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On the ecology and nutritional value of two *Echinochloa* species (*Echinochloa colona* and *Echinochloa stagnina*) in Egypt

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Abstract
In arid and semi-arid countries, where drought prevails together with population growth and limited food resources led to the search for non-conventional alternatives resources for food or feed. In the present study, the ecology, phytochemical composition, and nutritional value of two *Echinochloa* species (*Echinochloa colona* (L.) Link and *E. stagnina* (Retz.) P. Beauv.) collected from the canal banks of the Nile Delta, Egypt were investigated. The soils of *E. stagnina* had the highest values of moisture content (24.35%), water holding capacity (45.85%), pH (8.12), electric conductivity (5 dsm^{-1}), chloride (1.15%), sulphates (0.95%), organic carbon (2.52%) and Na^+ (66.78 $mgkg^{-1}$). The cover percentages of *E. stagnina* showed positive significant correlations with water-holding capacity, organic carbon, pH, EC, Na but negative correlations with sand-fraction and sulphates. The shoot of *E. stagnina* had the highest values of moisture (11.20%), fibers (27.65%), crude proteins (6.90%), total carbohydrates (70.36%), but the shoot of *E. colona* had the highest contents of total fats (2.80%) and digestible carbohydrates (43.18%). The shoots of *E. stagnina* had the highest values of flavonoids (6.88 mg g^{-1} dry weight), alkaloids (5.66 mg g^{-1} dry weight), tannins (18.23 mg g^{-1} dry weight), saponins (1.99 mg g^{-1} dry weight) and total phenols (33.09 mg g^{-1} dry weight). Regarding nutritional status, *E. colona* had the highest total digestible energy (60.55%) and nutritive value (11.11%) while *E. stagnina* had the highest caloric value (219.72 kcal/100 g dry matter) and potential energy (315.21 kcal/100 g dry matter). The two *Echinochloa* grass are rich-source in nutrients and showed a great energy value. Therefore, the studied grasses are candidates as feed for livestock or as supplementary feed but after detailed toxicological studies.

Keywords: Anti-nutritional compounds, forage, grasses, nutritive value

1. Introduction

In arid and semi-arid countries, the vast dry-lands coupled with great population growth and limited sources of food and feed led to a search for alternatives and non-traditional food and feed resources for both humans and animals [1].

Grasses (family Gramineae) is among the largest and invaluable family. Grasses are widely distributed all over the world under different climate and soil conditions [2]. Grasses are highly contributed to animal-feeding due to their high contents of nutritive rate [3]. This nutritive importance is attributed to their rich-content of carbohydrates, proteins, minerals and fibers. Therefore, for any rangeland rehabilitation strategy, it must include the planting of grasses to maintain a continuous supply of fodder for livestock. The nutritive quality of any plant is attributed to its composition and palatability [4]. In the present study, two *Echinochloa* species were selected, *Echinochloa colona* (L.) Link and *Echinochloa stagnina* (Retz.) P. Beauv. *E. colona* is an erect, annual summer rhizomatous grass/weed, globally considered as one of the most nuisance weeds [5, 6]. It is native to tropical and subtropical Asia, Africa and Australia and competes with crops. The high competition of *E. colona* is attributed to its rapid-growth, short-dormancy, allelopathic potential, high-seeds production, high adaptation and resistance against herbicides [6, 7, 8]. *E. colona* has reported as the most common annual weeds in summer crops, orchards and fallow-lands in many countries such as Egypt, Malaysia, Kenya, Japan, Colombia, USA, etc. [9, 10, 11]. *E. colona* preferred moist loamy soils and dominates on heavy-textured soils along the swamps, banks of canals and lakes, neglected lands, and field crops (maize, rice, tomatoes, etc.) [12]. The wide ecological niche of *E. colona* promotes its negative impacts on field crops through the globe [6].

