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***Journal of Scientific and Engineering Research*, 2018, 5(3):473-478**

Research Article

ISSN: 2394-2630
CODEN(USA): JSERBR

Proximate Analysis of Dry Watermelon (*Citrullus lanatus*) Rind and Seed Powder

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Abstract For efficient processes designed to convert lignocellulosic biomass to ethanol, it is imperative to know the composition of the biomass in order to evaluate the available energy that can be recovered from the substrate material. In this work, therefore, a proximate analysis of dry watermelon peel, as well as the watermelon seed was conducted by recourse to the method of the Association of Official Analytical Chemist (AOAC). The results reveled high carbohydrate content at 59.03% for the peel while a slightly moderate carbohydrate content of the seed at 19.45%. We conclude that the water melon peel is a potential reservoir of carbohydrate which can be converted to fermentable sugar in biofuel production.

Keywords Proximate analysis, Lignocellulosic, Peel, Biofuel production, Carbohydrate

1. Introduction

Lignocellosic materials and wastes are great feedstock for producing fuels and chemicals [1]. Nonedible plant materials such as wood, grass and agro-forest residues are lignocellulosic biomass from which energy can be derived. Currently biomass has been receiving increasing interest as a renewable energy source in the context of climate change and mitigation of impacts [2]. The predominant components of lignocellulosic biomass include the cellulose, hemicellulose and lignin. They are present in sample quantities, are renewable, inexpensive, and widely available. Recently there is continued increase interest in lignocelluloses biomass as source of fermentable sugars for biofuel (ethanol) production primarily due to their high availability. Large amount of lignocellulosic materials are often generated from commercial and agricultural processes [3].

In the agricultural sector, global fruit production has experienced a remarkable increase. Output has been growing at an annual rate of about 3 percent over the last decade. In 2011, almost 640 million tonnes of fruits were gathered worldwide [4-5].

The World Health Organization (WHO) gave a recommendation of a daily intake of 400g of fruits and vegetable for healthy life style, which also help prevent the prevalence of cardiovascular diseases [5-7].

Fruits are usually processed into bottled fruits, juices, jams, marmalades, jellies, bars, pickles, dried or crystallized fruits, etc. [5,8]. Consequently, high waste is generated as a bye product of these processes. One of such fruits common processed and is ubiquitous in Maiduguri metropolis of Borno State, Nigeria, is watermelon. A typical watermelon specie available in around Maiduguri is shown in Figure 1.Watermelon biomass can be categorized into three main components which are the flesh, seed and rind (peel). Watermelon constitute approximately 68 % flesh, the rind 30% and the seed 2% of the total fruit weight [9]. Figure 2 illustrates the percent proportion of the various components of watermelon fruit.

Scientific evidence have shown that watermelon contains vitamin C which is an essential nutrient for humans because it aids in the synthesis of collagen in addition to protecting against oxidative damage [10]. Watermelon helps also to maintain hair color, avoiding its fading as a result of a fast oxidative process. Therefore,

watermelon extract is recommended to formulate cosmetic products aimed at the protection of skin and hair integrity against oxidative processes [11].

(a) (b)

Figure 1: Watermelon Fruit (a) The fruit ball (b) Sliced watermelon fruit showing fibre and seeds [11]

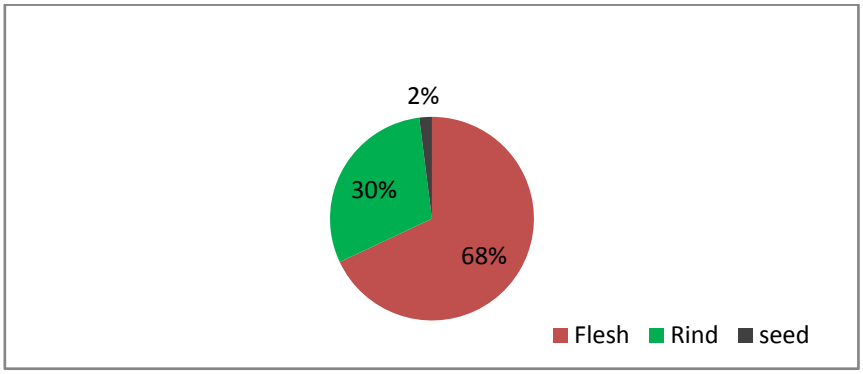

Figure 2: Composition of Watermelon [9]

2. Lignocellulosic Biomass

The composition of biomass constituents can vary greatly among various sources. Accurate measurements of the biomass constituents, mainly lignin and carbohydrates, are of prime importance because they assist tailor process designs for enhance maximum recovery of energy and desired products from the biomass substrate materials [12].

