HARNESSING THE POWER OF WILD EDIBLES: HOW INVASIVE WEEDS CAN HELP FIGHT MALNUTRITION

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RESEARCH ARTICLE – Case Study

Abstract

Often seen as problematic plants, many weeds can have remarkable nutritional potential. Amaranthus retroflexus (pigweed) and Chenopodium album (lamb's quarters) are two interesting and edible plants, considered mainly as wild weed species. They can thrive in various and harsh environments, and are usually avoided as food sources. Even classified as invasive weeds, these two species have a high nutritional profile, both for human and animal nutrition, rich in essential nutrients including vitamins, minerals, protein and bioactive compounds with significant health benefits. Their resistance allows them to grow and develop in poor soils and harsh conditions, making them a long lasting and an easily accessible option as potential functional food, and / or new future food sources.

Both plants are part of some traditional recipes in different cultures, like Asia and North America. The leaves, seeds and sprouts are valuable sources of proteins, fibers and antioxidants.

Rethinking the values of these neglected plants becomes more and more important as the concerns related to food security and sustainable agriculture are rising. By redefining Chenopodium album and Amaranthus retroflexus, through a new perspective, and transforming them from invasive weeds in to valuable crops, we contribute to the diversification of food sources in a sustainable and accessible way.

Keywords: alternative foods, edible weeds, *Amaranthus retroflexus*, *Chenopodium album*
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INTRODUCTION

At a global level, leafy vegetables have generated interest, because they offer multiple benefits for human health. Leafy vegetables can provide a cheap and accessible source of essential vitamins, minerals, fiber and essential amino acids, especially in the developing countries where processed foods and rich in starch dominate the daily diet. All over the globe, there is a multitude of local wild vegetables, which are not exploited due to the lack of scientific information regarding their nutritional potential. A rediscovered interest has appeared in wild vegetables for their medicinal and food potential. Being underexploited vegetables, *Chenopodium album* and *Amaranthus retroflexus* have a high functional potential, in addition to their basic nutritional benefits. These two species of plants also improve the sensory and functional values of food.

Chenopodium album is a fast-growing weed that can be found almost everywhere. It is native of Europe and Asia (Saha et al, 2015; Aman et al, 2016) and traditionally is known by the name bathua, fat hen or lamb's quarters. This plant prefers clay soils and sunlight, event it tolerates partial shade and a big range of different soil (NC State). In India, *Chenopodium album* has many traditional uses and some species are cultivated like vegetables and for the grain obtained from the plant (Neerja Yadav et al, 2007). Some studies reported that the plant (Khurana et al, 1986; Saini et al, 2020) grow like weed in the fields of wheat, barley, soybean, maize and other crops. Both weed species invade human cultivated lands and not only these, but also the abandoned areas due to their adaptability to unstable and unpredictable environments (Garbari & Pedullà, 2001). They compete with other plant species through different survival tactics for nutrients, water, light and space (Rodenburg et al, 2010).

The plant contains some chemicals and can be slightly toxic (saponins, oxalates, nitrates and sulfates) but they can be easily removed by cooking (Mamatha Hanumappa, 2019). Containing significant amounts of vitamin A (in

the leaves), a quantity that is greater than in the leaves of spinach or kale. It is rich in vitamins, minerals (especially calcium), proteins and fibers. It also has medicinal value being used as an anthelmintic, anti-inflammatory, anti-rheumatic, laxative, and it has uses in the treatment of insect bites, sunburns and skin problems (Mamatha Hanumappa, 2019).

Both plants produce large amounts of seeds that can remain viable in the soil many years and because of this fact, it becomes aggressive plants in the background (Rodenburg et al, 2010).

Amaranthus retroflexus known by the traditional name pigweed, it's an annual plant from the Amaranth family and it's considered to be native to North America (Bond & Turner, 2006). The same like *Chenopodium album*, it is considered a weed because it grows everywhere, like on the fields, farm lots and cultivated areas. From the amaranth plant the seeds can be eaten raw or cooked, they can be ground into flour for making bread and the fresh sprouts can be added in salads (Saini&Saini, 2020). Studies have shown that the leaves and seeds of the amaranth plant are an excellent source of protein (Kadoshnikov et al, 2008). The seeds have a significant nutritional value, having a high protein and lysine content compared to other cereals (Bressani, 1989). Besides that, *Amaranthus retroflexus* include a great amount of energy, proteins, fats, fibers, vitamins and minerals (Assad et al, 2017; Keskin et al; 2020; Temel et al, 2022).

