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Nutritive quality of cotton seed and oil of *Gossypium arboreum* (Karangunnni) variety

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Abstract
The present study was carried to investigate the nutritive quality of cottonseed and oil of *Gossypium arboreum* species, (karangunni) variety. This variety is native to India, but it found less utilizations in food application as the availability of other hybrid cottonseeds. The parameters were studied in proximate analysis include moisture, crude protein, crude fiber, ash content, fat, and total carbohydrate content of the seed. The chemical parameters were studied for the oil include iodine value, saponification value, free fatty acid value and the acid value. The proximate values obtained are moisture content 7.96 ± 0.35, crude protein 20.36± 06, crude fiber 18.27 ± 0.6, ash content 5.03 ± 0.6, fat content 18.31 ± 0.5, carbohydrates 30.06 ± 1.0, and energy value 376.9. The chemical properties values obtained are iodine value 109 ± 1.14, saponification value 182.13 ± 1.65, free fatty acid 1.71 ± 0.11, and acid value 2.95± 0.1, volatile matter 0.42 ± 0.08. Above analysis depicts the potential of *Gossypium arboreum* (karangunni variety) use in food application like other cottonseed variety.

Keywords: Physicochemical, proximate, *Gossypium arboreum* (karangunni variety)

1. Introduction
Cotton is a natural vegetable fiber obtained from the cotton plant of the genus gossypium and belongs to malvacae family. Cotton (*Gossypium* spp.) is a major cash crop and often known as the "King of Natural Fibers" of India. (Rathinavel, 2017) [6]. It is considered as one of the most important conventional oilseed crops with the ability to bridge the existing gap between the demand and supply for vegetable oils in India (Sekhar & Rao, 2011) [9]. It covers about 2.5% of the world's cultivable lands and is also recognized as a "dual-purpose crop", as it is not only utilized for its natural fiber but also for the production of vegetable oil which accounts to approximately 4% world's oil production (Taylor & Ashraf, 2010) [8]. Cottonseed is one of the principal oilseeds of the world and in recent decades, a lot of extensive research works has been carried out to investigate the potential of cottonseed as an abundant source of the food protein. The importance of cottonseed proteins for human foods has been recognized for several years. Cottonseed oil is popular for frying purposes and is less expensive compared to olive oil or canola oil. Due to its flavor stability, it is used for salad dressing and mayonnaise. Fine quality oil extracted from cottonseed is used in lubricants, paints, bath soaps and moisturizing lotions. (Saxena *et al*., 2011) [10]. It is obvious that utilization can maximize the available resources and result in the production of various new food. Cottonseed has the potential for meeting the needs of the worlds increasing population and improving nutritional status. Protein deficient diets of much of the world's population have been the subject of extensive research in the past decade. The limiting factor of the world food problem is not the protein supply, but rather the ability to transform available protein into products that the public will accept.

Other than consumption of cottonseed oil, Cottonseed flour also has been used in small quantities in various bakery product to enhance the dough characteristics, and as a protein supplement (Staats & Tolman, 1974) [7]. It has been not used in large quantities as a food product for human consumption. Cottonseed flour resulting from improved processing methods would be valuable on a commercial scale as a food supplement, because of its high quality protein.

G. hirisutam, *G. arboreum*, *G. herbareum*, and *G. berbaceum* are the most cultivable varieties. Extensive research studies have been carried out to explore their nutritional profile. However, the *G. arboreum* (karangunnni variety) of cottonseed is still underutilized in different applications. Literatures depicting its nutritional quality are limited.

Therefore, the main purpose of this study is to investigate the nutritional profile of cotton seed and quality of the extracted oil. This will help to incorporate cottonseed in various food systems and used it as an alternate and cheap source of vegetable oils and protein.

2. Materials and Methods

2.1 Material

Cottonseeds of variety *G. arboreum* (Krangunni) were collected from the local market in Thanjavur, Tamil Nadu, India. All the chemicals and reagents are purchased from Sigma-Aldrich.

2.2 Preparation of cottonseed powder

The cottonseed (*G. arboreum*) variety was collected and the dried seeds were carefully cleaned and sorted out to remove foreign particles and defective seeds so as to obtain clean seeds. The cleaned seeds were dehulled with the help of a dehulling machine and make it into powder form by grinding it, after they were packed in polyethylene bag and kept in a desiccator until when needed.

2.2.1 Extraction method

The ground cottonseed (10g) was placed on a filter paper and it was then properly folded and inserted into the assembled soxhlet apparatus. 300 ml of solvent extractant of petroleum ether (40-60) °C as extracting solvent was poured into it for 18 to 20 hrs. The oil obtained after the excess solvent removed. The crude cottonseed oil was then packed and properly stored.

