International Journal of Plant & Soil Science

Volume 35, Issue 21, Page 879-885, 2023; Article no.IJPSS.109002
ISSN: 2320-7035

Ultimate Analysis of Water Chestnut (*Trapa natans Var. bispinosa* Roxb) Affected by Various Inorganic and Organic Sources

Sarjesh Kumar Meena [a++*], Deepa H. Dwivedi [a#], Tendul Chouhan [a++], Krishna Jat [a++], Monika Bhanwariya [a++], Dilkush Meena [a++] and Neha [a++]

[a] *Department of Horticulture, BBAU (Central University), Lucknow, Uttar Pradesh-226025, India.*

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJPSS/2023/v35i214057

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here:
https://www.sdiarticle5.com/review-history/109002

Original Research Article

Received: 01/09/2023
Accepted: 02/11/2023
Published: 04/11/2023

ABSTRACT

The present investigation aimed to know the impact of various organic and inorganic fertilizers on the Ultimate parameters of water chestnuts. The ultimate analysis included the percentage of nitrogen, hydrogen, carbon, sulfur, protein, carbon-hydrogen ratio, and carbon–nitrogen ratio from kernels, fruit peel, and chestnut plants. For kernels, T_4 (Nano-Urea @ 4.0%) had the greatest percentages of Nitrogen (1.99), Carbon (41.95), Hydrogen (6.767), Sulphur (0.244), Carbon-Hydrogen ratio (6.20), and Protein (12.44). T_2 (½ RDF Nutrient + DAP) had the highest Carbon-Nitrogen ratio (23.26). The largest percentages of nitrogen (2.51), sulfur (0.342), and protein (15.69)

[++] *Research Scholar;*
[#] *Professor;*
**Corresponding author: E-mail: SARJESHMEENA5757@gmail.com;*

were found in T_5 (Jivamrut @ 10%) for peel estimate, whereas T_1 (Control) exhibited the highest ratios of carbon to nitrogen (21.27) and carbon-hydrogen (7.22). T_2 (½ RDF -Urea + DAP) had the highest proportion of hydrogen (5.53), whereas T_6 (RDF) had the highest percentage of carbon (39.33). In contrast, T_6 (RDF) had the largest percentages of carbon (36.75), hydrogen (5.29), and carbon-hydrogen ratio (19.02) for the chestnut plant. T_5 (Jivamrut @ 10%) had the highest percentages of nitrogen (2.68), sulfur (0.588), carbon-hydrogen ratio (6.93), and protein (16.75).

Keywords: Ultimate analysis; carbon-hydrogen ratio; carbon-nitrogen ratio; protein.

1. INTRODUCTION

Water chestnut (*Trapa natans*) belongs to the family *Trapaceae,* one the free-floating plants, grown in shallow water fields, ponds, or swampy lands in tropical and sub-tropical countries [1]. The interesting feature of water chestnut is the color and shape of its outer cover in which the kernel is encased. The water chestnut meat is covered with a thick jet-black outer pericarp shaped like a horn protruding from the head of a buffalo. The outer pericarp is hard, making it quite difficult to peel off to obtain the internal white fruit [2]. The fruit is used as a substitute for cereal in the Indian subcontinent during fasting days. The fruit is dried and the flour prepared from it is easily digestible with negligible fat content and helps the diet [3]. *T. natans* has a wide native range extending from Western Europe and Africa to Eastern and Southeastern Asia. The species has been introduced into North America and Australia. *T. natans* is on the Red List of Threatened Species in many European countries and is included in the Bern Convention on the Conservation of European Wildlife and Natural Habitats [4].

It comprises floating-rooted annual aquatic herbs that are typically found in slow-moving or stagnant waterways with significant water level variations [5]. The plant produces three different kinds of leaves: rhombic floating leaves with serrated borders, and thin submerged leaves. Fruit is a triangular-shaped, single-seeded drupe with 2-4 distinguishing horns. According to [6] seeds are high in water (22.5%), protein (15%), and carbohydrate (52%). Water chestnut was an essential food source for people (especially during the Neolithic Period) and certain livestock (mostly pigs) because of its high nutritional content. In several Southeast Asian nations, water chestnut aquaculture is still practiced today [7-9]. The plant is an invasive weed species in the United States; its dense stands make it difficult to navigate lakes and canals, and it shadows out and impedes the growth of other macrophytes. Its fruit decomposes quickly, which worsens the water's quality, promotes eutrophication, and decreases the amount of water that is useful [10].

