Comparative Nutritive Value of Rubber Seed, Rubber Seed Hull, Seaweed and Water Melon Seed

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Abstract

The goal of the current study was to estimate the approximate compositions of the rubber seed, seaweed, and watermelon seed, as well as their acid detergent fiber (ADF) and neutral detergent fiber (NDF) fractions. Data from each sample was analyzed in the laboratory and then calculated using formula. The findings demonstrated that the studied seeds and weeds can be regarded as significant new sources of crude fiber, crude protein, ether extract, and ADF, NDF in Bangladesh, while the feed and food crisis has been a major issue as a result of rising population and costs. Among these seeds and weeds both watermelon seed (23.38%) and rubber seed (17.94%) are high in crude protein. Additionally, watermelon seed (34.30%) and the hull of rubber seeds (74.08%) contain more crude fiber. Significant amounts of ether extract contain were found in Watermelon seeds which was24.41% and rubber seeds 42.76% The seaweed had a higher Ash content despite having lower CF and CP values. Rubber seed meal includes cyanogen's chemical despite the protein level in rubber seed being very promising. This issue can be avoided by boiling the meal and storing it for a longer period of time, which could boost the nutrients' availability and allow for the use of rubber seed as edible feed and food. Since seeds and weeds contained a significant number of essential components, it was considerate to believe that they may be used as edible food and a potential source of livestock feed.

Key words: ADF, NDF, Proximate Components, Seed & weed.

CHAPTER 1: INTRODUCTION

Due to slowing population growth and high levels of inflation in emerging nations like Bangladesh, there is a greater need for food and feed, which has raised competition for the supply of grain seeds approved for human use and resulted in a shortage and greater costs of sources of protein. Therefore, it is necessary to utilize many available but underutilized seeds in the area, such as rubber seeds, seaweed, watermelon seed.

The rubber tree (*Hevea brasiliensis*), which produces latex, has an economic value in Bangladesh, but its seeds are not used as food (Iyayi et al., 2008). Rubber plantation occupied 226,935 hectares (ha) of land in Bangladesh as of 2019, according to FAO data, with a rubber yield of 100.5 kg/ha. The maximum oil content of rubber seeds from rubber plants, which are regarded as a waste product is 49%. A rubber plantation may generate 217kg of rubber seed oil per hectare per year. The crop density, ecosystem of the surrounding area, type of planting materials used, and soil minerals all affect the yield (Lukman et al., 2018). The seeds are used only as seedling sources otherwise remain underutilized (Lukman et al., 2018). According to certain studies, rubber seed meal is a superior option to protein supplements in livestock diets because it has higher levels of essential nutrients than many traditional seed meals (Udo et al., 2018). Dried kernels might contain anywhere between 35 and 45% oil (George et al., 2000). Rubber seed oil has healthy fatty acid components and a larger proportion of linoleic acid, an essential omega 3 fatty acid for human nutrition. Nevertheless, obstacles have persisted in the use of rubber seeds as a food or feed product. Moreover, in the coastal area of Bangladesh, there is a variety of seaweed species found. According to different sources, there are around 193 to 215 species from 94 to 102 genera. Coastal waters near places like St. Martin's Island and Cox's Bazar contain about 140 to 155 seaweed species each. The western coast of St. Martin's Island is particularly rich in seaweeds. The Bangladesh Fisheries Research Institute (BFRI) has confirmed the presence of 132 seaweed species so far. Among these, there are 10 to 20 commercially important species, with recent studies mentioning 17 significant seaweeds on St. Martin's Island. There are thousands of different species of seaweed that fall under the three main groupings or phyla of seaweed, which are Rhodophyta (red algae), Chlorophyta (green algae), and Phaeophyta (brown algae) (Rindi et al., 2012). All of these seaweeds contain a significant amount of carbohydrates in the form of structural, storage, and functional polysaccharides, which can make up 20–76% of their dry weight (Holdt and Kraan, 2011).The majority of the essential amino acids are generally present in seaweed protein, with significant concentrations of glycine, arginine, alanine, and glutamic acid in particular (Dawczynski et al., 2007). Although seaweed is regarded as a better source of protein in comparison to other protein-rich meals, lysine and cysteine are present in very little amounts. The two most significant lipid subgroups in seaweeds are neutral lipids and glycolipids, and seaweed has a higher concentration of essential fatty acids than the majority of terrestrial plants (Shannon and Abu Ghannam, 2019). However, there can be major differences across species in both the amount and makeup of the fat present in seaweeds. On the other hand, the watermelon (*Citrullus lanatus*), which is a tasty fruit and one of the most economically significant fruits in the Curcurbitaceae family, is ranked among the top ten vegetable crops in the world in terms of economic importance (Sultana & Ashraf, 2019). It is impossible to overstate the usefulness of fresh fruits and vegetables in our daily lives (Olayinka & Etejere, 2018) because they are both nutritious and therapeutic. Considering that it contains 90% water, it is a vital crop during the dry season to supply the demand for water. It has minerals and vitamins (A, B, and C). Different regions of Bangladesh grow watermelon. In our nation, several indigenous watermelon cultivars are grown, including sugar baby, Charleston grey, Crimson red, and others (Rabbany et al., 2013). Watermelon seeds are regarded as being very nourishing.. The watermelon seed has a financial benefit. The seeds are ground into flour and used to make snacks and sauces. The protein-rich watermelon seed contains all nine of the essential amino acids as well as glutamic acid, lysine, and tryptophan. Although watermelon seeds are high in calories, they are low in carbohydrates. Additionally, the seed is a good source of various lipids, including monounsaturated fat, polyunsaturated fat, and omega-6 fatty acids, which help lowering blood pressure. The cooking type, also called cow watermelon, is normally used as animal feed, for cooking thick porridge or mixed in dry maize grain. Watermelon is a valued source of natural antioxidants with special reference to lycopene, ascorbic acid, and citrulline (Zamuz et al., 2021). Despite the various potential applications, unfortunately, there are little or no industrial uses of the watermelon seeds. The seeds are often discarded while the pulp is eaten. There is also limited literature on the nutritional, phytochemical, and antioxidant properties of watermelon seeds. It is in this regard that this study aims to evaluate the elemental and nutritionally valuable properties of watermelon seeds to create awareness of their potential nutritional values and increase their consumption as both food and feed. To eradicate hunger and minimize waste, there is need for continuous discovery, investigation and documentation of unharnessed potential food sources. This report is designed to assess the proximate composition and functionality of these samples to increase its acceptability and awareness as a high nutrient dense seed and suggest possible methods of utilizations for human consumption or at least for livestock feed formulation.

Objectives

The Objectives of this study was to investigate the relative nutrient content of rubber seed, sea weed, and watermelon seed in order to enhance animal nutrition and learn how these components might meet animal needs. Proximate analysis is useful in determining the quality of the samples and in providing significant information.

Chapter 2: Review

Developing a conceptual framework by drawing upon concepts and ideas synthesized from prior literature reviews is vital for effectively structuring a thorough research plan.