Echinochloa stagnina (commonly known as burgu or amshot) is a perennial emergent grass, native in tropical Africa and Asia [13]. This plant grows in canal banks, swampy habitats, and occasionally forms a floating mat singly or together with other *Echinochloa* species on the surface of the water. This plant is characterized by its resistance to both harsh-condition and floods [14]. In Mali, during the scarcity-period, the dried-culms and grains of *E. stagnina* are used as food. In addition, *E. stagnina* is used as a forage for animals during the dry-season [15]. Ado *et al*. [16] reported the importance of *E. stagnina* to improve the structure and reduce salinity in vertisols soils. Also, several studies [17, 18] highlighted the phytoremediation potential of *E. stagnina*. Moreover, *E. stagnina* is cultivated as a crop and also to remove pollutants and reduce salinity from soils. *E. stagnina* provides a substrate for fish breeding and feeding during floods [14].

To our knowledge, there is no previous study that addressed the ecology and nutritional status of *E. colona* and *E. stagnina* in Libya. Therefore, the main objectives of the present study were 1) to characterize the main features of habitats where the two *Echinochloa* species are growing and 2) to address the nutritional status of both *Echinochloa* species.

2. Materials and methods

a. Floristic sampling

Along with the canal banks habitats at the north of the Nile Delta of Egypt **(Figure 1)**, 60 sampled plots (25 m^2 each) for the two *Echinochloa* species (30 plots per each one) were selected. The Nile Delta belongs to the arid climate where hot-dry summer and milder rainy winter. The plant nomenclature was explored according to [19]. The cover percentages of two *Echinochloa* species as compared with the associated species were visually estimated.

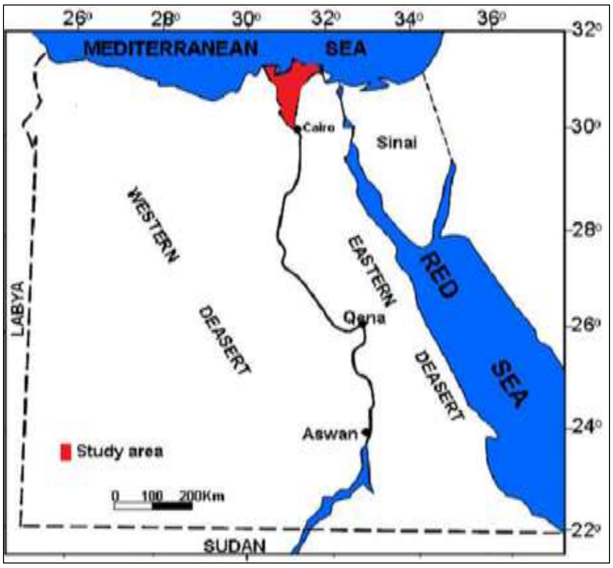

Fig 1: Map of Egypt shows the Nile Delta region (study area in red colour).

b. Soil analyses

Per each plot, a composite soil sample at a profile of 30 cm was collected, then air-dried and cleaned by removal of debris. The hydrometer was applied to distinguish different soil texture percentages (sand, silt and clay). In a soil solution of 1:5 (w/v), pH and electric conductivity (EC) were estimated by using pH and conductivity meters (Apera model), respectively. Moisture content, water holding capacity (Hilgard Pan-box method), Cl^-, HCO_3, SO_4 and organic carbon (OC) were determined according to the USDA/NRCS [20]. The concentrations of Na^+ and K^+ were determined using a flame photometer while Ca^{++} and Mg^{++} were estimated by an atomic spectrophotometer.

c. Phytochemical analyses of *E. colona* and *E. stagnina*

The healthy aboveground shoots of *E. colona* and *E. stagnina* were assembled from the canal banks habitats, then washed with tap water, air-dried and well-grinded. Primary constituents (moisture, ash, fibers, total fat, proteins, total carbohydrates and digestible carbohydrates) were estimated following the Association of Official Analytical Chemists [21]. Minerals (Na, K, Ca, Mg, Fe, Zn, Cu, Mn) were estimated in the dried samples after digestion with concentrated HNO_3, by using the flame photometer and atomic spectrophotometer [21]. Flavonoids, alkaloids, tannins, saponins and total phenols were estimated according to the standard methods of [22, 23, 24]. In brief, flavonoids were colorimetrically valued using $AlCl_3$, saponins by using separation method, tannins by using a vanillin-HCl reagent, alkaloids by precipitation method by using ethanol-acetic acid, while total phenols were spectrophotometrically estimated in presence of Folin-Ciocalteu reagent.

d. Nutritional status measurements

Based on chemical constituents, four categories were used to calculate the energy values of the two *Echinochloa* species (Table 1).