Water chestnut flour thus can be a good replacement for wheat flour concerning Celiac disease caused by indigestion of gluten (wheat protein). Demand for water chestnut flour rises during the *Navratras* and other fasting and sacred days when the consumption of wheat flour is avoided [3]. In India, drying of whole water chestnuts is done following old traditional methods comprising sun drying of whole water chestnuts followed by roasting in the sand in large iron pans which account for huge losses of time, a product having low yield and in addition produces a product of low quality [11].

Water chestnut is cultivated by the local farmers on the wetland site over an approximate area of 250 Ha. However, in a survey conducted in 2021-22 (Srivastava, 2022, Mishra 2022) it was found that the local farmers are doing indiscriminate applications of chemicals in the form of fertilizers, pesticides, and insecticides with the sole objective of high yield (Garg et at. 2020) Chemical fertilizers like Urea and Diammonium phosphate are applied at three times the recommended doses. To overcome this the farmers, treat the fruit with a bleaching agent to improve its appearance so that the market acceptability is high. It is hypothesized that varying doses of chemical fertilizers, Nano urea, and Jivamrut could improve the performance of the crop without affecting its overall yield.

2. MATERIALS AND METHODS

1. Sample Preparation

Fruit plants were randomly selected from farmer fields, and then a sharp knife was used to extract the kernels from the skin. After collection of these samples, seeds and fruit peels were cleaned and washed properly by using potable water to remove impurities and dirt from the seeds and peels' surface. Obtaining fine particles from the fruit seeds and peels requires milling, which is possible after only lowering the moisture content up to a desired level [12]. Therefore, the seeds were dried in a tray drier at 60°C for 48 h and to get better heat transfer efficiency, the seeds were pulverized in a pulverizer to obtain a suitable particle size (less than 1.0 mm). The obtained materials were sieved using a shaker to obtain identical particle sizes which were taken for further characterization [13]. 200 gm samples of each treated treatment were prepared after the kernels had been granted with a grander and power sieved through a 500-micrometer diameter sieve after 24 hours.

2. Treatment Details

Three replications and six treatments are included in experiments conducted using a completely randomized design. In this experiment, six treatments were carried out: T_1 Control, T_2 ½ RDF (Urea + DAP), T_3 ½ RDF (Urea + DAP) 19, T_4 Nano-Urea @ 4.0%, T_5 Jivamrut @ 10%, and T_6 RDF.

3. Ultimate Analysis

Nitrogen %: Nitrogen was determined using the micro-Kjeldahl method. About 2 g of dried sample was transferred into a digestion tube by adding 2 tablets of catalyst and 20 mL of sulfuric acid to digestion in 30 min using a Kjeldahl digester (Tecator Kjeltec System, Germany) at a minimum temperature of 400°C. After that, 50 mL of distilled water was added for distillation using Kjeldahl distillation. Then, the sample was titrated with hydrochloric acid (0.20 N) to calculate the amount of HCL present in the NaOH solution (40%). The boric acid solution (4%) was used for the catalyst reagent. The percentages of nitrogen were converted to protein by multiplying by 6.25.

Carbon %: Carbon determination: Weigh a portion of the dried fruit sample (usually around 0.5-1.0 grams). Carbon analysis can be done using techniques like dry combustion using techniques like dry combustion (usually around 900-1000°C) or using a carbon analyzer. (Lussier et al*.* 1994).

Hydrogen %: The same combustion process can be used to estimate the hydrogen content in the sample. In this step, the combustion products containing carbon dioxide are removed from the apparatus. The remaining residue, which contains water vapor, is subjected to further high-temperature heating (generally around 700-800°C) in the presence of a catalyst, such as copper or nickel. The water vapor in the residue is then converted into hydrogen gas (H_2), which can be captured and measured using suitable techniques like gas chromatography [14].