Rubber Tree and Rubber Seed

The Euphorbiaceae family includes rubber trees. The rubber tree is a perennial plant that grows quickly. It typically reaches heights of 30 to 40 m with a broad, green crown. The trunk has a smooth surface, a straight, grayish-gray back, and a cylindrical form. Between the ages of 4 and 6 years, the laticiferous structural compartment of the rubber tree begins to produce latex. About 800 to 1000 seeds (1.3 kg) are produced by each tree twice a year. The seed has a little amount of oil for industrial use hidden under a thin, hard shell (Onoji et al., 2016). The trifoliate, spiral leaves measure 3 to 6 cm in width and 10 to 15 cm in length.

The exterior shell of a rubber tree seed is a massive, slightly compressed, shiny, ovoid, 2 to 3.5 x 1.5 to 3.0 cm, weighing around 2 to 4 g, with sporadic dark brown spots, blotches, and lines. The morphologies of the seeds are influenced by capsule pressure. The endosperm has two distinguishable colors, with the whitish pigment denoting a seed's viability and the yellow color representing an older seed.

2.1 Nutritional Composition of Rubber Seed

The rubber seed's lowest moisture content ranges from 1.5 to 2.8% (Lukman et al., 2018). The Rubber seed meal with high moisture concentrations is probably more prone to microbial attack and that seed with low moisture content has a longer shelf life.

Total Ash (TA): According to several sources the rubber seeds' total ash concentration was 2.5%. The majority of outcomes lay between 3% and 5% while the lowest outcome was reported as 0.24% (Sharma et al., 2014).

Crude Fat: According to Lalabe et al., the crude fat content of rubber seeds was 45.50% in a recently completed study, compared to 42.5% (Onwurah et al., 2010). But this outcome is different from those of other publications, which had 68.5% and 38.47%, respectively (Chanjula et al., 2010; Suprayudi et al., 2015). Crude fat content seems to enhance digestibility and affect feed flavor. The change in the percentage of seeds that contain kernels or the methods used to prepare the rubber seed meal could be the cause of the high crude fat content.

2.2 Anti Nutritional factors in Rubber seed

Every edible plant portion contains common harmful substances called anti-nutritional factors. If the quantity is greater than what is safe for ingestion and has inadequate nutritional value, it poses a threat.

Additionally, anti-nutritional elements might cause delayed growth and inhibit normal digestion. The biological components created in edible feed/food that reduce nutrient utilization of edible food intake, in turn, contribute to impair gastrointestinal and metabolic performance, exerting effects that are at odds with the ideal nutrition process, can be referred to as anti-nutritional factors. In addition to having a high protein content, rubber seed also contains many anti-nutritional elements such phytic acid, oxalic acid, tannin, saponin, and trypsin inhibitor. In rubber seed, the cyanogen component is more noticeable. It directly affects the body's amino acids, and when consumed, it may result in an imbalance of amino acids. According to reports, processing edible plant-based foods positively affects the anti-nutritional elements' reduction. The anti-nutritional effects of rubber seed storage have been shown to be reduced after two months, although nutritionists believe this is insufficient. Other strategies have been used as a result to lower the anti-nutritional elements to a safe level for eating.

2.3 Utilization of Rubber seed as feed

Rubber seed meal might be an optional replacement for traditional feedstuffs in terms of its nutritional makeup. Excellent nitrogenous supplies were said to be the main obstacle to the appropriate growth of cattle production in many tropical regions around the world.

The rubber seed, which has 11–35% crude protein, is thought to provide an alternative protein supplement for cattle. Due to its widespread availability throughout the Asia and West Africa regions of the world, rubber seed is used as a feed ingredient for monogastric, ruminant, and aquatic animals. Rubber seed is an essential biomass by-product of rubber plantations in several Southeast Asian and Western African countries.

2.4 Existing development of rubber seed as feed

Numerous studies have been done to improve the use of rubber seed meal on all types of livestock, but no rubber seed-based commercial diets or rations have been created. Aquaculture has been shown to use rubber seed meal more frequently, and with good results. The use of rubber seed-based diets for production in monogastric and ruminant animals has not been adequately investigated.

Seaweed

Aquatic habitats are colonized by seaweeds, which are mostly utilized by coastal populations. Many types of seaweed are typically consumed raw for medicinal purposes, as food for humans and animals, and to improve the fertility of soil for growing crops.

2.5 Seaweed Species

According to Chapman and Chapman (1980; El Gamal, 2012), seaweeds comprise brown algae (Phaeophyceae), red algae (Rhodophyceae), and green algae (Chlorophyceae). They occupy a variety of environments and come in a wide range of sizes, colors, forms, and compositions. While some species form single- or multi-celled colonies and float on the water's surface, others are anchored to rocks or other supporting structures by root-like structures called holdfasts. Instead of having any taxonomic significance, the phrase "seaweed" is more commonly used to refer to the widespread big marine algae. I've reviewed green seaweed here because it is the subject of my study.

2.6 Green Seaweed

The phylum Chlorophyceae, which includes species that are both microscopic and macroscopic, is where the creatures that are often referred to as green algae reside. With more than 13,000 species, they are the most varied category of algae; it is thought that around half of these species are seaweeds.Because their chloroplasts contain chlorophyll, green algae are typically green in color. The harmony between these chlorophylls and other pigments like beta-carotene and xanthophylls determines the color of the plant as a whole. *Ulva*, *Codium*, *Enteromorpha*, *Chaetomorpha*, and *Cladophora* are the principal genera. In places with lots of light, like shallow waterways and tidal pools, green algae are frequent. Species of *Ulva* are known as sea lettuce because of their delicate, vivid green fronds. The *Ulva* species known as *Ulva lactuca*, or water lettuce, has been studied the most. There are several closely related and challenging to distinguish *Ulva* species. They can reach a height of 45 cm and are found in brackish or marine habitats globally in the intertidal zone, notably in estuaries (Edwards et al., 2012). Fast-growing algae are known as ulvoids, which include Ulva and related taxa (Enteromorpha, Chaetomorpha, Cladophora, Rhizoclonium, Percursaria, Ulvaria). Algal blooms known as "green tides" are a significant environmental problem in many nations. Optimal environmental circumstances (temperature, concentration in nutrients) can generate these algal blooms. The entire ulva genus can be eaten (Edwards et al., 2012). The protein concentration of Ulva's biomass is higher than that of other green seaweeds, making it a potential replacement source of proteins for animal feeding. It also contains extremely insoluble dietary fibers (glucans) and soluble fibers. Not just because of its high protein content is this seaweed being researched. In recent years, there has been an increase in both academic and commercial interest in the plentiful and highly sulfated ulvans that are derived from *Ulva*. Ulvan, a heteropolysaccharide of the cell wall, accounts for 9 to 36% of the biomass of Ulva species in dry weight. The components of ulvan, rhamnose, xylose, glucose, uranic acid, and sulfate, control immunological processes and serve as an antibacterial and antioxidant. Its anticoagulant, antiviral,anti-inflammatory, anti-hyperlipidemic, immunomodulatory, and anticancer properties are revealed by a high concentration of this sulfated polysaccharide in *Ulva* sp. Some *Ulva* species are used as feed for livestock and adding *Ulva* to diets in powder form can reduce abdominal and subcutaneous fat, enhance the quality of the meat, and increase the activity of the amylase enzyme in chicken duodenum. Since animal metabolism of this nutrient is inefficient, it is difficult to use *Ulva* as food or animal feed because the bioavailability of the polysaccharides has remained unchanged. In general, this chemical restriction makes *Ulva* ineffective for use as a single feed for animals.