Table 1. List of nutritional value categories used in the present study.

Category	Formula
Total digestible nutrient (TDN) [25]	TDP (%) = 0.623(100+1.25TF)-CP 0.72, where TF is total fats and CP is the crude proteins.
Nutritive value (NV) [25]	NV (%) = TDN/CP, where TDP is the total digestible nutrient and CP is the crude proteins.
Caloric value (CV) [26]	CV (kcal/100 g dry matter) = 4CP+ 9TF+ 4DC, where CP is crude protein, TF is the total fat and DC is the digestible carbohydrates.
Potential energy (PE) [27]	PE (kcal/100 g dry weight) = 3.75TC+ 4CP+ 9TF, where TC is total carbohydrates, CP is the crude proteins and TF is the total fat.

e. Statistical analyses

To prevent collinearity among the measured soil variables, a Pearson correlation (|r|< 0.7) was considered. Consequently, seven non-linear significant soil factors (sand fraction, water holding capacity, organic carbon, pH, electric conductivity, sulphates and sodium) were kept. To explain the correlation between the cover percentages of two *Echinochloa* species and selected soil variables, response-curves were applied. A Kruskal-Wallis test followed by Bonferroni's correction was applied to test the significance among mean values of phytochemical constituents of two *Echinochloa* species. All analyses were done in CoStat v. 6.

3. Results and discussion

a. Habitat features of *E. colona* and *E. stagnina*

The prevailing soil-texture of both *Echinochloa* species was a coarse sand texture (>90%) with minute percentages of silt and clay particles (Table 2). The soils of *E. stagnina* had the highest values of moisture content (24.35%) and water holding capacity (45.85%). This finding addressed the suitable habitats of *E. stagnina* where coarse and water-saturated soils [28]. Consequently, this supports its common-survival on the canal banks and wetlands in contrary to *E. colona* which widely-distributed on the roadsides, abandoned lands and also dry-lands. On the other hand, *E. stagnina* favored slight alkaline, saline and fertile soils as compared with *E. colona*. Soils of *E. stagnina* showed a pH value of 8.12, electric conductivity of 5 dsm^{-1}, chloride of 1.15%, sulphates of 0.95%, organic carbon of 2.52% and sodium value of 66.78 $mgkg^{-1}$. Therefore, *E. stagnina* able to reduce salinity and this improves its use for reclamation of sodic and alkaline soils [29, 30]. Manidool [12] reported that *E. colona* preferred moist loamy soils and dominates along the swamps, cultivated lands, banks of canals and lakes, neglected lands, and field crops. Moreover, the alkalinity of soil in the study area is not only corresponded to arid-climate but also due to high concentrations of sodium over the other cations. The soil properties of both studied *Echinochloa* species are completely agreed with the soil features of *Paspalidium geminatum* and *Panicum repens* in the same habitats in Egypt [4].

Table 2: Physico-chemical features (average± SE) of the soil samples maintaining the growth of the two *Echinochloa* species.

	E. colona	***E. stagnina***
Physical properties		
Sand (%)	93.35±1.58	90.50±1.16
Silt (%)	5.09±0.35	6.80±0.10
Clay (%)	1.56±0.0	2.70±0.08
Moisture content (%)	20.21±2.03	24.35±1.54
Water holding capacity (%)	40.18±1.50	45.85±2.46
Chemical properties		
pH	7.48±0.03	8.12±0.07
Electric conductivity (dsm^{-1})	2.10±0.23	5.00±0.08
Cl^- (%)	0.18±0.0	1.15±0.02
SO_4 (%)	0.75±0.11	0.95±0.03
HCO_3 (%)	0.12±0.0	0.31±0.0
Organic carbon (%)	1.66±0.11	2.52±0.22
Na^+ ($mgkg^{-1}$)	24.11±2.90	66.78±2.50
K^+ ($mgkg^{-1}$)	4.50±0.34	8.85±0.66
Ca^{++} ($mgkg^{-1}$)	18.11±1.06	26.57±1.50
Mg^{++} ($mgkg^{-1}$)	19.44±1.45	10.21±1.02

The correlations between significant soil variables and cover percentages of *E. colona* and *E. stagnina* are displayed in Figures 2 and 3, respectively. For *E. colona*, there are negative correlations between the cover and water holding capacity, pH, EC, SO_4, Na but positive correlations with sand-fraction and organic carbon. The cover percentages of *E. stagnina* showed positive significant correlations with water-holding capacity, organic carbon, pH, EC, Na but negative correlations with sand-fraction and sulphates. This finding agreed with previous studies [31, 32] that addressed the importance of soil-salinity, texture, fertility and pH on the distribution of plants specifically on the canals banks and roadsides where the study species survive. In addition to the adaptation of the plant itself, there are a group of factors that contributed to its spatial distribution and persistence in its habitat [33].