Sulphur %: A known quantity of water chestnut is burnt completely in a current of oxygen. Ash, thus obtained, contains Sulphur of the water chestnut as sulfate which is extracted with diluted hydrochloric acid. The extract is treated with barium chloride to precipitate the sulfate as barium sulfate [15].

C/N Ratio: The ratio of C/N is determined by the formula weight of total carbon divided by the weight of total nitrogen from the selected sample.

C/H Ratio: Once the carbon and hydrogen percentages are determined, the C-H ratio can be calculated by dividing the percentage of carbon by the percentage of hydrogen.

Protein %: The extracted soluble fraction from the Fibre bag system was examined for various food and paper wastes using the Lowry technique [16], calibrated on bovine serum albumin.

4. Statistical analysis

The data recorded for evaluation of different treatments in tomato and cucumber was statistically analyzed using the standard procedure as suggested by Panse and Sukhatme (1985) for analysis of the variance of F (CBD) to test the significance.

3. RESULTS

3.1 Ultimate Analysis

For Kernels: According to the results of the current examination (Table 1), the most significant percentages of Nitrogen (1.99), Carbon (41.95), Hydrogen (6.767), Sulphur (0.244), Carbon-Hydrogen ratio (6.20), and Protein (12.44) were found in T_4 (Nano-Urea @ 4.0%). In contrast, the highest Carbon-Nitrogen ratio (23.26) was found in T_2 (½ RDF Nutrient + DAP). However, T_1 (Control) had the lowest percentages of Nitrogen (1.74), Carbon (37.84), Sulphur (0.161), and Carbon-Hydrogen ratio (5.93). In contrast, T_2 (½ RDF -Urea + DAP) had the lowest percentages of Protein (10.63), and T_5 (Jivamrut @ 10%) had the lowest percentages of Hydrogen (6.35) and Carbo- Nitrogen ratio (20.02).

Table 1. Ultimate analysis of the water chestnut (*Trapa natans* Var. *bispinosa* Roxb)

Kernels							
Treatment	**N%**	**C%**	**H%**	**S%**	**C/Nratio**	**C/H ratio**	**Protein**
T_1	1.74	37.84	6.378	0.161	21.7633	5.9319	10.88
T_2	1.78	39.61	6.39	0.2	23.2669	6.1991	10.63
T_3	1.94	39.79	6.423	0.23	20.4999	6.1952	12.13
T_4	1.99	41.95	6.767	0.244	21.0789	6.2001	12.44
T_5	1.97	39.19	6.354	0.215	20.0222	6.1677	12.25
T_6	1.96	41.2	6.648	0.198	20.9825	6.1974	12.25
CD	**0.054**	**1.423**	**0.248**	**0.006**	**0.637**	**N/A**	**0.409**
SEM	**0.017**	**0.457**	**0.08**	**0.002**	**0.204**	**0.069**	**0.131**

Note – *T_1 Control, T_2 : ½ RDF (Urea + DAP), T_3 : ¼ RDF (Urea + DAP), T_4 : Nano-Urea @ 4.0%. , T_5:Jivamrut@ 10 % , T_6 : RDF*

Table 2. Ultimate analysis of the water chestnut (*Trapa natans* Var. *bispinosa* Roxb*)*

Fruit peel							
Treatment	**N%**	**C%**	**H%**	**S%**	**C/N ratio**	**C/H ratio**	**Protein**
T_1	1.84	39.07	5.405	0.239	21.2763	7.2281	11.50
T_2	2.08	38.32	5.533	0.274	18.3977	6.9259	13.00
T_3	1.93	37.4	5.441	0.271	19.363	6.8748	12.06
T_4	2.21	37.85	5.44	0.293	17.1116	6.9572	13.81
T_5	2.51	37.45	5.439	0.342	14.9378	6.8859	15.69
T_6	1.92	39.33	5.483	0.258	20.5182	7.174	12.00
CD	**0.069**	**N/A**	**N/A**	**0.009**	**0.685**	**0.231**	**0.706**
SEM	**0.022**	**0.474**	**O.O6**	**0.003**	**0.22**	**0.074**	**0.227**

