularly North East India [14].

Non-conventional food plants are therefore substitute to major food plants at times of scarcity and supplement to major food crops at normal times and thus they have become part of ethnic culture. Since the dawn of civilization man has identified nearly 80,000 plants to be edible out of which only about 130 are put to major use [15].

Rural areas and tribal societies are the bastions of non-conventional food plants. Growing urbanization, influence and invasion of urban culture in rural areas and also tribal societies are causing fast erosion of ethnic culture and along with it knowledge and germplasm of non-conventional food plants. However, mere enumeration of such plants is not enough. A thorough assessment of their nutritive values is of paramount importance to find out how to make best use of them. The present work deals with the biochemical analysis of the nutritive values of non-conventional food plant *Talinum triangulare* with pink and white flowers.

2. MATERIALS AND METHODS

2.1 Materials

The plant material for the present study is *Talinum triangulare* (Jacq.) Wild (*Talinaceae*). *T. triangulare* is occasionally grown as ornamental herb in courtyard and also occurs as weed in garden.

The biological material collected by us in the Commune of Ngaliema (Binza) in Kinshasa consists of samples of leaves, stems, roots and seeds for pink flowers *Talinum triangulare* harvested during the dry season and the whole plant for white flowers *Talinum triangulare* harvested during the rainy season.

2.2 Methods

2.2.1 Biochemical analyses

Freshly collected seeds, barks, roots leaves samples were first washed with tap water and then distilled water and dried water in the open air, away from the sun till constant weight was recorded. From this moisture, percentage was evaluated and chemical analysis was on dry weight basis. Crude protein was estimated by Kjeldahl method as described by Mbemba, and estimated by extracting the sample with petroleum ether in soxhlet apparatus for over eight hours after which the solvent was evaporated away. From the difference in weight [16]. Total lipid was of the flask total



Fig. 1. (a) Pink flower and leaves; (b) bark and leaves plant with pink flowers; (c) white flower and leaves; (d) bark and leaves plant with white flowers; (e) whole plant with pink flowers and (f) whole plant with white flowers of *Talinum triangulare* (Jacq) Willd (*Talinaceae*)

lipid was calculated [17]. Crude fibre was estimated as per the method outlined by Kurschner's [17] and [18]. For ash content, the sample was ashed in a muffle furnace at 600°C for four hours and the difference in weight was recorded from which ash content was calculated [19].

Calorific values were computed as per the formula of Sherman [20]. Carbohydrates, lipids and proteins are the main sources of energy. One gram of protein, lipid and carbohydrate produces 4.1; 9 and 4.1 Kcal respectively.

The method consists of multiplying the contents of different nutrients by the Atwater coefficient (4 for protein, 9 for lipid and 4 for carbohydrate) as follow: Calorific values = (% Protein x 4.1) + (% Fat x 9) + (% Carbohydrates x 4.1). Three replications were made for each sample and standard error of means was worked out. The data were subjected to one way analysis of variance.

Reducing sugars have been estimated following this protocol. Boil 15 ml of the prepared sugar solution for 5 minutes in a beaker and add 5 ml of Fehling's liqueur A and B of each solution. A brick-red precipitate (Cu₂O) is formed. The precipitate is then recovered by filtration; the filter paper washed with hot water is placed in the oven for about 2 hours at 150°C; cooling is done in the desiccator and the filter paper is then weighed [21].

Based on the weight of cuprous oxide obtained, the MEISSL-ALLIHM table is used to determine the weight of glucose, invert sugar and hydrated lactose corresponding to various

weights of cuprous oxide. By interpolation, the weight of sugar per 100 g of fresh material is obtained.

2.2.2 Thin layer chromatography

For TLC, we used aluminum plates (10x20 cm) covered with silica gel GF₂₅₄ Merck (1:10) with 0.5 mm thickness of stationary phase. The plates were dipped in diethyl ether and air dried, then activated in an oven at 110°C for 30 minutes (adsorption chromatography) and stored in the desiccator. The eluents used for the separation of the essential oils were toluene=ethyl acetate in proportion (v=v) 1:9.