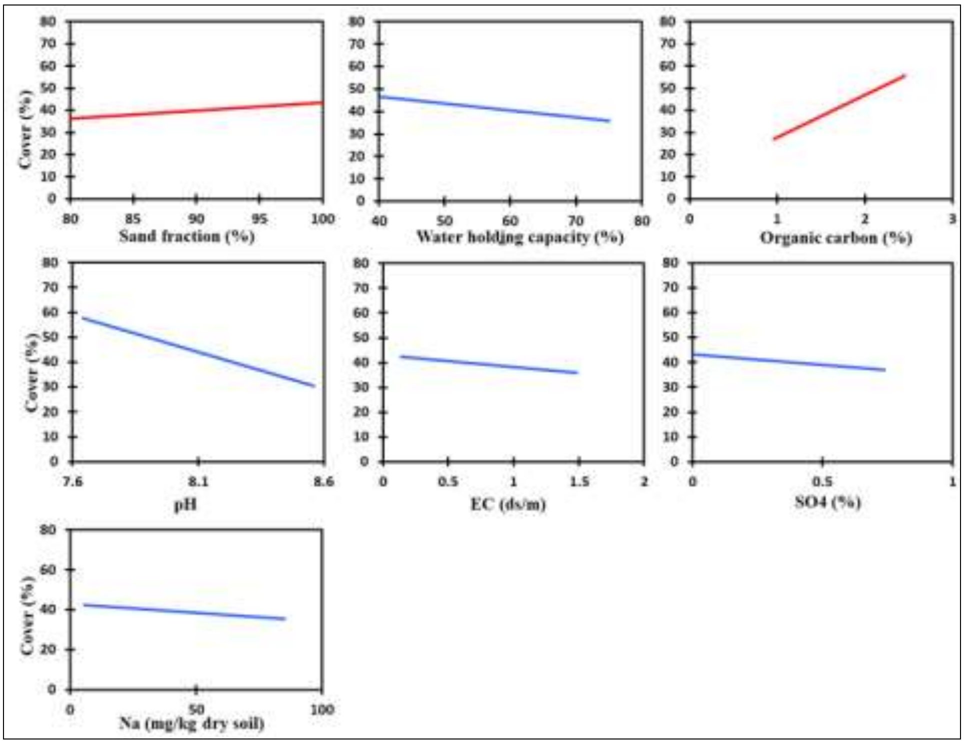

Fig 2: Response-curves of *E. colona* cover percentage versus the significant soil factors.