In the phytochemical extract from amaranth leaves are reported biologically active components (Qumbisa et al, 2020) such as tannins, saponins, phenols, flavonoids, cardiac glycosides, steroids and triterpenoids (Reyad-ul-Ferdous et al, 2015). The chemical constituents of this plant show strong activities such as antiviral, anti-inflammatory, anti-hepatotoxic, antiulcer and other allergic actions (Reyad-ul-Ferdous et al, 2015).

The aim of the study is to evaluate the food potential of these two invasive weeds, *Chenopodium album* and *Amaranthus retroflexus* and to integrate in our daily diet.

MATERIAL AND METHOD

A selection of 100 research papers were investigated, as well as the main European and USDA databases in order to answer the main question of the present study if this weeds, *Amaranthus retroflexus* and *Chenopodium album,* can become a viable source of nutrition.

The statistical analysis was conducted using the PAST program, version 2.17 (Hammer & Harper, 2001), along with cluster analysis and MVSP, version 3.22. Cluster aims to identify groups in a data set, based on similarities or differences between them. Principal Component Analysis (PCA) allows the representation of observations by a set of correlated dependent variables. PCA is a mathematical model used to reduce the dimensionality of data, facilitating the formation of groups that highlight the most significant correlations.

RESULTS AND DISCUSSIONS

Table 1 was realized based on the studied literature data and database information and shows the comparison of the nutritional composition between the leaves of *Chenopodium album* and *Amaranthus retroflexus*.

Table 1

Macronutrients in *Chenopodium album* and *Amaranthus retroflexus*

Components	Symbols	Unit	*Chenopodium album* leaves	*Amaranthus retroflexus* leaves
			CA [USDA]	AR [USDA]
Water	H2O	%	76.70	91.70
Energy	Kcal	Kcal	47.00	23.00
Protein	Prot	g	4.22	2.46
Total fat lipid	TotF	g	0.33	0.33
Ash	Ash	g	0.03	1.50
Carbohydrate	Carbh	g	7.00	4.02
Fatty acids	Fac	g	0.33	0.09
Total dietary fiber	TotDF	g	6.33	6.02 [Sarker et al, 2020]
Starch	Starch	g	1.07	0.00

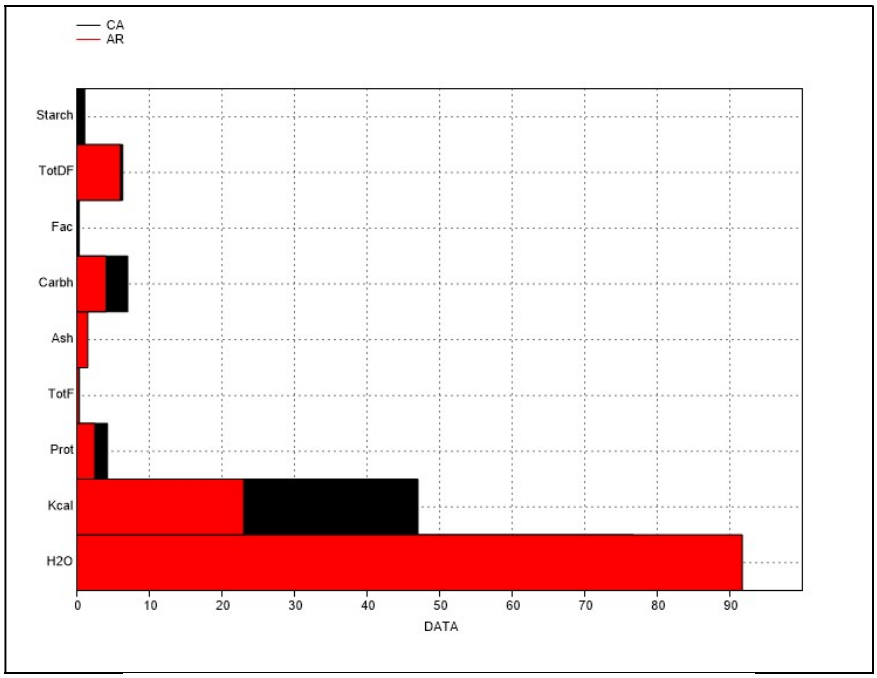
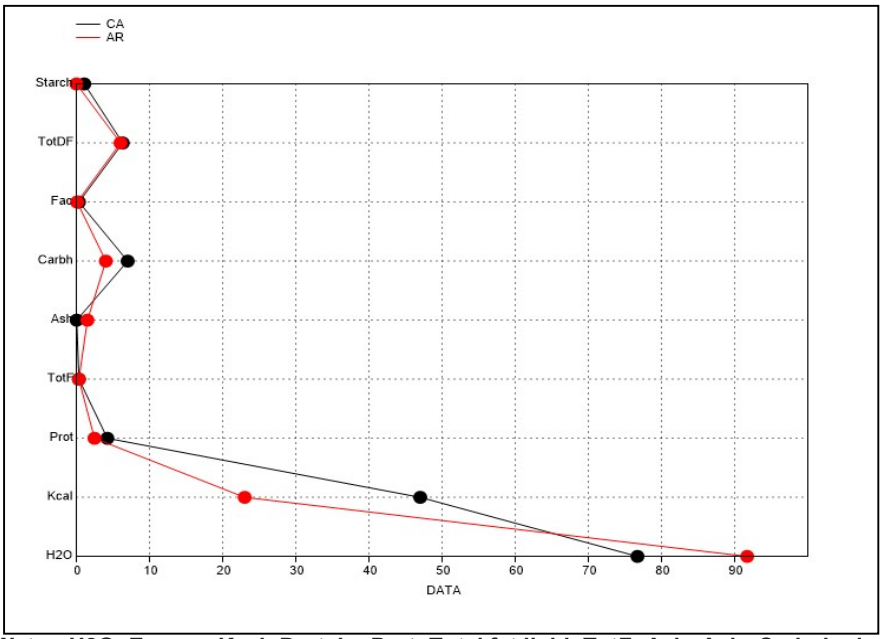