3. RESULTS AND DISCUSSION

3.1 Results

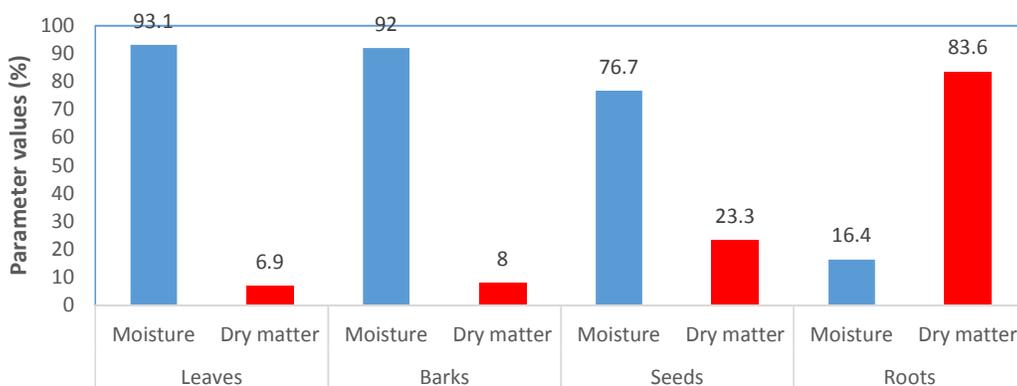
3.1.1 Biochemical analysis

- Moisture content and quantity of dry matter

The parameters analyzed (moisture and dry matter) vary according to the explant analyzed (Fig. 2 and Fig.3).

Moisture content varies in the opposite direction to the amount of dry matter, except for the roots. The variation of these two parameters is highly significant at P>5% (R² = 0.987).

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Part of the analyzed plant of pink-flowered

Fig. 2. Moisture content (%) and amount of dry matter (%) of pink-flowered *Talinum triangular* explants

- Ash content

The ash content varies according to the explants analyzed, whose average (16.08% + 2.45) is not significantly different according to the nature of the samples but they are different with the other parts of the plant ($R^2 = 0.98$) (Fig. 4).

The average ash content of the pink leafed variety is high compared to the white leafed variety. This variation is highly significant between the two varieties ($R^2 = 1$). It evolves in the opposite direction to the moisture content because it is consistent with the moisture content (Fig. 5).

- Crude fiber content of *Talinum triangulare* explants

The crude fibre content of the explants analyzed, with the lowest average (1.92% + 0.065) in the root. The other values are close.

The average crude fiber content of the pink leaf variety is high compared to the white leaf variety.

This variation is highly significant between the two varieties ($R^2 = 1$).

- Total Lipid Content

Fat levels, with an average of (0.321% + 0.07) are similar in the stem, leaf and root; this content is slightly lower in the seeds. The variation between the different explants is significant.

The average fat content of the pink leafed variety is high compared to the white leafed variety. This variation is highly significant between the two varieties ($R^2 = 1$).

- Total protein content

The total protein content ranges from a low 1.13% for the root to 2.4% for the leaf, with an average value of 1.68% + 0.22 (Fig. 10). This leaf protein content, although low, could empirically justify the consumption of leaves by the population. The variation of this parameter shows a highly significant difference between the different explants ($R^2 = 0.9607$).

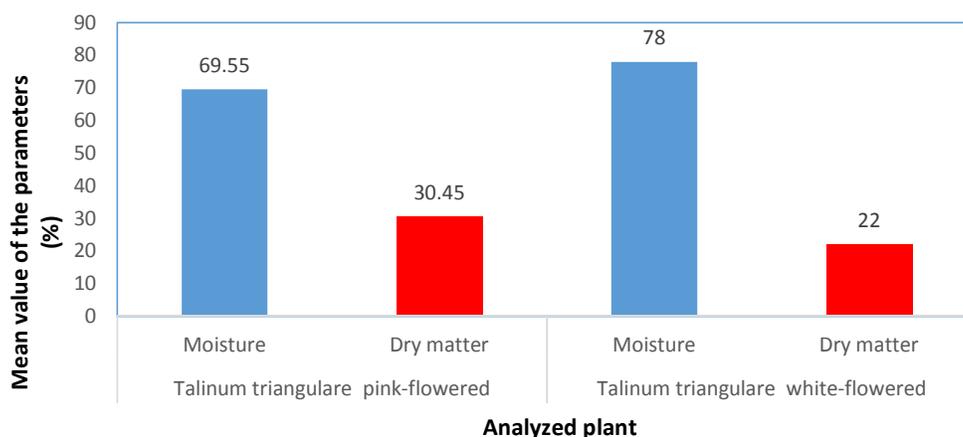


Fig. 3. Average moisture content (%) and dry matter content (%) of the whole pink-flowered and white-flowered plant