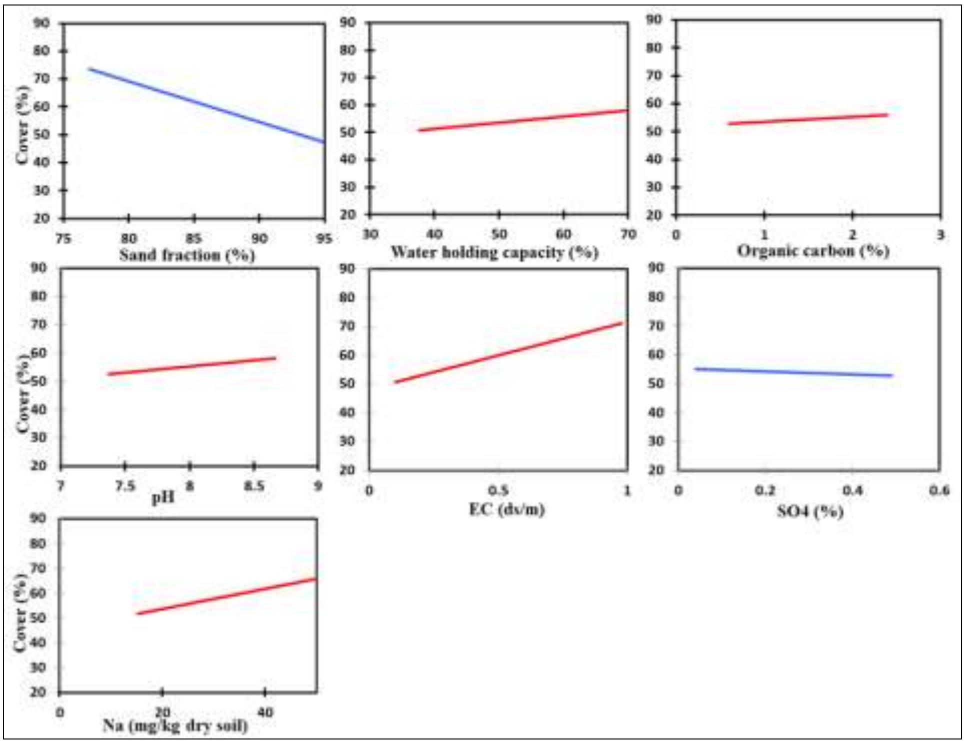

Fig 3: Response-curves of *E. stagnina* cover percentage versus the significant soil factors.

b. Phytochemical analysis of two *Echinochloa* species

The proximate composition is the first step towards the potentiality of considering any plant as a good source for food or feed and labeling its nutritional status [34]. The primary composition, minerals and secondary metabolites of the aboveground shoots of *E. colona* and *E. stagnina* are displayed in Table 3. Except for total fats, potassium, alkaloids and saponins, all the other measured parameters are significantly different ($p< 0.05$) between the two *Echinochloa* species. The shoot of *E. stagnina* had the highest values of moisture (11.20%), fibers (27.65%), crude proteins (6.90%), total carbohydrates (70.36%), but the shoot of *E. colona* had the highest contents of total fats (2.80%) and digestible carbohydrates (43.18%). The value of moisture content expresses the food quality, palatability, and storage period. The results displayed that, the two *Echinochloa* species had low moisture as compared with two-related grasses *Panicum repens* and *Paspalidium geminatum* (12.51 and 11.15%, respectively) in Egypt [4]. The ash content which indicated the minerals content was low in *E. stagnina* as compared with *Paspalidium geminatum* (13.56%) but high in *E. colona* [4]. The fibers in both *Echinochloa* species showed similar values with *Panicum repens* (25.67%). A diet that contains rich-fibers is healthy important as it improves digestion [35]. Adequate concentrations of carbohydrates, proteins and fats in the diet/feed maintain energy and optimal-growth for humans and animals [36]. The shoots of both *Echinochloa* species attained comparable values of carbohydrates, proteins and total fats with shoots of *P. repens* and *P. geminatum* in Egypt [4]. Regarding the minerals content, the shoot of *E. stagnina* attained the highest values as compared with *E. colona* shoot (Table 3). Sodium content varied from 12.65 mg g^{-1} dry weight in *E. colona* to 28.90 mg g^{-1} dry weight in *E. stagnina*, calcium varied from 4.84 mg g^{-1} dry weight in *E. colona* to 10.89 mg g^{-1} dry weight in *E. stagnina* while magnesium ranged between 2.45 mg g^{-1} dry weight in *E. colona* and 5.09 mg g^{-1} dry weight in *E. stagnina*. Sufficient minerals in the diet help in building bones and metabolic activities. The values of other essential microelements are displayed in Table 3. The minerals values in the studied *Echinochloa* species are in intimate concord with shoots of *P. repens* and *P. geminatum* [4]. In the current study, the proximate composition and minerals of the two studied *Echinochloa* species meet the requirements for animal diet.

The food/feed quality depends on the equilibrium between concentrations of nutritional and anti-nutritional contents [37]. The main anti-nutritional components include alkaloids, saponins, cyanogenic glycosides, phytates, tannins, etc. The shoots of *E. stagnina* had the highest values of flavonoids (6.88 mg g^{-1} dry weight), alkaloids (5.66 mg g^{-1} dry weight), tannins (18.23 mg g^{-1}), saponins (1.99 mg g^{-1} dry weight) and phenols (33.09 mg g^{-1}). Low levels of these secondary metabolites are known to have antibacterial, antiviral and antitumor activities [38], but high levels reduce the absorption of nutrients and palatability of the feed. Due to the lack of standard optimal/safe-scale of these metabolites, it is difficult to recommend safe levels. As compared with relative grasses, *P. repens* and *P. geminatum* [4], the two *Echinochloa* species had the highest values of the studied secondary metabolites.