Figure 1. Nutritional composition of the investigated plants

Legend: Water=H2O; Energy=Kcal; Protein=Prot; Total fat lipid=TotF; Ash=Ash; Carbohydrate=Carbh; Fatty acids=Fac; Total dietary fiber=TotDF; Starch=Starch.

Figure 1 shows that the *Chenopodium album's* leaves are richer in proteins, energy, carbohydrates and starch, which makes them a concentrated source of nutrients. In contrast, the leaves of *Amaranthus retroflexus* have higher water and mineral contents, providing less energy and protein.

Figure 2. Nutritional compounds variations of studied plants



Legend: Water=H2O; Energy=Kcal; Protein=Prot; Total fat lipid=TotF; Ash=Ash; Carbohydrate=Carbh;

In Figure 2, we have illustrated the variations in nutritional values for the two plants, CA and AR and highlighting significant differences between them.

Significant fluctuations are observed in high value components, such as starch and total

fiber, while calories and water show a progressive decrease..

The differences indicate distinct nutritional profiles for each category, suggesting possible variations in composition

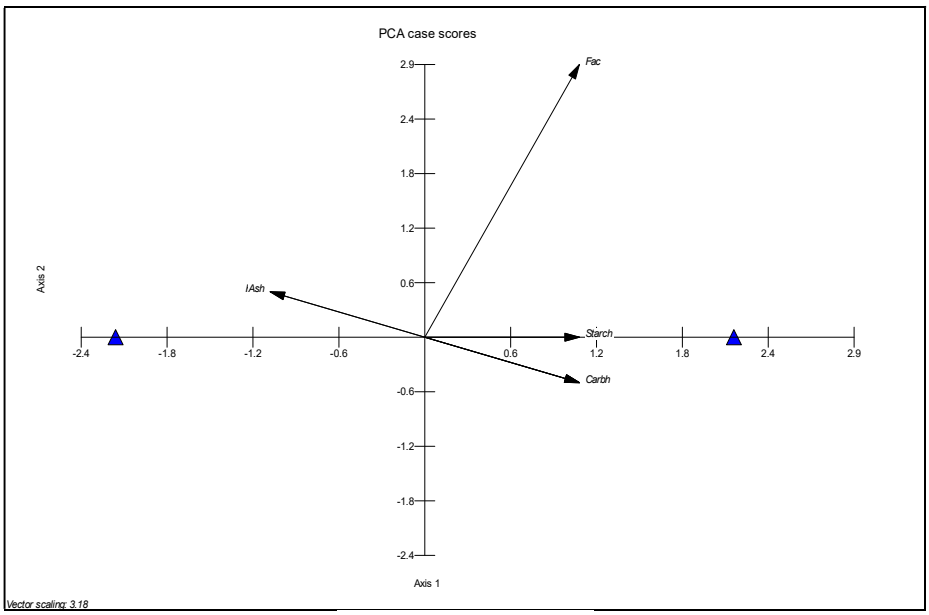


Figure 3. PCA Joint Plot
Legend: Ash=Ash; Carbohydrate=Carbh; Fatty acids=Fac; Starch=Starch.