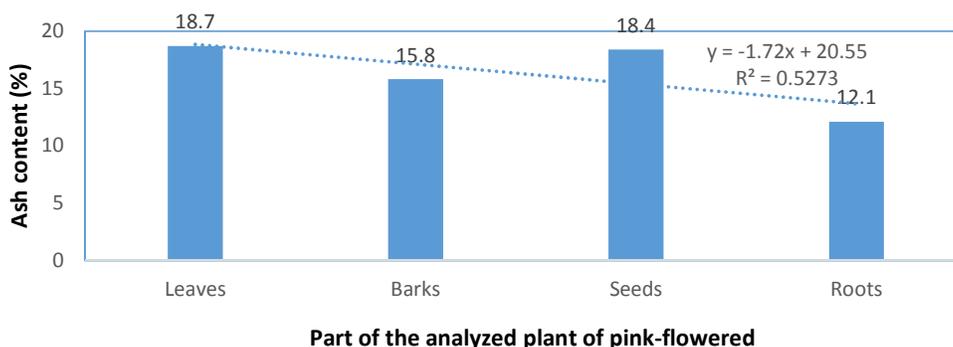


Fig. 4. Mineral content or ash content (%) of pink leaf *Talinum triangulare* explants

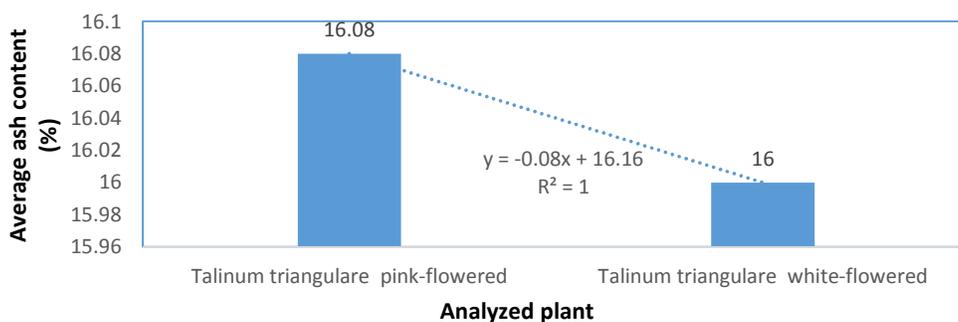


Fig. 5. Average ash content (%) of the whole pink-flowered and white-flowered plant

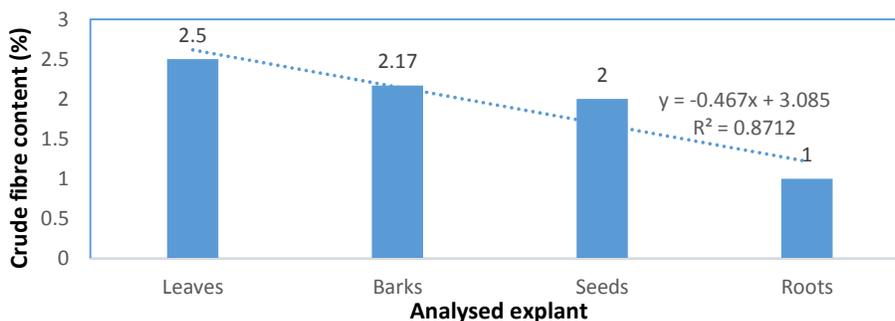


Fig. 6. Crude fiber content (%) of pink leaf *Talinum triangulare* explants

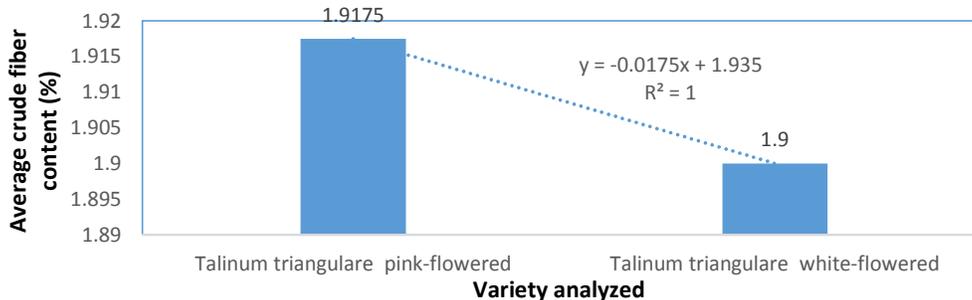


Fig. 7. Average crude fiber content (%) of whole pink and white- flowered plants

The average total protein content of the pink leaf variety is high compared to the white leaf variety. This variation is highly significant between the two varieties ($R^2 = 1$).