Table 3: Primary composition, minerals and secondary metabolites (average ±SE) of *E. colona* and *E. stagnina*. Different letters in the same row are significantly different at $p< 0.05$

Parameter	*E. colona*	*E. stagnina*
Primary composition (%)		
Moisture	9.55±0.90^a	11.00±1.40^b
Ash	15.22±1.02^a	8.90±0.89^b
Fibers	22.80±2.11^a	27.65±1.67^b
Crude proteins	5.45±0.09^a	6.90±0.50^b

Total fat	2.80±0.0^a	2.64±0.0^a
Total carbohydrates	65.98±3.18^a	70.36±2.88^b
Digestible carbohydrates	43.18±3.81^a	42.71±2.90^b
Minerals (mg/g dry weight)		
Sodium (Na^+)	12.65±1.08^a	28.90±1.80^b
Potassium (K^+)	7.05±0.50^a	7.95±0.56^a
Calcium (Ca^{++})	4.84±0.89^a	10.89±1.23^b
Magnesium (Mg^{++})	2.45±0.09^a	5.09±0.34^b
Iron (Fe)	2.10±0.0^a	3.10±0.06^b
Zinc (Zn)	1.78±0.01^a	2.33±0.0^b
Cupper (Cu)	4.67±0.06^a	9.87±0.69^b
Manganese (Mn)	2.03±0.0^a	4.67±0.80^b
Secondary metabolites (mg/g dry weight)		
Flavonoids	3.20±0.09^a	6.88±0.86^b
Alkaloids	5.23±0.80^a	5.66±0.90^a
Tannins	12.10±1.12^a	18.23±1.35^b
Saponins	1.86±0.0^a	1.99±0.0^a
Total phenols	18.45±1.45^a	33.09±2.10^b

d. Nutritional values of *E. colona* and *E. stagnina*

Four categories were measured to detect the forage quality of the studied *Echinochloa* grasses: total digestible nutrients, nutritive value, caloric value and potential energy (Figure 4 a, b). *E. colona* had the highest total digestible energy (TDN) (60.55%) and nutritive value (11.11%) while *E. stagnina* had the highest caloric value (219.72 kcal/100 g dry matter) and potential energy (315.21 kcal/100 g dry matter). The value of TDN is low in the two *Echinochloa* species as compared with the value of 66.55% reported by [39] but close similar (61.7%) to that recommended for sheep by NRC [40]. The nutritive value, caloric value and potential energy in the studied *Echinochloa* species exceeds the requirements for cattle as recommended by NRC [40].

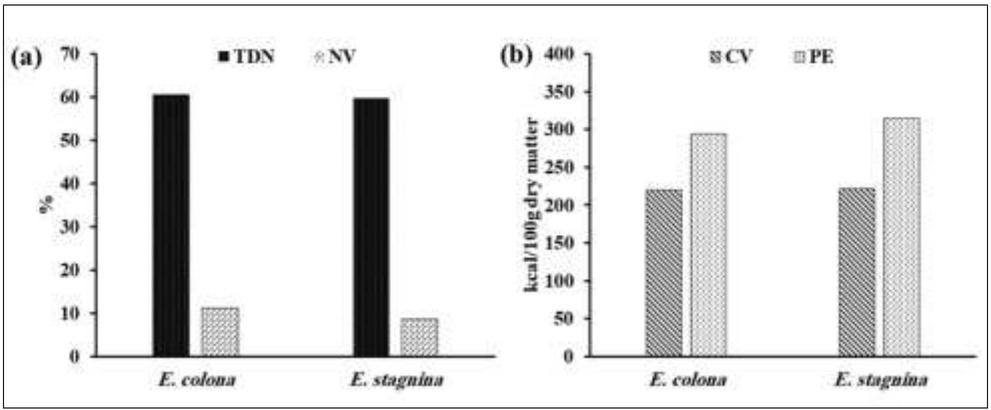

Fig 4: Energy categories a) total digestible nutrients (TDN) and nutritive value (NV), and b) caloric value (CV) and potential energy (PE) of *E. colona* and *E. stagnina*.