2.7 Uses

Seaweeds have a variety of purposes. They are eaten as food in a variety of civilizations, particularly in Asia. Nori, or red seaweed (Pyropia and Porphyra), is a staple sushi wrapper and soup ingredient in Japan. In addition to being used as vermifuges, seaweeds are also utilized as hypocholesterolemic and hypoglycemic agents, as well as to treat intestinal problems, goitre, Basedow's disease, and hyperthyroidism (El Gamal, 2012). They provide numerous ingredients to the food or pharmaceutical industries such as hydrocolloids (agar-agar, alginates used as stabilizers, thickeners and fillers), pigments, vitamins, chelated micro-minerals (selenium, chromium, nickel, arsenic) and prebiotic substances in the form of complex carbohydrates (alginates, fucose-containing polymers, mannitol and laminarin) and phlorotannins (Evans and Critchley,2014). For bioremediation, species of seaweed including *Ulva* (green algae) and Gracilaria (red algae) are ideal. According to some studies, integrated aquaculture systems use seaweeds. Seaweeds are typically grown for food in Asia, whereas they are collected from the wild in Europe. Saccharina japonica (Japanese kelp), Euchema species, Gracilaria species, Pyropia and Porphyra (nori), and U. pinnatifida (wakame) are the principal species used for food. Small-scale farming is practiced for other species as Sargassum fusiforme and Caulerpa spp. Drying and milling seaweed results in seaweed meal, which is sold commercially in Europe, Asia, and North America. The primary commercial ingredients used to feed land animals appear to be seaweed meal and extracts obtained from *Ascophyllum* and *Laminaria* species in Iceland, *L. digitata* in France, *A. nodosum* in Norway, and the UK (McHugh, 2002). Up to 90% of the nitrogen outflow from an intensive fish farm can be removed by seaweeds in integrated fish farming systems. They make excellent biogas production substrates as well (Herrmann et al., 2015).

2.8 Seaweed Cultivation, Harvest And Meal Production

Seaweed cultivation is a rapidly expanding global industry. Seaweed production increased annually by 9.5% during the 1990s and by 7.4% during the 2000s, from 3.8 million tonnes in 1990 to 19 million tonnes in 2010, driven by the growth of fish aquaculture. China, Japan, and Indonesia were the primary producers of seaweed in 2012, and cultivation accounted for more than 95% of total production. Seaweed grows in a variety of situations. Each species has specific needs in terms of light, temperature, nutrition, water velocity, salinity, and nutrients. When propagating vegetatively, certain species of seaweed connect their parts to nets or ropes, sink them at the bottom of ponds, or hold them in place using a fork-shaped instrument (in sediments) or tubes filled with sand (in sandy soil). In the case of such species, the plant is either completely removed or only a tiny portion is taken out and used as seedstock for subsequent cultivation. Seaweeds must be treated quickly after being harvested for seaweed meal manufacture since they are high in water and can mold. To make it into tiny particles, the wet seaweed is run through hammer mills with successively smaller screens. Then, it is dried in a drum drier, which operates between 700 and 800 °C and exits at no more than 70 °C. The ultimate moisture content of seaweed meal should be around 15%, and it should be kept in sealed bags. According to McHugh (2003), seaweed meal can be kept for roughly a year. The drying of seaweeds at moderate temperatures is advised because of their high phytochemical content. The bioactive chemicals would be least inactivated by low temperature drying and storage.

2.9 Animal feed

Seaweed has been shown to be a reliable source of dietary lipids, proteins, and polysaccharides (Holdt & Kraan 2011). It contains a number of substances that are good for your health and have antibacterial, anti-inflammatory, and other bioactive qualities. Seaweed powder is consequently also included in the animal feed. Different seaweeds have quite different levels of effectiveness. In a prior study, Nile tilapia were administered Ulva powder in place of dietary lipids. Improvements were made to the Nile tilapia's physiological characteristics and feed-utilization capacity (Ergün et al. 2009). The increased demand for animal feed protein, the need for substitutes for the conventional soybean and animal protein feed, as well as food market restrictions pertaining to livestock feeding have all had an impact on the usage of seaweed in ruminant diets. Studies done to date on the use of seaweed in bovine, caprine, and other ruminant nutrition have mainly concentrated on adding small amounts of various macroalgal species to the feed and then evaluating the animal to see if there was any potential for prebiotic activity and improved animal performance.There is little available information on the use of green seaweeds in ruminant feed. Male lambs may receive up to 20% of their food as ulva lactuca without experiencing any unfavorable effects on taste. It has low protein degradability (40%) and moderate energy digestibility (60%) and is suited for use with feeds that have a high energy/low protein ratio, such as cereal grains. It is comparable to a medium to low grade forage. Also used to feed developing lambs, *Chaetomorpha linum* (Chlorophyta) with a 20% seaweed meal had a mildly negative effect on growth and feed conversion ratio, presumably because of the high ash content . The presence of some beneficial minerals and metals in seaweeds should be highlighted, along with a few poisonous ones including lead, copper, and mercury. According to rumors, seaweeds can take up arsenic (AS) from the water. Because toxic AS is used in livestock feed, it builds up in the body and causes mental harm. In comparison to brown seaweeds, green seaweeds have a reduced AS concentration (Francesconi & Edmonds 1996). U. lactuca from the Mediterranean Sea contained a significant buildup of trace metals, according to Bonanno et al. (2020). Therefore, it's important to look for potentially toxic components when adding seaweed to animal feed. The aquaculture sector has a significant obstacle in this regard. Seaweed can replace antibiotics and other medications, lessen the residual of veterinary pharmaceuticals, and increase a number of growth indices of aquatic and terrestrial animals (Bizzaro et al. 2022).

2.10 Inclusion in poultry

The best nutritional availability and high apparent metabolizable energy were provided by green seaweed Enteromorpha prolifera fed to broilers at inclusion rates ranging from 2% to 4%, which may be related to a high level of amylase in the duodenum. It increased the quality of the breast meat while decreasing the thickness of the abdomen and subcutaneous fat. It also had a good impact on feed intake, feed conversion ratio, and average daily growth. According to some study, feeding U. lactuca to broilers between the ages of 12 and 33 days had no impact on their feed intake, body weight gain, feed conversion ratio, or nutrient retention. However, feeding it to broilers and cockerels over the age of three weeks resulted in lower feed intake and slower growth rates. When green seaweed *E. prolifera* was fed to laying hens, it boosted egg weight, shell thickness, and yolk color while lowering cholesterol levels. This led to better egg output and quality. Additionally, it caused the E. coli burden in the feces to decrease, indicating improved animal health.