- Reducing sugar content

Reducing sugar contents range from a low of 0.07% for the root to 3.58% for the stem, with an average value of $2.356\% + 0.34$ (Fig. 12). The variation of this parameter shows a highly significant difference between the different explants ($R^2 = 0.82$).

The average content of reducing sugars (%) of the whole plant with pink leaves is high

compared to that with white leaves. This variation is highly significant between the two varieties ($R^2 = 1$).

- Overview table

The results of this study indicate that this plant species can be used to combat malnutrition.

- The energy value of two varieties

The energy value of these plants shows the variety *Talinum triangulare* with pink leaf has a much higher caloric intake than the *T. triangulare* with pink leaf. This difference is supported by mathematical regression which shows a highly significant difference between the two (Fig. 15).

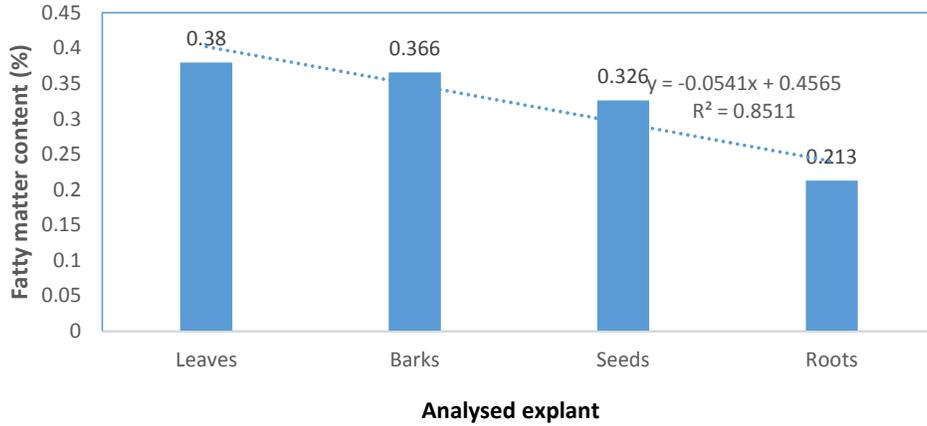


Fig. 8. Fatty matter content (%) of pink leaf *Talinum triangulare* explants

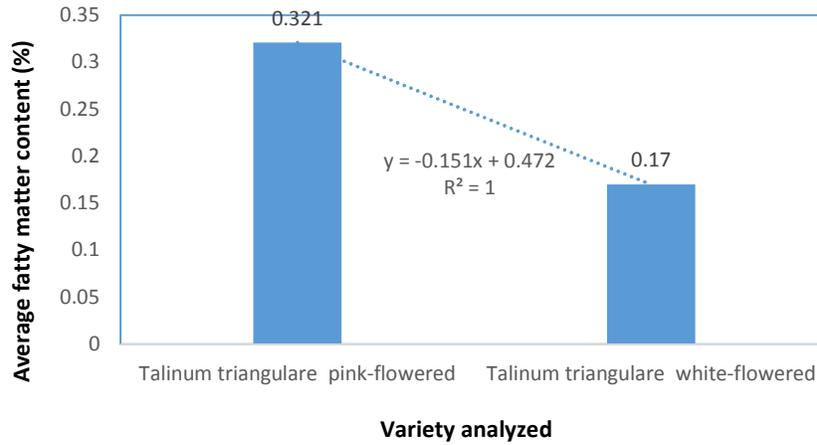


Fig. 9. Average fatty matter content (%) of the whole pink and white-flowered plant