4. Conclusion

The aboveground grazeable shoots of *Echinochloa stagnina* had high proximate composition, minerals and secondary metabolites than *E. colona*. However, the two *Echinochloa* species are rich-source in nutrients and showed great energy value. Therefore, the studied grasses are candidates as feed for livestock or as supplementary feed but after detailed toxicological studies.

5. References

1. Chandrasekaran B, Annadurai K, Somasundaram E. A textbook of Agronomy. New Age International Limited, New Delhi, 2010.
2. Strömberg CA. Evolution of grasses and grassland ecosystems. Annual Review of Earth and Planetary Sciences 2011;39:517-544.
3. Heneidy SZ, Halmy MW. The nutritive value and role of *Panicum turgidum* Forssk. in the arid ecosystems of the Egyptian Desert. Acta Botanica Croatica 2009;68(1):127-146.
4. Mashaly IA, Abdelaal M, Elias F. Habitat and nutrient status of two grasses: *Paspalidium geminatum* (Forssk.) Stapf and *Panicum repens* L. in Nile Delta, Egypt. Mansoura Journal of Biology 2015;40:67-77.
5. Alarcón-Reverte R, García A, Watson SB, Abdallah I, Sabaté S, Hernández MJ, Fischer AJ. Concerted action of target-site mutations and high EPSPS activity in glyphosate-resistant junglerice (*Echinochloa colona*) from California. Pest Management Science 2015;71(7):996-1007.
6. Peerzada AM, Bajwa AA, Ali HH, Chauhan, BS. Biology, impact, and management of *Echinochloa colona* (L.) Link. Crop Protection 2016;83:56-66.
7. Wu H, Walker S, Osten V, Taylor I, Sindel B. Emergence and persistence of barnyard grass (Echinochloa colona L. Link) and its management options in sorghum. In 14th Australian Weeds Conference Papers and Proceedings'.Eds BM Sindel, SB Johnson) 2004, 538-541).
8. Mahajan G, Chauhan BS, Gill MS. Dry-seeded rice culture in Punjab State of India: lessons learned from farmers. Field Crops Research 2013;144:89-99.
9. Hegazy AK, Fahmy GM, Ali MI, Gomaa NH. Vegetation diversity in natural and agro-ecosystems of arid lands. Community Ecology 2004;5(2):163-176.
10. Michieka RW. A general overview of Kenya's most