2.3. Proximate analysis

2.3.1 Determination of moisture content

Hot air oven method was used to determine the moisture content of the refined wheat flour. Three grams of the sample was weighed in the moisture dish and kept inside the oven maintained at a temperature of 105 ± 2 ºC for 3 hours. It was then kept in a desiccator to cool down and then weighed. The process of drying, cooling and re-weighing were continued until a constant weight was obtained. Moisture content was calculated on a wet basis using the following formula:

$$\text{Moisture content (\% wb)} = \frac{\text{Initial weight} - \text{Final weight}}{\text{Initial weight}} \text{ X } 100 \quad (1)$$

2.3.2 Determination of ash content

Five grams of the wheat flour was weighed in a silica crucible and charred over the heating mantle. The charred sample was kept inside the muffle furnace for incineration at the temperature of 550 ± 5 ºC till grey color ash was obtained. Desiccate the crucibles until they reach room temperature and note down the weight. The ash content (%) of the sample can be determined using Equation 2:

$$\text{Ash (\%)} = \frac{\text{Residue weight (g)}}{\text{Sample weight (g)}} \text{ X } 100 \quad (2)$$

2.3.3 Determination of crude protein

The amount of crude protein present in wheat flour was determined by the improved Kjeldahl method. Two grams of the sample along with 15 g of K_2SO_4 and 0.04 g of $CuSO_4$ and 20 ml of concentrated H_2SO_4 was taken in the digestion flask. Flasks were heated for 90 to 120 minutes until the solution becomes clear. When the temperature of the flasks decreases to room temperature, 50 ml of NaOH was added along with the indicator and attached to the condenser. Ammonia vapors were distilled and collected. The distillate was titrated against 0.1N NaOH using methyl solution as indicator. Similarly, blank titration was also carried out. Crude protein (%) was calculated using Equation 3:

$$\text{Crude protein (\%)} = \frac{\text{(B-S) X N X 1.4007 X f}}{\text{Sample weight (g)}} \quad (3)$$

where, B = blank titration value, S = sample titration value, N = normality of NAOH, f = conversion factor which is 5.7 for flour.

2.3.4 Determination of fat content

The crude fat content of the wheat flour was estimated by the Soxhlet extraction method using petroleum ether as a solvent. Three grams of the sample was weighed in a filter paper and kept inside the thimbles. Thimbles were placed inside the extraction flask along with petroleum ether. The extraction was then carried out for 4 hours at the condensation rate of 5 to 6 drops per second. The flask was dried at 105 ºC in a hot air oven till constant weight is reached. The cooled flasks were weighed. Blank was also carried out but without the sample. The crude fat content was calculated by Equation 4.

$$\text{Crude fat (\%)} = \frac{\text{Extracted weight (g)} - \text{Blank weight (g)}}{\text{Sample weight (g)}} \text{ X } 100 \quad (4)$$

2.3.5 Determination of Carbohydrate

Carbohydrate content was obtained according to Onwuka (2005). The carbohydrate content of the wheat flour was calculated using Equation 5:

$$\text{Carb. (\%)} = (100 - \text{Fat \%} - \text{Protein \%} - \text{Ash \%} - \text{Moisture \%}) \quad (5)$$

2.4 Chemical Analysis of the extracted oil

2.4.1 Determination of Iodine Value

The iodine value of the extracted oil is calculated by treating it with the Wij's solution and then the excess of iodine mono chloride is treated with potassium iodide and the iodine liberated is titrated against sodium thiosulphate solution. Weigh about 0.3gm of the sample in the flask and add 25ml of carbon tetrachloride and mix the contents properly.25ml of Wij's solution is added to it and swirled for proper mixing. The mixture is kept in the dark for about half an hour and then add 15ml of potassium iodide solution and 100ml of freshly boiled and cooled distilled water. The liberated iodine is titrated against sodium thiosulphate solution using starch as an indicator until the blue color disappears. Carry out the blank simultaneously. The iodine value is calculated using the formula:

$$\text{Iodine value} = \frac{\text{12.69 x (B-S) x N}}{\text{W}} \quad (6)$$

where, B= volume of standard sodium thiosulphate solution required for blank
S= volume of standard sodium thiosulphate solution required for oil sample
N= normality of standard sodium thiosulphate solution
W= weight of the sample

2.4.2 Determination of Saponification Value

The saponification value is calculating by refluxing the extracted oil with a known excess of alcoholic potassium hydroxide solution. About 2gm of the oil sample is weighed in the 250ml Erlenmeyer flask and is connected to the reflux

condenser and kept on the water bath. The contents which were constantly stirred were allowed to boil gently for 1 hour until saponification is complete which can be indicated by the appearance of a clear solution. The flask is cooled down and the inside of the condenser is washed with 10ml of hot ethyl alcohol and then titrated against 0.5N hydrochloric acid using phenolphthalein as an indicator. The blank is also carried out simultaneously. The saponification value was calculated using the Equation 7.

$$\text{Saponification value} = \frac{12.69 \text{ x } (B-S) \text{x } N}{W} \quad (7)$$

2.4.3 Determination of Free Fatty Acid (FFA)

25ml of diethyl ether and 25ml of ethanol were mixed in a 250ml beaker. The resulting mixture was added to 10g of oil in a 250ml conical flask and few drops of phenolphthalein were added into it. The mixture was titrated with 0.1M NaOH to end point with constant shaking; the volume of 0.1M NaOH was noted.