The Principal Component Analysis (PCA) is used to highlight variations and relationships between different nutritional factors. As we can observe in Figure 3, starch and carbohydrates vectors are positively correlated on Axis 1, although the ash data vector has an opposite relationship with them.

Axis 2 is influenced mostly by Fat and the blue dots indicating differences between the samples.

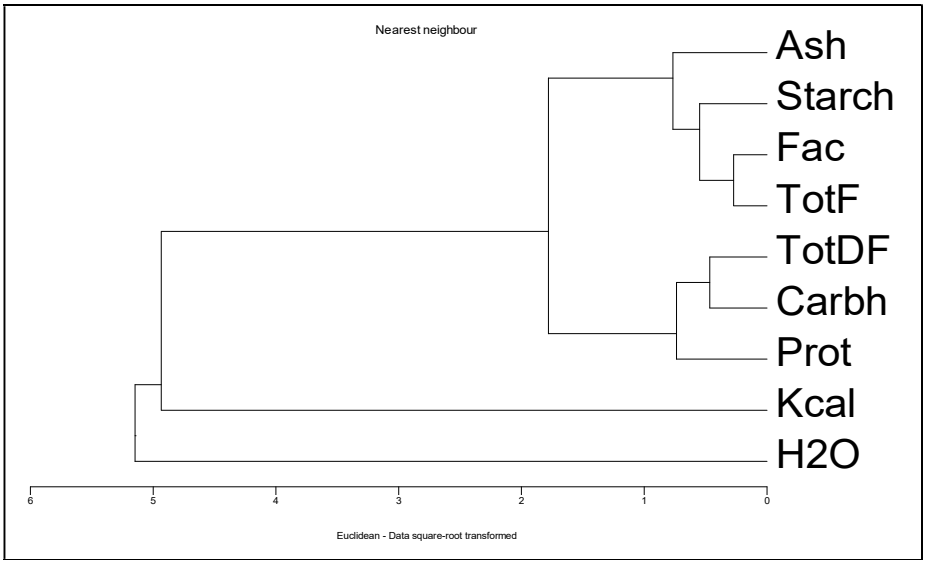


Figure 4. Cluster analyses of components based of Euclidian distance of nearest neighbor
Legend: Water=H2O; Energy=Kcal; Protein=Prot; Total fat lipid=TotF; Ash=Ash; Carbohydrate=Carbh; Fatty acids=Fac; Total dietary fiber=TotDF; Starch=Starch.

The degree of similarity is observable in Figure 4. Distinct groups, such as Ash, Starch and Fac are strongly correlated, indicating a possible association. Another group, consisting of TotDF and Carbh suggests a link between fiber and carbohydrate content. The most different from the rest of the groups are H2O and Kcal, indicating a separate influence on the other components.

CONCLUSIONS

Following these results, we can conclude that Chenopodium album is more valuable from nutritional point of view, while *Amaranthus retroflexus* stands out with a higher water and mineral content.

Having a balanced nutritional profile, *Chenopodium album* and *Amaranthus retroflexus* offers significant amounts of protein, fiber, vitamins and minerals.

The differences observed between the nutritional compositions of the two plants, suggest a varied potential in their use in food industry.

Cluster and PCA analysis show how nutrients groups together, suggesting that the two species may complement each other in the diet providing an optimal balance of essential nutrients.

Both species can be considered a sustainable food sources, having a wide distribution and a high capacity to adapt in different environmental conditions, which makes them an accessible and easy to cultivate or exploit.