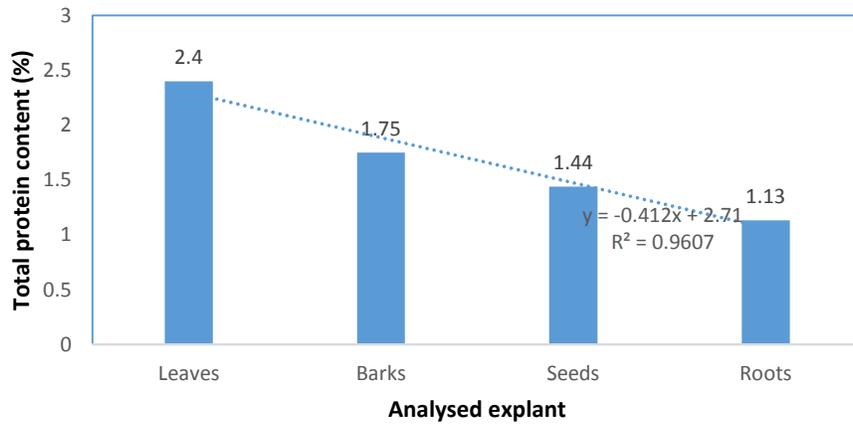


Fig. 10. Mean total protein content (%) of pink-flowered *Talinum triangulare* explants

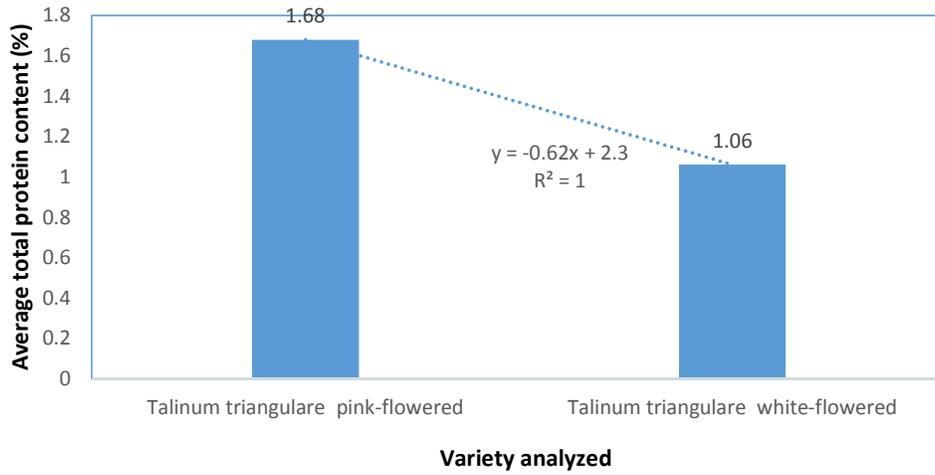


Fig. 11. Average total protein content (%) of the whole pink and white-flowered plant

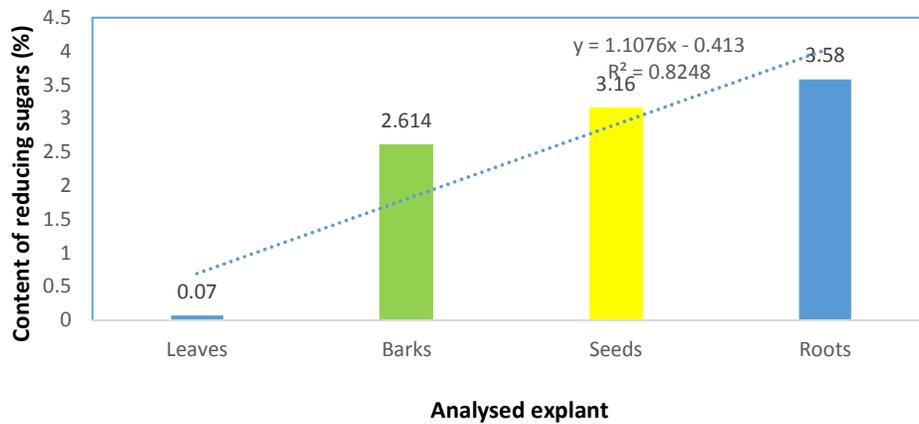


Fig. 12. Reducing sugar content (%) of pink-flowered *Talinum triangulare* explants