The overall efficiency of processes designed to convert lignocellulosic biomass to ethanol lies on determining the compositions of such material [13]. It is therefore imperative to know the composition of watermelon peel as well as the seed biomass to quantify the available energy that can be recovered from these materials prompting the essence for proximate analysis. According to Godwin [14], proximate analysis refers to the determination of the major constituents of lignocellulosic biomass materials. Principally, the process involves determination of moisture, ash, crude fiber, crude protein, ether extract, nitrogen free extract and carbohydrate contents of the biomass.

Often, effective methods of proximate analysis for biomass materials and conditions of pretreatment depend greatly on the type of lignocellulose materials. For instance, pretreatment of bark from popular trees or corn leaf with a dilute-acid process seems to be promising, but this method is not effective for treating the bark from sweet-gum or corn stalks [15]. In this work, a detailed compositional analysis of watermelon peel and seed was conducted.

3. Materials and Method

3.1. Materials and Equipment

Ripe Watermelon fruit was purchased from Gamboru market, Custom area of Maiduguri metropolis, Borno State Nigeria. Equipment used are hotbox oven, desiccators, electric milling machine, weighing balance, crucibles, laboratory glassware and filter papers. Reagents used are concentrated H_2SO_4, caustic soda, distilled

water, boric acid, tri-chloric acid, petroleum ether and 0.1N HCl. All reagents were laboratory grade sourced from the animal science laboratory, Department of Agriculture, University of Maiduguri.

3.2. Preparation of Watermelon Rind

The watermelon fruits were sliced to remove the rind, flesh and seeds separately. The rinds were washed and left to dry at ambient temperature. The colored part of the fruit's peels were carefully scrapped to minimize the inclusion of albedo which is an inner layer of spongy white tissue. The fresh peels were further dried at 50° C, cooled and then grinded to obtain a fine powder, the prepared rind samples and the rind powder are shown in Figure 3.

(a) (b)

Figure 3: Fresh Watermelon Peels (a) Dry rinds (b) Rind powder

3.3. Proximate Analysis of the Watermelon Rind

The proximate analysis of watermelon peel and the seed was conducted in the Animal Science laboratory, Faculty Agriculture of the University of Maiduguri, Borno State, Nigeria, using the standard method described by Association of Official Analytical Chemist [16] 15th Edition. The method is outlined as follows:

3.3.1. Determination of Moisture Content

Clean aluminum dish was dried at a temperature of 105°C for a period of one hour in an oven after which it was cooled in a desiccator. The empty aluminum dish was then weighed (W_1). The dish was reweighed (W_2) after adding 25g of the sample and was returned to the oven where it was allowed to dry to a constant weight at a temperature of 105°C. The dish was removed, cooled in a desiccator and reweighed (W_3).The percent moisture content of the sample was calculated from equation (1).

$$\%Moisture\ Content = \frac{(W_2 - W_3)}{(W_2 - W_1)} \times 100\% \quad (1)$$

The percent dry matter is therefore obtained using equation (2).

$$\%\ Dry\ matter\ of\ sample = (100 - \%\ moisture\ content\ of\ sample) \quad (2)$$

3.3.2. Determination of Ash Content

Crucible container was well cleaned and weighed (W_1). Two gram (2g) of the pretreated watermelon peel powder was poured into the crucible and reweighed (W_2). The crucible containing the sample was then placed in a furnace set at 600 °C, and was allowed to stay for a period of 10 hours; long enough for the sample to turn to a whitish-grey ash after which it was transferred to a desiccator and allowed to cool. The crucible containing the ash was then reweighed (W_3). Similar procedure was carried out on the watermelon seed. The percent ash content of the samples was calculated using equation (3).

$$\%\ Ash = \frac{(W_3 - W_1)}{(W_2 - W_1)} \times 100\% \quad (3)$$

3.3.3. Determination of Crude Protein Content

Crude protein content of the samples was analyzed using Kjeldahl tablet. Two gram (2g) of the samples were weighed into the digestion tube and 2 Kjeldahl tablets and 20 ml of concentrated sulphuric acid (H_2SO_4) was added into the tube and digested at 420 ^oC for 5 hours. Upon cooling, 90 ml of distilled water was added into the digested solution. About 50 ml of 40% caustic soda (NaOH) was added in the solution, and then placed on a heating section of a distillation chamber. 30 ml of 4% boric acid plus bromocreted green and methyl red indicator was put into conical flask and placed underneath the distillation chamber for collection of ammonia. The solution changed from orange to green color. A burette was filled with 0.1 N solution of hydrochloric acid (HCl), the solution in the conical flask was titrated with the acid until the color changed from green to pink. The burette reading was recorded and the crude protein (*Cp*) was calculated using equation (4):

$$\% \, Cp = \frac{(A-B)\times N\times F\times 6.25}{mg \ of \ samples} \times 100\% \quad (4)$$

Where *A*= ml of acid used for titrating the sample; *B*= ml of acid used for titrating blank sample (*O*); *N*= normality of acid used for titration; *F*= Factor= 14.007; 6.25= constant.

