

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

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, T₄ (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). T₂ (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) were found in T₅ (Jivamrut @ 10%) for peel estimate, whereas T₁ (Control) exhibited the highest ratios of carbon to nitrogen (21.27) and carbon-hydrogen (7.22). T₂ (½ RDF -Urea + DAP) had the highest proportion of hydrogen (5.53), whereas T₆ (RDF) had the highest percentage of carbon (39.33). In contrast, T₆ (RDF) had the largest percentages of carbon (36.75), hydrogen (5.29), and carbon-hydrogen ratio (19.02) for the chestnut plant. T₅ (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

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 (Takano & Kadono, 2005). 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 (Tulyathan, Boondee, & Mahawanich, 2005). 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 (Puste, 2004). *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 (Džigurskiet *al.*, 2013).

It comprises floating-rooted annual aquatic herbs that are typically found in slow-moving or stagnant waterways with significant water level variations (Gond *et.al.*,2018). 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 (Marković *et. al.* 2015) 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(Ishidet. *al.*, 2020) 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 (Borojević, 2009).

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 (Puste,2004). 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(Balwajet. *al.*,2019)

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.

Material 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 (Prasad *et. al.*, 2020). 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 (Poletto *et. al.*, 2012). 200gm 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: T₁ Control, T₂ ½ RDF (Urea + DAP), T₃ ½ RDF (Urea + DAP) 19, T₄ Nano-Urea @ 4.0%, T₅ Jivamrut @ 10%, and T₆ 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 (TecatorKjeltec 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 (H₂), which can be captured and measured using suitable techniques like gas chromatography. (Teixeira *et. al.*, 2008).

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. (Chakraborty *et. al.*, 2009).

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 (Lowry *et al.*, 1951), 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.

Result

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 T₄ (Nano-Urea @ 4.0%). In contrast, the highest Carbon-Nitrogen ratio (23.26) was found in T₂ (½ RDF Nutrient +

DAP). However, T₁ (Control) had the lowest percentages of Nitrogen (1.74), Carbon (37.84), Sulphur (0.161), and Carbon-Hydrogen ratio (5.93). In contrast, T₂ (½ RDF -Urea + DAP) had the lowest percentages of Protein (10.63), and T₅ (Jivamrut @ 10%) had the lowest percentages of Hydrogen (6.35) and Carbo- Nitrogen ratio (20.02).

For Peels

The results of the current examination (Table 2) showed that T₅ (Jivamrut @ 10%) had the highest percentages of nitrogen (2.51), sulfur (0.342), and protein (15.69), while T₁ (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 T₂ (½ RDF -Urea + DAP), whereas the highest percentage of carbon (39.33) was seen in T₆ (RDF). On the other hand, T₁ (control) had the lowest percentages of nitrogen (1.84), hydrogen (5.40), sulfur (0.239), and protein (11.50). T₃ (¼ RDF -Urea + DAP) had the lowest percentage of carbon (37.40) and the lowest carbon-hydrogen ratio (6.87), whereas T₄ (nano-urea @ 4.0%) had the lowest carbon-nitrogen ratio (17.11).

For Chestnut Plant

The current examination's results (Table 3) demonstrated that T₅ (Jivamrut@10%) had the highest percentages of nitrogen (2.68), sulfur (0.588), carbon-hydrogen ratio (6.93), and protein (16.75), while T₆ (RDF) had the highest percentages of carbon (36.75), hydrogen (5.29), and carbon-hydrogen ratio (19.02). Conversely, T₃ (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 T₄ (Nano-Urea @ 4.0%) had the lowest percentages of carbon (16.87) and carbon-nitrogen ratio (13.56).

Discussion

Emissions of carbon, hydrogen, oxygen, nitrogen, and sulfur are evaluated as part of the ultimate evaluation. According to Thipkhunthodet. *al.*, (2005) and Tao *et. al.*, (2012), 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 (Oberberger and Thek, 2004). Moreover, the consistency of the analyzed data is evident when they are compared with the investigations conducted by Garcia *et al.* (2012) 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.*, 2010 and Kaynak (2008) and Akalin *et al.* (2012) 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 (Oberberger and Thek., 2004) 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.*, 2012, Akalin *et al.*, 2012). Also, since nitrogen content, together with sulfur, influences the emissions of harmful gases (NO_x and SO₂) during biomass combustion (Sáez Angulo and Martínez García, 2001; Garcia *et al.*, 2012), concentrations of these gases should be as low as possible. Garcia *et al.* (2012), Atimtay and Kaynak (2008), and Vassilev *et al.* (2010) 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 (Muchtadi *et al.*, 2011, Anwar *et al.*, 2021).

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 T₅ (Jivamrut) and minimum T₁ (control).

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

T₅	1.97	39.19	6.354	0.215	20.0222	6.1677	12.25
T₆	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 : ½RDF(Urea+ DAP), T ₃ : ¼RDF(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							
TREATMEN T	N%	C%	H%	S%	C/Nratio	C/Hratio	Protein
T₁	1.84	39.07	5.405	0.239	21.2763	7.2281	11.50
T₂	2.08	38.32	5.533	0.274	18.3977	6.9259	13.00
T₃	1.93	37.4	5.441	0.271	19.363	6.8748	12.06
T₄	2.21	37.85	5.44	0.293	17.1116	6.9572	13.81
T₅	2.51	37.45	5.439	0.342	14.9378	6.8859	15.69
T₆	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	0.06	0.003	0.22	0.074	0.227
Note –T ₁ Control, T ₂ : ½RDF(Urea+ DAP), T ₃ : ¼RDF(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
T₁	2.17	35.08	5.077	0.298	16.1873	6.9107	13.56
T₂	1.05	17.39	2.532	0.123	16.5017	6.8668	6.56
T₃	1.03	17.05	2.168	0.121	14.0654	0.5864	6.44

T₄	1.24	16.87	2.488	0.228	13.5651	6.7796	7.75
T₅	2.68	25.71	3.706	0.588	9.6087	6.9384	16.75
T₆	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 : ½RDF(Urea+ DAP), T ₃ : ¼RDF(Urea+ DAP), T ₄ :Nano-Urea @4.0%. , T ₅ :Jivamrut@ 10% , T ₆ : RDF							

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