Note – *T_1 Control, T_2 : ½ RDF (Urea + DAP), T_3 : ¼ RDF (Urea + DAP), T_4 : Nano-Urea @ 4.0%. , T_5:Jivamrut@ 10 % , T_6 : RDF*

Table 3. Ultimate analysis of the water chestnut (*Trapa natans* Var. *bispinosa* Roxb*)*

Plant							
Treatment	**N%**	**C%**	**H%**	**S%**	**C/N ratio**	**C/H ratio**	**Protein**
T_1	2.17	35.08	5.077	0.298	16.1873	6.9107	13.56
T_2	1.05	17.39	2.532	0.123	16.5017	6.8668	6.56
T_3	1.03	17.05	2.168	0.121	14.0654	0.5864	6.44
T_4	1.24	16.87	2.488	0.228	13.5651	6.7796	7.75
T_5	2.68	25.71	3.706	0.588	9.6087	6.9384	16.75
T_6	1.93	36.75	5.298	0.333	19.0286	6.9374	12.06
CD	**0.06**	**0.993**	**0.131**	**0.009**	**0.639**	**0.221**	**0.428**
SEM	**0.019**	**0.319**	**0.142**	**0.003**	**0.205**	**0.071**	**0.137**

Note – *T_1 Control, T_2 : ½ RDF (Urea + DAP), T_3 : ¼ RDF (Urea + DAP), T_4 : Nano-Urea @ 4.0%. , T_5:Jivamrut@ 10 % , T_6 : RDF*

For Peels: The results of the current examination (Table 2) showed that T_5 (Jivamrut @ 10%) had the highest percentages of nitrogen (2.51), sulfur (0.342), and protein (15.69), while T_1 (Control) had the highest ratios of carbon to nitrogen (21.27) and carbon-hydrogen ratio (7.22). The highest percentage of hydrogen (5.53) was recorded in T_2 (½ RDF -Urea + DAP), whereas the highest percentage of carbon (39.33) was seen in T_6 (RDF). On the other hand, T_1 (control) had the lowest percentages of nitrogen (1.84), hydrogen (5.40), sulfur (0.239), and protein (11.50). T_3 (¼ RDF -Urea + DAP) had the lowest percentage of carbon (37.40) and the lowest carbon-hydrogen ratio (6.87), whereas T_4 (nano-urea @ 4.0%) had the lowest carbon-nitrogen ratio (17.11).

For Chestnut Plant: The current examination's results (Table 3) demonstrated that T_5 (Jivamrut @10%) had the highest percentages of nitrogen (2.68), sulfur (0.588), carbon-hydrogen ratio

(6.93), and protein (16.75), while T_6 (RDF) had the highest percentages of carbon (36.75), hydrogen (5.29), and carbon-hydrogen ratio (19.02). Conversely, T_3 (¼ RDF -Urea + DAP) had the lowest percentages of nitrogen (1.03), hydrogen (2.16), sulfur (0.121), carbon-hydrogen ratio (0.58), and protein (6.44%), whereas T_4 (Nano-Urea @ 4.0%) had the lowest percentages of carbon (16.87) and carbon-nitrogen ratio (13.56).