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REFERENCES

1. Aman, S., Mazumder, A., Gupta, A. K., & Nayak, A. (2016). Pharmacological activities of Chenopodium album Linn—a review. *World J Pharm Res*, *5*(10), 361-371. https://wjpr.s3.ap-south-1.amazonaws.com/article_issue/1475216665.pdf ;
2. Assad, R., Reshi, Z.A., Jan, S., Rashid, I. **2017**. Biology of amaranths. *The Botanical Review,* *83*(4): 382-436. https://www.researchgate.net/publication/370400416_AMARANTHUS_Amaranthus_spp ;
3. Bond, W., & Turner, R. (2006). The biology and non-chemical control of common amaranth (Amarantus retroflexus L.). *New York. John Wiley and Sons, INC 33-42, 1.* ;
4. Bressani, R. (1989). The proteins of grain amaranth. *Food Reviews International*, *5*(1), 13-38. https://www.tandfonline.com/doi/pdf/10.1080/87559128909540843 ;
5. Garbari, F., & Pedullà, M. L. (2001). Alternanthera philoxeroides (Mart.) Griseb.(Amaranthaceae), specie nuova per la flora esotica d'Italia. *Webbia*, *56*(1), 139-143. https://www.tandfonline.com/doi/abs/10.1080/00837792.2001.10670707 ;
6. https://fdc.nal.usda.gov/food-details/168385/nutrients (Accessed: 07 March 2025);
7. https://fdc.nal.usda.gov/food-details/168995/nutrients (Accessed: 07 March 2025);
8. Kadoshnikov, S. I., Kadoshnikova, I. G., Kulikov, Y. A., & Martirosyan, D. M. (2008). Researches of fractional composition of protein of amaranth. *Current Nutrition & Food Science*, *4*(3), 196-205. https://www.ingentaconnect.com/content/ben/cnf/2008/00000004/00000003/art00007 ;
9. Keskin, B., Temel, S., Tosun, R., Çakmakçı, S. **2020**. Determination of Feed Quality Characteristics of Seed and Straw of Some Amaranth Varieties Grown under Irrigation and Dry Conditions. *International Journal of Agriculture and Wildlife Science (IJAWS), 6*(3): 625 – 637. https://www.researchgate.net/publication/370400416_AMARANTHUS_Amaranthus_spp ;
10. Khurana, S. C., Malik, Y. S., & Pandita, M. L. (1986). Herbicidal control of weeds in potato cv. Kufri Badshah. https://www.cabidigitallibrary.org/doi/full/10.5555/19870700823 ;
11. Mamatha Hanumappa September 2019 Fact Sheet 005, University of the District of Columbia, College of Agriculture, Urban Sustainability and Environmental Science. http://docs-do-not-link.udc.edu/causes/Fact-Sheet-Lambsquarters-Chenopodium-album-is-a-Nutrient-Packed-Edible-Weed-final.pdf ;
12. Neerja Yadav, N. Y., Neeru Vasudeva, N. V., Sumitra Singh, S. S., & Sharma, S. K. (2007). Medicinal properties of genus Chenopodium Linn. https://www.cabidigitallibrary.org/doi/full/10.5555/20073132233 ;
13. North Carolina, Extension Gardener, Plant toolbox. https://plants.ces.ncsu.edu/plants/chenopodium-album/ ;
14. Poonia, A., & Upadhayay, A. (2015). Chenopodium album Linn: review of nutritive value and biological properties. *Journal of food science and technology*, *52*, 3977-3985. https://link.springer.com/article/10.1007/s13197-014-1553-x ;
15. Qumbisa, N. D., Ngobese, N., & Kolanisi, U. (**2020**). Potential of using amaranthus leaves to fortify instant noodles in the South African context: A review. *African Journal of Food, Agriculture, Nutrition and Development*, *20*(4),

16099-16111.https://www.mdpi.com/2076-3417/11/15/6879 ;

16. Reyad-ul-Ferdous, M., Shahjahan, D. S., Tanvir, S., & Mukti, M. (**2015**). Present biological status of potential medicinal plant of Amaranthus viridis: a comprehensive review. *Am. J. Clin. Exp. Med*, *3*(5), 12. https://www.mdpi.com/2076-3417/11/15/6879 ;
17. Rodenburg, J., Riches, C. R., & Kayeke, J. M. (2010). Addressing current and future problems of parasitic weeds in rice. *Crop Protection*, *29*(3), 210-221. https://www.sciencedirect.com/science/article/pii/S0261219409002646 ;
18. Saha, J., Biswal, A. K., & Deka, S. C. (2015). Chemical composition of some underutilized green leafy vegetables of Sonitpur district of Assam, India. *International Food Research Journal*, *22*(4). https://www.researchgate.net/profile/Achyut-Biswal/publication/377575743_Chemical_composition_of_some_underutilized_green_leafy_vegetables_of_Sonitpur_district_of_Assam_India/links/65ae1719f323f74ff1e45379/Chemical-composition-of-some-underutilized-green-leafy-vegetables-of-Sonitpur-district-of-Assam-India.pdf ;
19. Saini, S., & Saini, K. K. (2020). Chenopodium album Linn: An outlook on weed cum nutritional vegetable along with medicinal properties. *Emergent Life Sciences Research*, *6*, 28-33. https://www.emergentresearch.org/abstract.php?article_id=7338 ;
20. Sarker, U., Hossain, M. M., & Oba, S. (2020). Nutritional and antioxidant components and antioxidant capacity in green morph Amaranthus leafy vegetable. *Scientific Reports*, *10*(1), 1336. https://pmc.ncbi.nlm.nih.gov/articles/PMC6987210/ ;