2.11 Prospects, challenges and future aspects

Different green seaweed species are the subject of investigations because they could be used as animal feed, nutraceuticals, pharmaceuticals, cosmetics, and cosmeceuticals. The development of new active compounds that increase the value of utilising marine resources is made possible by research that focuses on the examination of active substances isolated from green seaweeds. However, there is still much to learn about the useful qualities of green seaweeds, and for effective use, the bioactive chemicals in these plants must be fully defined. Diverse polysaccharides, vitamins, proteins, organic acids, and other beneficial compounds can be found in green seaweeds. The most significant substances are polysaccharides, which have steadily emerged as a research hotspot in the fields of functional food and medicine. However, there are still a lot of issues that require attention. Further research is needed, in particular, on the unique mechanism underpinning biological activity and the link between structure and activity of polysaccharides. To establish a theoretical foundation for illuminating the structure-activity relationship of polysaccharides, it is essential to understand its complex structures, such as spatial conformation. When used as the primary component of animal feed, green seaweeds can have a favorable impact on environmental sustainability, animal growth, and meat quality. They offer promising substitutes for dependable food crops like feed and forage.

However, there are possible drawbacks to feeding seaweeds, such as increased bioaccumulation of inorganic substances such heavy metals. Seaweed's value can be seen in biofuels, bio fertilizers, functional foods, animal feed, and medications, among other applications. The fatty acids found in seaweeds may one day be used to make biofuels. If the price of seaweed biodiesel is effectively lowered, it will not only significantly ease the fuel resource scarcity but also lower emissions of acidic and greenhouse gases like sulfur dioxide.

Watermelon

One of the well-known crops in the Cucurbitaceae family is the watermelon, whose scientific name is *Citrullus lanatus*. It has a light or dark green, striped or unstriped, rind on the outside. The seed is decorated in the centre third of the red-colored pulp that makes up the fruit's inside (Maynard, 2001). The fruit watermelon has a variety of vitamins, minerals, protein, and fats in its many parts, including the flesh, seeds, and rind. Watermelon is known locally as Tormuj in Bengali and Tarbooz in Hindi and Urdu. According to Verma and Tomar (2017), it is also known as Tarbuj in Manipuri and Indrak in Gujarati. Due to its high yield and farmers' choice of the fruit for commercial cultivation as a lucrative crop for economic gain, watermelon is grown in Bangladesh as an auxiliary crop but holds a significant rank among the fruit crops grown there (Rabbany et al., 2013). The fruit's flesh is a good source of the carotene and lycopene compounds that the human body needs to combat free radicals.

2.12 Watermelon Seed

A good source of fat, protein, fatty acids, vitamins, and minerals including manganese, potassium, zinc, magnesium, copper, etc. is the watermelon seed. The potential for financial advantage of watermelon seed is growing every day as a result of the significant health benefits of the seed. Due to its abundance of proteins, watermelon seeds are utilised to produce a variety of protein-based products (El- Adway and Taha, 2011). Because seeds include significant levels of protein, fat, and phytochemical compounds, they are used in infant food to help children develop their nutritional needs (Maynard et al., 2001). Because of seeds include significant levels of protein, fat, and phytochemical compounds, they are used in infant food to help children develop their nutritional needs (Maynard et al., 2001).

The seed's high protein content and excellent functional qualities make it a great ingredient in baking. As a flavouring and soup thickening agent, watermelon seeds are used as food additives (Fokou et al., 2004). Even though seeds are little, they are packed with vital nutrients like protein, fibre, vitamins, minerals, omega-3 fatty acids, and phytochemicals (Omorayi and Dilworth, 2007).

2.13 Proximate Composition of Watermelon Seed

In a study on the chemical make-up of watermelon seeds, Mehra et al. (2015) discovered that the percentages of moisture, ash, protein, fat, fibre, and energy were, respectively, 3.575%, 3.636%, 34.22%, 31.999%, 0.1%, and 531.151 Kcal/100g. According to the study, watermelon seeds are a good source of protein, fat, and energy. In a different study, two varieties of indigenous watermelon seeds from Limpopo, South Africa, were studied to compare their proximate composition, according to Mogotlane et al. (2018). The results showed that the seed from the Capricorn district had a fat content of 34.4%, higher than the seed from the Sekhukhune district's fat content of about 31.6%. According to an analytical study, the nutritional value of watermelon seed and rind was assessed. It was found that the seed had 531.15 Kcal/100g of energy and contained 2.48% ash, 3.81% moisture, 28.05% carbohydrate, 2.37% fibre, and 21.46% protein. Jacob et al. (2015) looked into the proximate makeup of melons and discovered that the moisture, ash, and fibre contents were, respectively, 7.10%, 2.7%, and 6.4%. Hannah and Krishnakumari (2015) found that the watermelon seed extract had a relative ash content of 1.60%, a moisture content of 7.03%, a fat content of 26.4%, and an energy content of 465.68 Kcal/100g.

2.14 Phytochemical Compound of Watermelon Seed

Watermelon seed's phytochemical composition was examined by Mehra et al. (2015). They claimed that many phytochemical substances, including alkaloids, flavonoids, unprocessed phenol and saponin, were present in watermelon seeds. The research found that the amounts of flavonoid, saponin, and crude alkaloid in watermelon seeds were, respectively, 4.22%, 0.041%, and 15.688%. It revealed that watermelon seed had more crude alkaloid than other phytochemicals. In an analytical investigation on the phytochemical components of two types of watermelon seeds in Limpopo, South Africa, Mogotlane et al. (2018) discovered that the range value of flavonoid concentration in the two varieties of watermelon seed was 0.015 to 0.347%.

2.15 Health Benefits of Watermelon Seed

Watermelon seeds are very nutrient-dense and are regarded as a quality source of protein. Similar to other types of protein-rich seeds including soybean, mustard, and almond, the seed is consumed as a food source of protein (Mustafa and Alamin, 2012). Protein content in the seeds ranged from 25 to 40 percent. Leucine, glutamic acid, and arginine are just a few of the numerous types of amino acids that make up the protein in watermelon seeds (Mello et al.,2001).Due to their high protein content, seeds can be utilised to make goods that are protein-rich as well as nutrient supplements and additives like thickeners (El-Adawy and Taha, 2011).

The watermelon's seed, which is rich in oil or fat, is found in the pulp. The watermelon seed is employed in the oil industry due to its high fat content (Nyam et al., 2009). Due to the high nutritious content of watermelon seeds' oil, there is a considerable demand for watermelon seeds in Africa. The seeds are separated from the rind's flesh and dried in the sun. Oil is produced from seed by squeezing after drying.

CHAPTER 3: MATERIALS AND METHODS

3.1 Study Area: The study was performed at the department of Animal Science and Nutrition in Chattogram Veterinary and Animal Sciences University.