4. DISCUSSION

Emissions of carbon, hydrogen, oxygen, nitrogen, and sulfur are evaluated as part of the ultimate evaluation. According to Thipkhunthod et al*,* [17] and Tao et al*.,* [18] the two most significant readings among the many biomass attributes are the contents of energy-carrying chemical bonds between the most prevalent ultimate components and the overall ash content. Carbon is one of the most important elements in the combustion process. Favorable carbon content in biomass composition is exceptionally important because its increased presence boosts the heating value of biomass [19]. Moreover, the consistency of the analyzed data is evident when they are compared with the investigations conducted by Garcia et al. [20] on pruned biomass of apples, almonds, apricots, and cherries. These investigations determined the level of carbon between 43.25 to 59.59% while Varol et al. [21] and Kaynak [22] and Akalin et al. [23] determined it between 46.44 to 52.38% in peach, apricot, and cherry stone. Reduced hydrogen content may represent a problem because, together with carbon, hydrogen is essential for determining the energy properties of solid biofuels [24] the oxygen content in apricot, plum, and peach stones is below the values of literature data (38.78- 42.40%), but higher in cherry stones (Atimtay and Kaynak, 2008; Garcia et al., [20], Akalin et al., [23]). Also, since nitrogen content, together with sulfur, influences the emissions of harmful gases (NOx and SO2) during biomass combustion (Sáez Angulo and Martínez García, 2001; Garcia et al*.,* [20]), concentrations of these gases should be as low as possible. Garcia et al. [20], Atimtay and Kaynak (2008), and Vassilev et al. [25] determined the nitrogen and sulfur content in pruned biomass of cherry, grapevine, and apple (0.52–0.81%; 0.17- 0.46%, respectively) as well as their content in plum, apricot, and peach stone (0.52– 0.81%; 0.17-0.46% respectively). As the heating process progresses, there will be a decrease in the protein content in the food. Proteins that are heated will experience the Maillard reaction, which will increase the solubility of protein levels and protein structures will be denatured [26-30].

5. CONCLUSION

Water chestnut is a minor fruit crop of India it is a tremendous nutritive fruit among unadopted fruit crops. water chestnuts are a starchy, low-fat, and low-protein food with a notable moisture content. They are a source of dietary fiber and various minerals. The composition of fruit pulp, kernels, and plant parts will differ, and the ultimate analysis can provide more precise information on their nutritional content. Present-time ultimate analysis is a modern and popular method to detect many nutrients in one attempt. In the present investigation, the ultimate result was found superior in treatment T_5 (Jivamrut) and minimum T_1 (control).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Takano A, Kadono Y. Allozyme variations and classification of Trapa (Trapaceae) in Japan. Aquatic Botany. 2005;83(2):108-118.
2. Tulyathan V, Boondee K, Mahawanich T. Characteristics of starch from water chestnut (*Trapa bispinosa* Roxb.). Journal of Food Biochemistry. 2005;29(4):337-348.
3. Puste AM. Agronomic management of wetland crops. Kalyani Publishers; 2004.
4. Džigurski D, Ljevnaić-Mašić B, Nikolić Lj. Trapetum natantis Müller et Görs 1960 in hydromeliorative facilities in Serbia. - Acta Societatis Botanicorum Poloniae. 2013;82 (2):125-133.
   DOI: 10.5586/absp.2013.008
5. Gond M, Dwivedi DH, Singh N, Dwivedi SK. August. Morphological characterization and SEM analysis of intervarietal variability in water chestnut (Trapa natans var. bispinosa Roxb.) collections. In XXX International Horticultural Congress IHC2018: V International Symposium on Plant Genetic Resources and International 1297. 2018;181-186.
6. Marković G, Vićentijević-Marković G, Tanasković S. First record of water chestnut (*Trapa natans* L., Trapaceae,