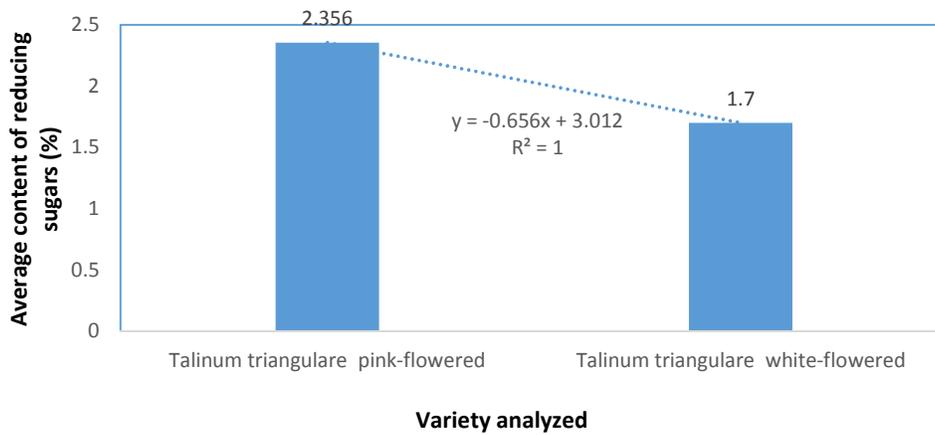


Fig. 13. Average reducing sugar content (%) of the whole pink and white-flowered plant

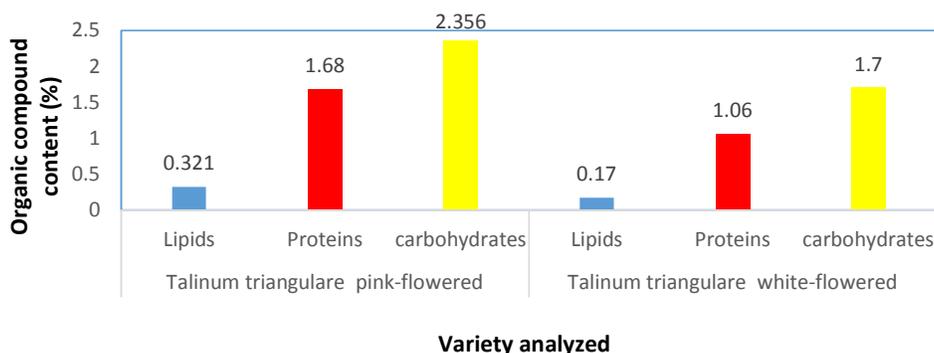


Fig. 14. Average organic compound content (%) of the whole pink and white-flowered plant

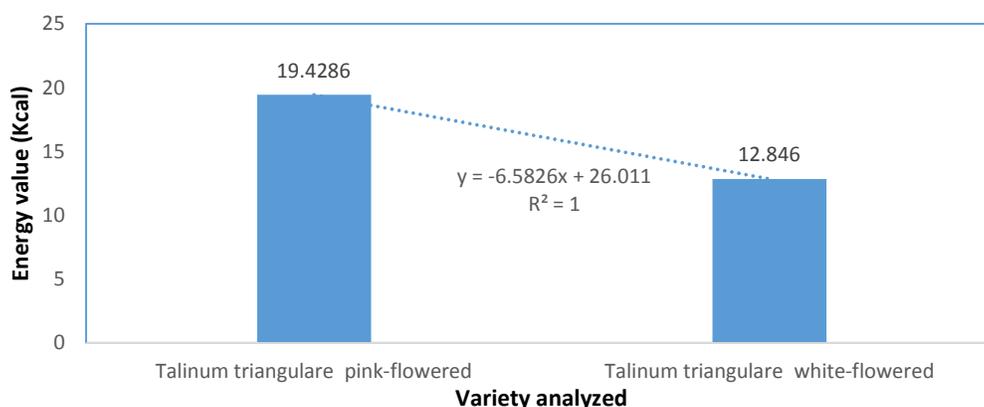


Fig. 15. Energy value (Kcal) of the whole plant with pink and white-flowered

Table 1. Chromatographic profil of leaves and roots

Parameter	Oleic acid	Margaric acid	Palmitic acid	Root	leaf
Ratio to the front (Rf)	0,61	0,785	0,91	0,33	0,19
PM (g/mol)	282,47	276	256,43	Nd ⁽¹⁾	Nd ⁽¹⁾

⁽¹⁾ Nd= not determined

3.1.2 Chromatographic profile

The chromatographic profile (Table 1) reveals the presence in the leaf and in the root of fatty acids of larger size than the control fatty acids: their migration in the chromatogram is low as revealed by their Rf.