3.2 Sample Collection: Rubber Seeds were collected from Ramu, Cox's Bazar. Sea Weed collected from Saint Martin and Water Melon seed collected from available market. Then the samples were cleaned, dried (sun dried & oven dried) and ground the samples in an electric grinder and make into fine powder and sieve the powder then stored in small zipper bags until further chemical analysis.

3.3 Sample Identification: Table of these samples with scientific name, family and common name is given below (Table 1).

Table 1. Scientific name, family and common name of seed and weed

Sl. No.	Scientific name	Family	Common name
1	*Hevea brasiliensis*	Euphorbiaceae	Rubber seed
2	*Caulerpa*	Chlorophyceae	Seaweed (Green algae)
3	*Citrullus lanatus*	Cucurbitaceae	Watermelon seed

Whole Rubber Seed

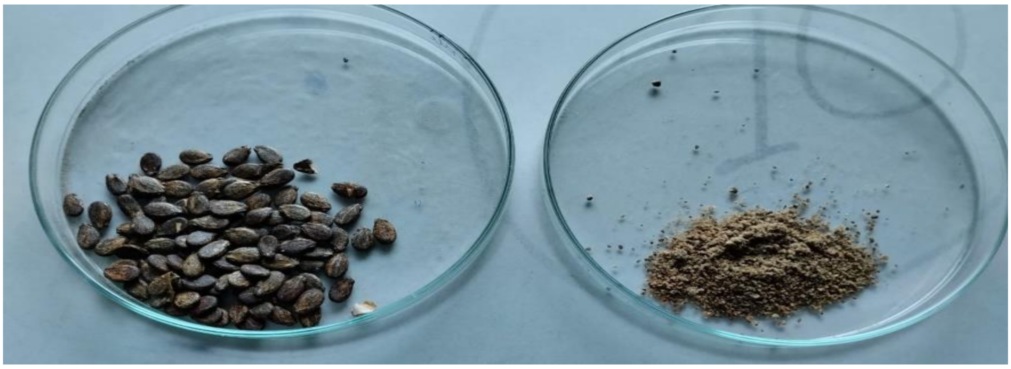
Rubber Seed Hull

Rubber Seed without hull

Grind Rubber Seed

Grind Rubber Seed Hull

Dry Green Seaweed **Grind Green Seaweed**



Watermelon Seed (Whole & Powder)

3.4 Proximate analysis

Following AOAC (2006), proximate analysis procedures were used to analyze the sample's moisture percentage, crude protein, ash, and crude fiber contents.

Fiber fraction : Cell wall constituents (%) or neutral detergent fiber and cell content(%) were determined by the method developed by P J Van Soest (Van Soest,1963). Acid detergent fiber was also estimated by the method developed by P J Van Soest and R H Wine (Van Soest and Wine,1968).

Determination of Dry Matter

I precisely weighed the crucible, added about 3gm sample, and reweighed. After that, I placed the crucible in hot air oven and dried it for 48–72 hours at 105^{o}C. Then, I removed the crucible from the oven and covered it in a desiccator and weighed it. Lastly, repeatedly re-dried until constant was gained.

$$\textbf{\% Moisture} = \frac{\text{Weight of fresh sample – Weight of dried sample}}{\text{Weight of dried sample}} * 100$$

% Dry Matter = 100 – Moisture Content

Determination of Crude Protein (CP)

Three stages were taken to determine the amount of crude protein. In digestion step I used 1gm of the sample and added 5gm of digestion mixer, and 20 ml of concentrated sulphuric acid to it. Then I positioned the digestion flask on the Kjeldahl digestion set and gradually increased heat and digestion reached a residue that is clear. The flask was then taken out and chilled.

In Distillation, 20 ml of distilled water was added to the cooled clear residue, the content was transferred to distillation, added 100 ml of 40% NaOH solution and set the condenser. Following that, I added 20 ml of 2% boric acid solution and mixed indicator in a conical flask and heated the distillation flask and collected 100ml of distillate. Finally, I titrated the distillate against standard N/10 HCL solution.

$$\textbf{\%CP} = \frac{\text{Volume of standard N/10 HCL solution * Normality of standard HCL solution * 0.014 * 6.25}}{\text{Weight of the sample}} *100$$

Determination of Crude Fiber

The acid-base digestion method was used to calculate the crude fiber. 1.25% sodium hydroxide and 1.25% diluted sulfuric acid used. Put 2gm of ground sample in a beaker and added 125ml 1.25% Sulphuric acid solution and also added 3-5drops n-octanol as antifoam agent . The sample was boiled for 30min then chilled and then washed it three times with distilled water to make it acid free. After draining the last wash I added 125 ml 1.25% sodium hydroxide, 3-5 drops antifoam and then boiled it for 30 minutes, then cooled and filtered the residue as above. And performed second wash with 1% HCL solution to make it acid free. This residue was dried by placing it in the oven at 105^0 C up to constant weight, allowing it to cool in desiccator, then weighing it. Finally ignited the residue in Muffle Furnace for 6hours at 550^{0} C and then weighed the ash.

% CF = $\dfrac{\qquad}{\text{Weight of the sample}}$ *100

crucible and ash

Determination of Ether Extract (EE)

A thimble was filled with around 2gm of ground sample. After that the Ether extraction beaker was carefully cleaned, dried in hot air oven and placed in a desiccator to cool down then measured the beaker's weight. Placed the thimble into the extractor and closed the top with cotton. Fit the extractor and pour the ether up to siphoning. Again pour ether up to half of the previous amount. Turn on the heater, then continue boiling for 6–8 hours at 40–60 ^{o}C. Place the flask in the hot air oven and heat it to constant weight at 100 ^{o}C. Cool the flask in desiccator and weight to measure ether extract.

$$\%EE = \frac{\text{Weight of the flask with either extract – Weight of the flask}}{\text{Weight of the sample}} * 100$$

Determination of Ash:

To determine the amount of ash, around 2gm of ground sample was weighed, put into a crucible, and burnt until no smoke. The sample was then cooled and moved to a muffle furnace for 6 to 8 hours at 550 to 600 ^{o}C until white ash. Then, cooled it at 150 ^{o}C, transferred it to the desiccator, cooled and weighted the sample.

$$\%Ash = \frac{\text{Weight of crucible and ash – Weight of crucible}}{\text{Weight of the sample}} * 100$$

3.5 Determination of Neutral Detergent Fiber (NDF)

At first I put 2gm of ground sample in a beaker and added 100ml cold neutral detergent solution and also added 2ml decahydronapthalene, 0.5gm anhydrous sodium sulphite. The sample was boiled for 5-10 minutes at high temperature then it reduced and boiled for 60min then chilled and then washed it with hot distilled water and washed twice with acetone in the same manner .Then weighted the crucible and residue. This residue was dried by placing it in the oven at 105^0 C up to constant weight, allowing it to cool in desiccator, then weighing it. Finally ignited the residue in Muffle Furnace for 6hours at 550^0 C and then weighed the ash.

$$\textbf{\% NDF} = \frac{\text{Weight of crucible with ADF} - \text{Weight of crucible}}{\text{Weight of the sample}} * 100$$