Myrtales) in Central Serbia. Journal of Central European Agriculture; 2015.
7. Ishida H, Shibata T, Shibata S, Tanaka Y, Sasaki H, Kubo E. Lutein plus water chestnut (*Trapa bispinosa* Roxb.) extract inhibits the development of cataracts and induces antioxidant gene expression in lens epithelial cells. BioMed Research International; 2020.
8. Jana BR, Bhatt BP, Singh IS, Idris M. A study on commercial cultivation and storage of water chestnut (*Trapa natans* L.) under wetland ecosystem of North Bihar, India. Journal of Applied and Natural Science. 2019;11(2):528-33.
9. Taher MA, Zouidi F, Kumar P, Abou Fayssal S, Adelodun B, Goala M, Kumar V, Andabaka Ž, Širić I, Eid EM. Impact of Irrigation with Contaminated Water on Heavy Metal Bioaccumulation in Water Chestnut (*Trapa natans* L.). Horticulturae. 2023 Feb 2;9(2):190.
10. Borojević K. Kulturna istorija vodenog oraha (*Trapa natans* L.) od preistorije do danas. - Rad Muzeja Vojvodine. 2009;51:159-173. (in Serbian).
11. Balraj J, Subramaniam S, Mohtar M, et al. Proximate Composition, Minerals, and Vitamins of the Culinary-Medicinal Tiger's Milk Mushroom, *Lignosus rhinocerus* (Agaricomycetes), from Sabah, Malaysia. International Journal of Medicinal Mushrooms. 2019;21(1): 49-55.27
12. Prasad N, Thakur P, Pal DB. Cadmium removal from aqueous solution by jackfruit seed bio-adsorbent. Springer Nat Appl Sci. 2020;2:1018.
13. Poletto M, Zattera AJ, Forte MMC, Santana RM. Thermal decomposition of wood: Influence of wood components and cellulose crystallite size. Bioresour Technol. 2012;109:148–153
14. Teixeira L, Ferreira Á, Ashburner M. The bacterial symbiont Wolbachia induces resistance to RNA viral infections in Drosophila melanogaster. PLoS Biology. 2008;6(12):e1000002.
15. Chakraborty H, Gu H. A mixed model approach for intent-to-treat analysis in longitudinal clinical trials with missing values; 2009.
16. Classics Lowry O, Rosebrough N, Farr A, Randall R. Protein measurement with the Folin phenol reagent. J Biol Chem. 1951;193(1):265-75.
17. Thipkhuntho, P, Meeyoo V, Rangsunvigit P, Kitiyanan B, Siemanond K, Rirksomboon T. Predicting the heating value of sewage sludges in Thailand from proximate and ultimate analyses. Fuel. 2005;84(7-8):849-857.
18. Tao S, Monteiro APA, Thompson IM, Hayen MJ, Dahl GE. Effect of late-gestation maternal heat stress on growth and immune function of dairy calves. Journal of Dairy Science. 2012;95(12):pp.7128-7136.
19. Thek G, Obernberger I. Wood pellet production costs under Austrian and in comparison to Swedish framework conditions. Biomass and Bioenergy. 2004;27(6):671-693.
20. Garcia A, Rhoden SA, Bernardi-Wenzel J, Orlandelli RC, Azevedo JL, Pamphile JA. Antimicrobial activity of crude extracts of endophytic fungi isolated from medicinal plant *Sapindus saponaria* L. Journal of Applied Pharmaceutical Science. 2012;2(10).035-040.
21. Varol M, Atimtay AT, Bay B, Olgun H. Investigation of co-combustion characteristics of low-quality lignite coals and biomass with thermogravimetric analysis. Thermochimica Acta. 2010;510 (1-2):195-201.
22. Kaynak H, Hartley JL. A replication and extension of quality management into the supply chain. Journal of Operations Management. 2008;26(4):468-489.
23. Akalin A, Kormaksson M, Li S, Garrett-Bakelman FE, Figueroa ME, Melnick A, Mason CE,. methylKit: A comprehensive R package for the analysis of genome-wide DNA methylation profiles. Genome Biology. 2012;13(10):1-9.
24. Obernberger I, Brunner T, Bärnthaler G. Chemical properties of solid biofuels—Significance and impact. Biomass and Bioenergy. 2006;30(11):973-982.
25. Vassilev SV, Baxter D, Andersen LK, Vassileva CG. An overview of the chemical composition of biomass. Fuel. 2010;89(5):913-933.
26. Muchtadi-Alamsyah I, Yuliawan F. Basis conversion in composite field. International Journal of Mathematics and Computation. 2013;16(2).
27. Anwar F, Zainol ZA, Abdul Hamid A. Proximate composition, nutritional properties and potential applications of *Moringa oleifera* Seeds: A review. Foods. 2021;10(4):776.
28. Kamal K. Taha, Fahad M. Al Ghtani, Determination of the elemental contents of

date palm (*Phoenix dactylifera* L.) from Kharj Saudi Arabia. World Scientific News. 2015;12:125-135.
29. Poletto M, Zattera AJ, Santana RM. Thermal decomposition of wood: kinetics and degradation mechanisms. Bioresource Technology. 2012;126:7-12.
30. Prasad S, Singh A, Korres NE, Rathore D, Sevda S, Pant D. Sustainable utilization of crop residues for energy generation: A life cycle assessment (LCA) perspective. Bioresource Technology. 2020;303:122964.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/109002