3.3.4. Determination of Crude Fiber Content

The crude fiber of the samples was determined by weighing 2g of the samples and then placed in a round bottom flask onto which 50 ml of tri-chloroacetic acid reagent (TCA) was added. The mixture was boiled and refluxed for 40 minutes. Filter paper, cooled to room temperature was used to filter the residue. The residue obtained was washed four (4) times with hot water and once with petroleum ether. The filter containing the residue was folded together and dried at 50 ^oC in an oven for 24 hours. The sample was thereafter reweighed and then ash at 650 ^oC and was cooled and reweighed. The percent crude fiber was calculated using equation (5).

$$\% \, CF = \frac{Difference \ \ in \ weighing}{weight \ of \ sample \ \ on \ dry \ \ matter \ \ basis} \times 100\% \quad (5)$$

3.3.5. Determination of Ether Extract (Fat)

The ether extract was determined using soxhlet apparatus. Two gram (2g) of the feed sample was weighed into a thimble and 200 ml of petroleum ether was measured using measuring cylinder. The solution was poured into round bottom flask and was heated at 45 ^oC for 2 hours at 1 hour interval. The collecting flask was removed and cooled in a desiccator for 15 minutes and percentage fat of the sample was determined using equation (6).

$$\% \, Fat = \frac{Weight \ of \ fat}{Weight \ of \ sample} \times 100\% \quad (6)$$

3.3.6. Determination of Nitrogen Free Extract Content

Percent nitrogen free extract was determined through computation using equation (7).

$$\% \, NFE = 100 - (\%CP + \%CF + \%EE + \%Ash) \quad (7)$$

3.3.7. Determination of Carbohydrate Content

Percent carbohydrate of the samples was also computed using the equation (8).

$$\% \, Carbohydrate = 100 - (\%MC + \%Ash + \%CP + \%CF) \quad (8)$$

4. Results and Discussions

Dry Watermelon peel and dry watermelon seed were analyzed for dry matter, crude proteins, crude fiber, ether extract or fat, ash, carbohydrate and nitrogen free extract (NFE) by adopting the procedure of AOAC [16]. The result of the analysis is presented in Table 1 and Table 2 for watermelon dry peel and dry seed respectively.

Table 1: Proximate analysis of dry watermelon rinds

Sample	% DM	% MC	% CP	% EE	% CF	% Ash	%NFE	%CBH
Dry Watermelon peel	98.9	1.1	7.87	1.0	30.0	2.0	59.13	59.03

Table 2: Proximate analysis of dry watermelon seeds

Sample	% DM	% MC	% CP	% EE	% CF	% Ash	% NFE	% CBH
Dry Watermelon Seed	96.92	3.08	21.44	15.0	55.0	1.0	7.56	19.45

DM= Dry matter, ***MC***= Moisture content, ***CP***= Crude protein, ***EE***= Ether extract, ***NFE***=Nitrogen free extract and ***CBH***= Carbohydrate

The results indicates that the moisture content of the rind samples is a decimal value of about 1%; which is significantly less than that of the seeds, it could be seen that the moisture content of the dry seeds more than doubles that of the rind. This results also shows moisture content of the rind much less than the value reported by Masudul and Abdullah [17] at 10.72%. The value of the fiber content of the dry seed as expected is higher than that of the dry peel. A higher fiber content is likely to hold higher moisture content as observed. It is interesting to note however, that even though the moisture content of the seeds more than doubles that of the rinds, the seeds are only about 80% higher in fiber content than the peels.

Ash is the inorganic content of a material which does not volatilize after subjecting the sample to high temperature. Tit could be seen that the ash content of the peels and seeds were 2%.and 1% respectively.

The results also indicates that the watermelon rinds have higher carbohydrate content of 59.03% compared to the seed with carbohydrate content of 19.45%. This shows the potential of the peel as a reservoir of carbohydrate which can be converted to fermentable sugar for biofuel production. The carbohydrate content observed in this work is again slightly lower than that reported by Masudul and Abdullah [17] for rinds.

5. Conclusion

The study conducted and the result obtained shows the potentials of watermelon dry peel as a reservoir of fermentable sugar (glucose). The proximate analysis carried out revealed high carbohydrate content of 59.03% in the peel than that of the seed of 19.45% showing the potential of the peel as a reservoir of carbohydrate which can be converted to fermentable sugar for biofuel production.

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