3.6 Determination of Acid Detergent Fiber (ADF):

About 2gm of ground sample was taken in a beaker and added 100ml cold Acid detergent solution and also added 2ml decahydronapthalene. The sample was boiled for 5-10 minutes at high temperature then it reduced and boiled for 60min then chilled and then washed it with hot distilled water and washed twice with acetone in the same manner. Finally washed with hexane. Then weighted the crucible and residue. This residue was dried by placing it in the oven at 105^0 C up to constant weight, allowing it to cool in desiccator, then weighing it. Finally ignited the residue in Muffle Furnace for 6hours at 550^0 C and then weighed the ash.

$$\textbf{\%ADF} = \frac{\text{Weight of crucible with NDF} - \text{Weight of crucible}}{\text{Weight of the sample}} * 100$$

CHAPTER 4: RESULTS & DISCUSSION

4.1 Proximate component of Rubber seed (RS) and Rubber seed hull (RSH)

Figure-1 shows the approximate content of rubber seed meals. The largest amount of dry matter (DM) present in rubber seed (RS) and rubber seed hull (RSH) which is 94.81% and 94.56% respectively. The DM is higher than the DM of *Sphnostylis Stonocarpa* Seed (85.55%-89.10%) (Anya et al., 2012). Ash content provides a rough estimate of the sample's mineral content. In this study the values of Ash was found 3.38% (RS) and 0.37% (RSH). The highest ash percentage was found in the fermented seed meal, which differed considerably from the raw (3.47%) and cooked (3.10%) seed meals (Agbai et al., 2020). This might be explained by how fermentation reduces antinutrients, increasing the amount of minerals available (Kumar et al., 2010). The results of the rubber seed meal ash percentage were consistent with estimates of 3.10 to 5.90% from earlier studies (Mmereole, 2008; Suprayudi et al., 2015; Udo et al., 2018).

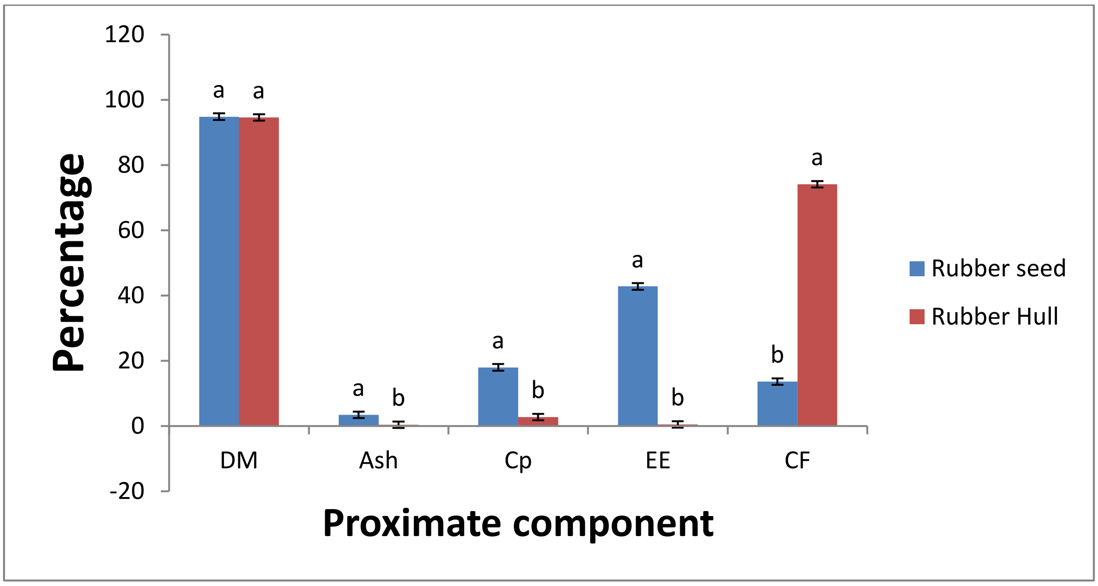


Fig 1: Proximate component of Rubber seed (RS) and Rubber seed hull (RSH)

The fat content of the RS 42.75% and RSH 0.46% , which is a good comparison to past studies that found 42.50%, 45.50%, and 49.30% fat contents, respectively, according to Lalabe et al. (2017), and Suprayudi et al. (2015). It is however less than the 68.53% given by Eka et al. (2010). This might be brought on by variations in rubber tree species and seed meal preparation techniques. The findings can also be contrasted with the crude fat content of well-known oil seeds like soybean, which was found to be 28.20% (Ogbemudia et al., 2018), and groundnut, which was found to be 46.10% (Ayoola et al., 2012). Therefore, it may be claimed that rubber seed, in terms of oil output, is a good replacement for these seeds. The crude fiber findings in RS 13.57% and RSH 74.08%, which is higher to earlier studies from Suprayudi et al. (2015) who reported 3.19%, Lalabe et al. (2017) who reported 4.50%, and Aguihe et al. (2017) who reported 5.61%. Farm animals need fiber in their diets because it functions as a diluent and, to some extent, helps promote healthy bowel movements. (Oke et al., 2007; Odoemelan and Ahamefule, 2006). The percentages of Crude protein in my study are 17.94% (RS) and 2.71% (RSH), which are compare favorably with past research as described 17.41% (Eka et al., 2010), 19.40 (Lalabe et al., 2017), 21.87 (Suprayudi et al., 2015), and 22.30% (Onwurah et al., 2010),. According to McKevith (2005), the protein content of groundnuts ranges from 22 to 30 percent, that of soybeans is between 37 and 40 percent (Ogbemudia et al., 2018; Grieshop and Fahey, 2001). Rubber seed can be compared to these legumes in that it is a strong source of plant-based protein and can help meet daily protein requirements.

4.2 Proximate component of Sea weed

The approximate moisture, ash, EE, crude fiber, crude protein, and dry matter compositions of the seaweeds that were presented in figure 2. According to Figure 2, green seaweed measured dry matter content was 66.67%. Normally dry matter percentage varied from 13%-28%. This study result has shown higher than the normal range, which may change due to sun, salinity, soil and other weather issues. Green seaweed has ash 44.417%. Seaweeds typically have a high amount of ash content because their cell wall polysaccharides and proteins contain anionic carboxyl, sulphate, and phosphate groups that are excellent binding sites to hold metals (Davis et al., 2003), which consistently directs the existence of significant amounts of different mineral constituents (Matanjun et al., 2009). Ash was the most common ingredient in all dried material, despite the fact that none of the species are calcareous. This study found green seaweed has 0.564% fat (EE). EE content was significantly lower in all seaweed species than other proximal component values, which may have been due to variations in their physiological make-up or physical characteristics. Additionally, seaweeds frequently contain only a little amount of EE or fat (between 1 and 5% of dry weight), as shown by Polat and Ozogul (2008). Green seaweed had a crude fibre content of 3.55% (Figure 2). Variations in the crude fibre content of seaweeds may result from changes in the stages of growth and photosynthetic function among seaweed species (Siddique et al., 2013). Additionally, it could change as a result of seasonal environmental factors that influence how well seaweeds can take in nutrients and control photosynthesis. According to this study's findings, the green seaweed had the protein content 10.866% (Fig-2). The protein composition of diverse species may vary depending on geography. The findings of the present investigation are confirmed by the observation that protein content varied geographically among different seaweed species. From different studies, found that the protein content of distinct seaweed species can vary from species to species. According to the results, ash was the main constituent, and this seaweed had high proximal compositions while EE had a lower one.