2.4.4 Determination of Acid Value (A.V)

Acid value tells about the measure of rancidity as free fatty acids which are normally formed by the decomposition of oil glycerides. The acid value is expressed as a percent of oleic acid, lauric or palmitic acid. The mustard oil is mixed thoroughly before weighing. 10g of the extracted oil is taken in a conical flask. 50 to 100 ml of freshly neutralized hot ethyl alcohol and about one ml of phenolphthalein indicator solution is added to it and the mixture is boiled for about five minutes. It is then titrated against the standard alkali solution (0.05M KOH) while shaking vigorously during the titration till pale pink color appears. The acid value is then calculated using the Equation 9.

$$\text{Acid value} = \frac{56.1 \text{ x } V \text{ x } N}{W} \quad (9)$$

Where, V=Volume in ml of standard potassium hydroxide or sodium hydroxide used
N= Normality of the potassium hydroxide solution or sodium hydroxide solution;
W=Weight in grams of the sample

The acidity is frequently expressed as free fatty acid for which calculation shall be

$$\text{Free fatty acid as oleic acid} = \frac{28.2VN}{W}$$

Percent by weight

Acid value = Percent fatty acid (oleic) x 1.99

2.4.5 Determination of Moisture Content and Volatile Matter

The moisture content and the volatile matter of oil was determined using hot air oven method. 15g of oil sample was weighed into a known weight of tarred Petri dish. The Petri dish was placed in the oven for approximately 2 hours. The dish was carefully removed from the air oven, cooled and was re-weighed. The process of drying, cooling and reweighing was continued until a constant weight was obtained.

2.5. Statistical analysis.

The results obtained were subjected to a Standard Deviation to compare the means.

3. Results & Discussion

Table 1: Proximate Composition of *Gossypium arboreum* cotton seed

Seed parameter	% Composition
Moisture	7.96 ± 0.35
Ash	5.03 ± 0.60
Protein	20.36 ± 0.64
Fiber	18. 27 ± 0.60
Fat	18.31 ± 0.54
Carbohydrate	30.06 ± 1.06
Energy value	376.93

Each data is mean of three replicates ± standard deviation (SD)

Table 1 indicates the proximate composition of cottonseed. The moisture content of *Gossypium arboreum* seeds is low when compared with the moisture of legumes ranging between 7.0% and 11.0%. This shows that the seeds are very high in dry matter content which is an advantage because it reduces microbial activities, and increase their shelf life when properly stored. Lower moisture content is an indication of longer shelf life. The lower the initial moisture contents of a product to be stored, the better the storage stability of the product. The protein obtained is low compare to other variety of cottonseed but it shows similar result to sesame seed range between 19-25% protein. (Kajihausa, Fasasi, & Atolagbe, 2014) [5]. It is a good source of protein if different pretreatment applied on enhancing the nutritional value. Soaking, fermentation is very effective in increasing the crude protein content. (Duodu *et al*., 2018) [4]. The percentage ash reveals high inorganic matter that could be retained in the body while the % oil reveals that the seed is rich in oil and fat and is very important in the diet as it promotes absorption of fat, soluble vitamin and provides high energy nutrient. The value of this seed oil is quite promising and suggests obtaining commercial quantities for industries, pharmaceutical, cooking, and other purposes. Fat content of the cottonseed is 18.31% which showed the average fat content. Their total calculated carbohydrate is considered sufficient for energy the body required.

Table 2: chemical properties of oil extracted from of *G. arboreum* cottonseed

Chemical properties	Composition
Iodine Value (g iodine/100g)	109.86 ± 1.1
Saponification Value (mgKOHg^{-1})	188.13 ± 0.7
Free fatty acid (%)	1.71 ± 0.1
Acid Value (mg KOHg^{-1})	2.98 ± 0.2
Volatile matter (%)	0.4 ± 0.08

Each data is mean of three replicates + standard deviation (SD)

Chemical properties of oil are the most important properties that determine the present condition of oil. The iodine value which indicates the degree of oil saturation shows that the oil of *Gossypium arboreum* is semi-drying and unsaturated and this makes it suitable for utilization in certain industrial applications. The low acid value and free fatty acids shows the ability of the oil to resist hydrolytic rancidity (Akubor 2008) [1]. The saponification value of cotton seeds is 188.13 + 0.71mgKOH/g and it fall within the range of values obtained for some vegetable oil 188 - 235mgKOH/g (Aremu *et al*., 2006) [3].

4. Conclusion

The *G. arboreum*, (karangunni variety) of cottonseeds are good source of oil and protein. They contain less moisture. As it shown good nutritive quality it can be used in various application in food industry. The study of these seeds might be beneficial for selection and cultivation of such cotton seed variety which would yield maximum nutritional benefits.

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