4. DISCUSSION

It appears from this study that the leaves of *Talinum triangulare* have a moisture content of 93%, which is slightly higher than the values given successively (90.8%) for *Talinum triangulare* (Jacq.) Wild in the food composition table [3], and (92%) [22]. However, this result is lower (94.4%) than that found [23] and higher than that found in certain vegetables consumed

in Kinshasa city such as: *Amaranthus gracilis* and *Psophocarpus scandens* (82.7%) [16], *Phytolacca dodencadra* (86.72%) and *Pteridium acquilinum* (91.52%) [24]. The average value (69.55%) is essentially attributed to the low value observed in the root (16.4%), the samples having been collected in the dry season and a high average (78%) for those collected during the rainy season. Indeed, the plant is relatively drought tolerant, but when exposed to drought, it adopts a *crassulaceous* acid metabolism (Cam), which results in efficient use of available moisture, particularly that of the tuberous root [25].

The moisture content of the leaves is slightly higher than that found in the stems (92%) in, that

found in the seeds (76.7%) and far higher than that found in the roots (16.4%).

The mineral matter or ash content of *T. triangulare* leaves is 18.7%. This rate is higher than that found by Ilunga [26] in pumpkin leaves (16%). The food composition table [27] gives 2.0%, which is corroborated by Tandu [22] (2.24%). The rate of ash found in the leaves is slightly higher than that found in the stems (18.4%) and higher than that found in the roots (15.8%) and seeds (12.1%). The season influences the average mineral content (16.08% in the dry season and 16% in the wet season).

The total protein found by us in the leaves of *Talinum triangulare* is 2.4% compared to the value found by Sadasivam and Manickam[19], i.e. 2.04%. The protein rate on dry matter in the leaves is higher (2.27%) than that found in the roots 1.13%, stems 1.75% and seeds 1.44%. This rate varies considerably depending on the season, dry (1.68%) and wet season (1.06%).

The fat content found in the leaves is 0.326%, it is lower than that found in the roots 0.366% and lower than that found in the stems 0.38%, the fat content found in the seeds is lower compared to the others. Thus constituting the energy reserve during the dry season, the fat content is largely abundant in the dry season (0.321%) than in the rainy season (0.17%).

The carbohydrate content analysed in the leaves of *T. triangulare* is 0.07%, a value lower than that found in *Portulaca quadrifida* (5.378%) [28], in the leaves of *Pteridium aquilinum* (3.66%) [24] and in *Solanum nigrum* (4.5%) [29]. The level of carbohydrates found is lower than that found by Tandu (Op. cit.) (1.98%), lower than that found in roots (2.614%), stems (3.58%) and seeds (3.16%).

The whole plant consumed releases an energy value of 19.4286% in the dry season and 12.846% in the rainy season, much lower than that found by Ngondo [30] with an energy value of 450.12 Kcal.

The high contents of Ca (83.18 ± 0.39), Mg (75.87 ± 0.04), P (124.96 ± 0.28), Fe (3.77 ± 0.11) and Zn (1.52 ± 0.04), even after cooking [26], make *Talinum triangulare* a wild vegetable that deserves to be domesticated for food reasons.

The same research also indicates the presence of secondary metabolites in fresh and cooked

leaves: Tannin, Alkaloids, Flavonoids, Sterols, HCN (0.44 vs 037 mg/kg), Saponins [16].

It would be interesting in further studies to carry out photochemical analysis of the different explants of *T. triangulare* in order to determine the opportunity to use the tuberous roots in feed rations for cattle, after a detoxification process.

5. CONCLUSION

The present study revealed that *T. triangulare* is excellent sources of protein and minerals with moderate level of crude fibre. There is a general misconception that non-conventional leafy vegetables as well as other edible plants are nutritionally poor and hence unimportant. Since these leafy vegetables are readily available at nominal or no cost, they are promising low cost food supplement and substitute for major food in times of scarcity. Therefore, they should be considered as reliable ingredients of food security system.

The consumption of *T. triangulare* can be recommended in the same way as *Basella alba*. For the moment it grows wild and few market gardeners are trying to cultivate it. The cultivation of *T. triangulare* should be promoted along with other vegetables as part of nutrition education, especially in low-income middle-income countries. We invite all those interested in this kind of study to be able to exploit other aspects that we have not studied, such as the content of mineral salts and vitamins. We only hope that this work, which undoubtedly is not perfect, will certainly contribute to the revelation of local foodstuffs, in the perspective of solutions to the problems of food deficiency in our country. The results of this study can only be beneficial and accessible to the population through the popularization of culture and consumer awareness.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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