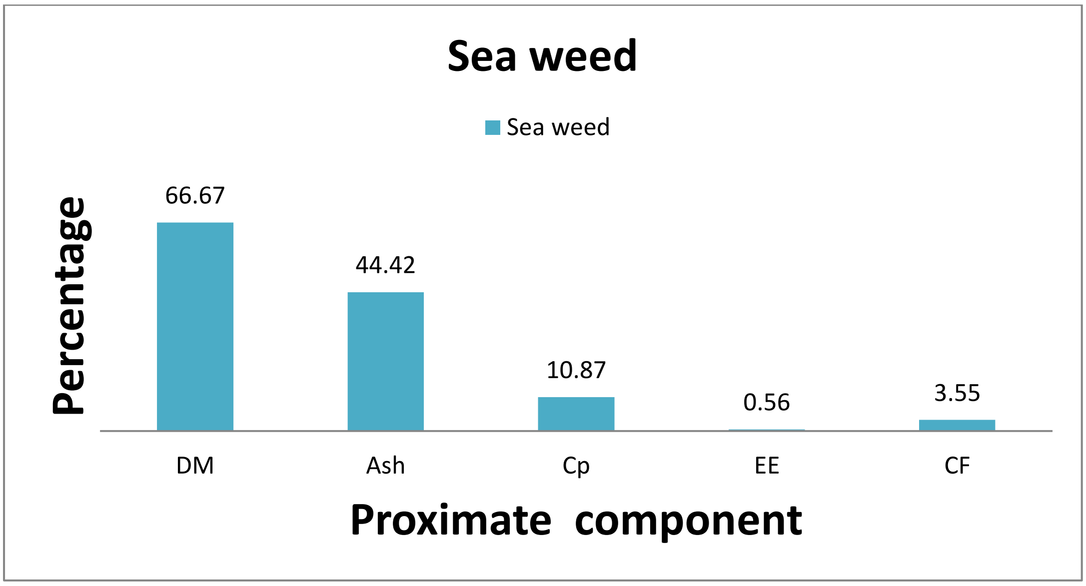


Fig2: Proximate component of Sea weed

Figure-3, displays the findings of the proximate analysis of watermelon (*Citrullus lanatus*) seed. The seed's measured dry matter content turned out to be 80.74%. In comparable investigations, Milala et al. (2018) and Sajjad et al. (2020) reported relatively lower moisture content values for watermelon seeds of 5.06±0.12 and 3.39±0.09, respectively. Any food's moisture level serves as an indicator of its water activity and indicates how stable and susceptible it is to microbial contamination. According to this study's high moisture content results, seeds can be kept for a respectable amount of time without being at risk of microbial degradation and rotting (Saidu et al., 2021). The amount of ash in the dietary material is a reflection of the amount of minerals (Gemede et al., 2016). The amount of ash in the dietary material is a reflection of the amount of minerals . (Gemede et al., 2016). According to the figure-3, The ash content of watermelon seed was determined to be 3.2050%, which is somewhat greater than Cherry's (2.000.00) and lower than the ash contents of watermelon (6.000.10), pawpaw (4.000.00) and bitter melon (5.000.10) (Mathew et al., 2014). However, Jacob et al. (2015) reported melon seed ash content values that were greater than the ones found in this study (6.70%). Similar to this, slightly higher numbers of 2.98, 3.67, and 3.73 for the ash content of watermelon seeds were reported by other studies (Kausar et al., 2020). It's possible that the difference in sample ash content across research is caused by according to the kind and quantity of ions in the soil that plants use to obtain nutrients (Saidu et al., 2021).

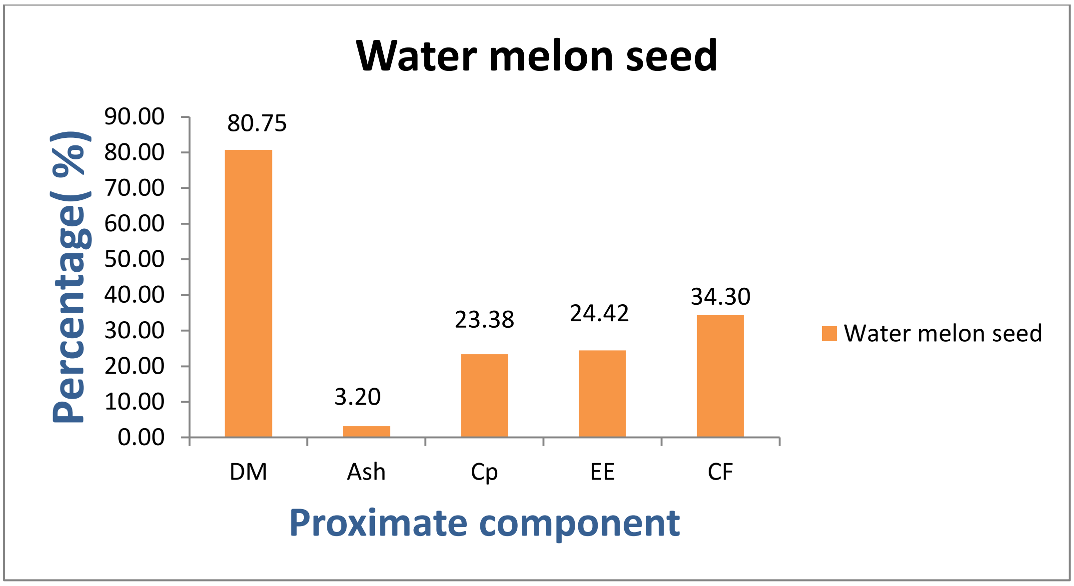


Fig 3: Proximate Component Water Melon Seed

Fat is a useful source of energy and a vehicle for the absorption of vitamins A, D, E, and K; hence, a lack of fat may impair growth, cause fatty liver issues, or increase the risk of respiratory illnesses (Ferrara et al., 2019). Our bodies cannot function properly without fat; it protects our internal organs from stress, regulates our body temperature, and supports good cell function (Bender & Cunningham, 2021). The fat content of watermelon seeds (24.4179%) found in the current study was higher than the 22.773.3% found in a previous study by Enemor et al. (2019). The presence of fat in the seed suggests that it might be a source of edible vegetable oil. According to Enemor et al. (2019), oils are renowned for their capacity to give the body the most energy possible. The amount of indigestible pentose, cellulose, lignin, and other components of this material is measured by its crude fiber (Saidu et al., 2021). In this investigation, the crude fiber content was 34.30%, which exceeds the 4.1% found by Kausar et al. in 2020. The crude fiber readings (4.97± 0.46%) were also lower reported in a comparable investigation for the watermelon seeds (Sajjad et al., 2020). Petkova and Antova (2015) discovered that the crude fiber concentration ranged from 4.5 to 8.5 percent in their study of the proximate composition of seeds and seed oils from four different types of melons. The significant high level of crude fiber found in this study demonstrates that the seed is a source of dietary fiber, which is necessary for a healthy bowel movement and may help prevent obesity, diabetes, colon cancer, and other conditions affecting the human and animal gastrointestinal tract (Alagbe, 2020). As can be shown in fig-3, the protein content discovered in this study was 23.38%, which is greater than the 8.9250±0.25% reported for watermelon seeds by Enemor et al. (2019). The crude protein 23.38% in this study is higher than the kinds of melons reported in a comparable study (Anjum et al., 2012), which are 2.100±31 (Dora), 2.400±05 (Dhaki)respectively. According to Enemor et al. (2019), watermelon seeds have the potential to be used as food and feed supplements due to their high protein content.