problematic grassy weeds. Tropical Grassy Weeds 1991, 179-182.
11. Chauhan BS, Johnson DE. Seed germination ecology of junglerice (*Echinochloa colona*): a major weed of rice. Weed Science 2009;57(3):235-240.
12. Manidool C. Echinochloa colona (L.) Link L. Minute, R.M. Jones (Eds.), Plant Resources of South-east Asia, Pudoc Scientific Publishers, Wageningen 1992, 303.
13. Yabuno T. Biosystematics of *Echinochloa stagnina* (Retz.) P. Beauv., cytological relationship between the 12- and 14-ploid strains. Genetica 1970;41:311-315.
14. Leauthaud C, Hiernaux P, Musila W, Kergoat L, Grippa M, Duvail S, Rode NO. Influence of floods and growth duration on the productivity of wet grasslands of *Echinochloa stagnina* (Retz) P. Beauv. in an East African Floodplain. Wetlands 2019;39(5):935-944.
15. Quattrocchi U. CRC World Dictionary of Grasses: Common names, scientific names, eponyms, synonyms, and etymology. CRC Press, Taylor and Francis Group, Boca Raton, USA, 2006.
16. Ado MN, Michot D, Guero Y, Hallaire V, Lamso ND, Dutin G. *Echinochloa stagnina* improves soil structure and phytodesalinization of irrigated saline sodic Vertisols. Plant and Soil 2019;434(1-2):413-24.
17. Barbiero L, Valles V, Régeard A, Cheverry C. Residual alkalinity as tracer to estimate the changes induced by forage cultivation in a non-saline irrigated sodic soil. Agricultural water management 2001;50(3):229-241.
18. Ado MN, Guero Y, Michot D, Soubeiga B, Kiesse TS, Walter C. Phytodesalinization of irrigated saline Vertisols in the Niger Valley by *Echinochloa stagnina*. Agricultural Water Management 2016;177:229-240.
19. Boulos L. Flora of Egypt Checklist. Al Hadara Publishing. Cairo, Egypt, 2009.
20. Burt R. Soil Survey Laboratory Methods Manual. Soil Survey Investigation Report, Version 4.0. Washington: NRCS-USDA, 2004.
21. AOAC. Official methods of analysis, 15th Edition. Association of Official Analytical Chemists, Arlington, Virginia, 2000.
22. Harborne JB. Phytochemical Methods: A Guide to Modern Techniques of Plant Analysis, 2nd ed. Chapman and Hall, New York, 1984.
23. Obadoni, BO, Ochuko PO. Phytochemical studies and comparative efficacy of the crude extracts of some homostatic plants in Edo and Delta States of Nigeria. Global Journal of Pure and Applied Sciences 2001;8:203-208.
24. Sadasivam S, Manickam A. Biochemical methods. 3rd ed. New Age International. Limited, New Delhi, 2008.
25. Abu El-Naga MA, El-Shazly K. The prediction of the nutritive value of animal feeds from chemical analysis. Journal of Agricultural Science 1971;77:25-37.
26. Onyeike EN, Olungwe T, Uwakwe AA. Effect of heat-treatment and defatting on the proximate composition of some Nigerian local soup thickeners. Food Chemistry 1995;53(2):173-175.
27. FAO. Food analysis. Food and Agricultural Association. Rome, 2001.
28. Shaltout KH, El-Sheikh MA. Vegetation-environment relations along watercourses in the Nile Delta region. Journal of Vegetation Sciences 1993;4(4):567-570.
29. Helalia AM, El-Amir S, Abo-Zeid ST, Zaghloul KF. Bio-reclamation of saline- sodic soil by amshot grass in Northern Egypt. Soil and Tillage Research 1992;22(1-2):109-115.
30. Mousa ME. Productivity of aquatic grass (*Echinochloa stagnina* L.) under different row spacings and nitrogen levels in saline soil. Zagazig Journal of Agriculture Research 1995;22(3):617-630.
31. Shaltout KH, Sharaf El-Din A, El-Sheikh MA. Species richness and phenology of vegetation along the irrigation canals and drains in the Nile Delta, Egypt. Vegetatio 1994;112:35- 43.
32. Shaltout KH, Sharaf El-Din A, Ahmed DA. Plant life in the Nile Delta. Tanta University Press, Tanta, Egypt, 2010.
33. Grinberga L. Macrophyte species composition in streams of Latvia under different flow and substrate conditions. Estonian Journal of Ecology 2011;60(3):194.
34. Keyata EO, Tola YB, Bultosa G, Forsido SF. Proximate, mineral, and anti-nutrient compositions of underutilized plants of Ethiopia: Figl (*Raphanus sativus* L.), Girgir (*Eruca sativa* L) and Karkade (*Hibiscus sabdariffa*): Implications for in-vitro mineral bioavailability. Food Research International 2020;137:109724.
35. DeVries JW, Camire ME, Cho S, Craig S, Gordon D, Jones JM, Tungland BC. The definition of dietary fiber. Cereal Food World 2001;46(3):112-129.
36. Rios RV, Pessanha MDF, Almeida PFD, Viana CL, Lannes SC. Application of fats in some food products. Food Science Technology 2014;34(1):3-15.
37. Aberoumand A, Deokule SS. Studies on nutritional values of some wild edible plants from Iran and India. Pakistan Journal of Nutrition 2009;8(1):26-31.
38. Roy A. A review on the alkaloids an important therapeutic compound from plants. International J. of Plant Biotechnol 2017;3(2):1-9.
39. Heneidy SZ. Role of indicator range species as browsing forage and effective nutritive source, in Matrouh area, a Mediterranean Coastal region, NW-Egypt. Online Journal of Biological Sciences 2002;2(2):136-142.
40. NRC. Nutrient requirements of domestic animals: nutrient requirements of beef cattle: (6th ed). Research Council Pamphlets. Research No 4. National Academy of Science, Washington DC, 1984.