In Figure 4, The fibre fraction content of the examined seed and weed is shown. RSH (97.15%) and watermelon seed (75.53%) had the greatest levels of ADF compared to the other examined samples. RSH (78.61%) and watermelon seed (37.77%) had the highest NDF level of these seeds compared to the other seeds. RSH, watermelon seed, has the highest extent of cell components. The highest concentration of NDF and ADF was found in the powdered RSH and watermelon seed. The amount of indigestible pentose, cellulose, lignin, and other components of this material is measured by its crude fiber (Saidu et al., 2021). These seeds are therefore abundant in insoluble fibre, which aids in improved animal digestion, particularly in poultry and cattle.

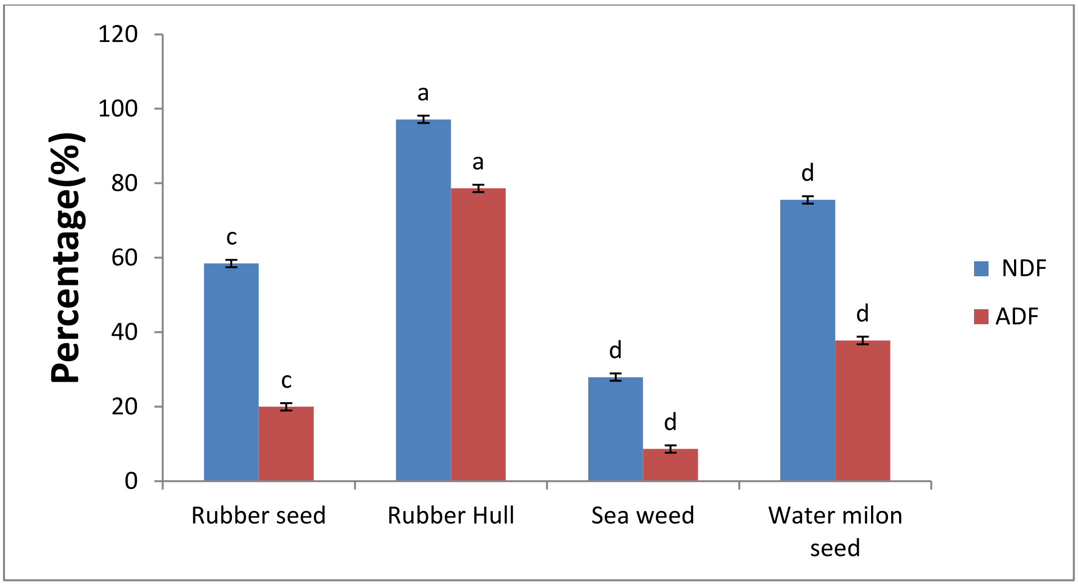


Fig 4: NDF and ADF content of Different unconventional feed resources

Table 2 & 3, represent the comparative proximate values and fiber fraction (ADF, NDF) among the tested samples. According to Table 2 Watermelon seed (23.38%) and rubber seed (17.94%) are two of the seeds and weeds that are particularly high in crude protein. Additionally, watermelon seed (34.30%) and rubber seed hull (74.08%) have higher crude fiber content. Watermelon seeds (24.41%) and rubber seeds (42.76%) are both rich in ether extract. The seaweed's Ash concentration was higher though its lower CF and CP values. The RSH and watermelon seed had the highest levels of NDF and ADF in table 3.

Table 2. Comparative proximate components for rubber seed, rubber hull, seaweed, watermelon seed.

Parameter(%)	Treatment				P value	Level of significance
	Rubber seed	Rubber seed hull	Seaweed	Watermelon seed		
DM	94.806[a]	94.559[a]	66.667[c]	80.748[b]	0.0001	***
CP	17.9375[b]	2.7125[d]	10.8663[c]	23.3815[a]	0.0001	***
CF	13.573[c]	74.083[a]	3.548[d]	34.300[b]	0.0001	***
Ash	3.3775[b]	0.3700[c]	44.4167[a]	3.2050[b]	0.0001	***
EE	42.7550[a]	0.4625[c]	0.5643[c]	24.4179[b]	0.0001	***

Table 3. Comparative ADF and NDF for rubber seed, rubber hull, seaweed, watermelon seed.

Parameter	Treatment				P value	Level of significance
	Rubber seed	Rubber hull	Seaweed	Watermelon seed		
ADF	58.440[c]	97.145[a]	27.915[d]	75.525[b]	0.0001	***
NDF	19.945[c]	78.605[a]	8.857[d]	37.765[b]	0.0001	***

Conclusion

To state it briefly, the current study introduces to some entirely new, incredibly nutrient-dense food additives that may be highly beneficial for the development of poultry and cattle animals. Although rubber seed is an underutilized biomass, it offers potential nutritional value as feed and food resources in the majority of production nations. Rubber seeds can be used as good sources of food, animal feed, and biofuel based on their chemical compositions. Green seaweeds can be extrapolated to be functional foods with high nutritive content based on several reliable kinds of information. In this study, nutritional components of green seaweeds were examined and high value of CP and fat were found. The findings of this study's investigation of the nutritional composition it may be said that watermelon seeds are a wonderful source of essential nutrients that are good for both human and animal health, watermelon seeds so indicated that there is a great deal of potential for using the seeds rather than throwing them out after eating the pulp. Therefore, it can be concluded that the rubber seed, seaweed and watermelon seed contain high protein and fat and lower CF and ADF. Thus, it can be used as animal feed specially in poultry which would be lower production costs and good performance in animal.

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Biography

My name is Shimu Moni, and I'm daughter of Laila Sarkar and Md. Esha Sarkar. I was born in Chattogram Division. I received my Secondary School Certificate (SSC) from Chattogram Metropolitan School & College in 2014, and my Higher Secondary Certificate (HSC) from Chattogram Govt. Women College in 2016. I enrolled at Chattogram Veterinary and Animal Sciences University (CVASU), in Chattogram, Bangladesh, for the 2016–2017 academic year in order to pursue a Doctor of Veterinary Medicine (DVM) degree. In the near future, I would like to be a skilled Veterinarian.