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Study the engineering and chemical properties of tarwad (*Cassia tora* L.) seed powder

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Abstract

Cassia tora L. is legume annual plant of species in which the seeds grow to develop into pods. It is also known as sickle pod, tora, coffee pod, tovara, chakvad, thakara in Malayalam foetid cassia. Tarwad is a dicot legume in the family and subfamily *Caesalpinioideae*. It grows wild in most of the tropics and is considered as a weed. Its native range is probably South Asia. Its most common english name is sickle senna or sickle wild sensitive-plant. Tarwad with high nutritive value is available abundantly in India. It is an "Underutilized Vegetable", plant resistant to pests, diseases and thrives well in minimally nutritive soils. It is an annual foetid herb, 30-90 cm high. Leaves are green in colour, pinnate, up to 6-8 cm long, leaflets are in 3 pairs, distinctly petioled, opposite, conical at one end, ovate, oblong and base oblique. Flowers are pale yellow in color usually in nearly sessile pairs in the axils of the leaves with five petals, upper one are very crowded. Pods are substrate or 4 angled, very slender, 6-12 inch long, incompletely septet, membranous with numerous brown oblong, rhombohedral seeds. The engineering properties of tarwad (*cassia tora* L.) seeds were observed. The average shape, length, width, thickness, GMD, kernel weight, bulk density, tapped density, true density, angle of repose and coefficient of friction of tarwad seed was found to be irregular and rectangular, 4.37 mm, 2.16 mm, 2.08 mm, 2.69 mm, 29.24 g, 0.87 g/ml, 0.89 g/ml, 1.3 g/ml, plywood (16.4± 0.16) degree and plywood (130.2± 1.98), respectively. The engineering properties of tarwad (*cassia tora* L.) seed powder were observed. The average colour, angle of repose, bulk density, tapped density, carr's index, hausners ratio and average particle size of tarwad seed powder was found to be yellowish, 35.02 degree, 0.608 g/ml, 0.690 g/ml, 11.71 per cent, 1.12 and 0.33 mm. The chemical properties of tarwad seed powder were observed. The average moisture content, ash content, crude fat, crude protein, crude fibre, carbohydrate, non-protein nitrogen, true protein and free amino acids of tarwad seed powder was found to be 5.55 per cent, 3.57 per cent, 1.06 per cent, 15.72 per cent, 4.07 per cent, 69.46 per cent, 0.25 per cent, 12.37 per cent and 0.99 per, cent respectively. The minerals content of tarwad seed powder was observed. The average of Ca, Mg, Fe, Cu, and Zn of tarwad seed powder was found to be observed that the mineral content of tarwad seed powder was found to be 70.522 mg/l, 11.122 mg/l, 0.4596mg/l, 0.003 mg/l and 0.8483 gm/l respectively. The water holding capacity in tarwad seed powder was found to be non-significantly superior in S2 Size. The water holding capacity of tarwad seeds powder was observed highest in case of S2 Size 80.02 per cent. Products prepared from tarwad seed powder i.e Pakoda and sweet shira showed better results for 4% concentration of tarwad seed powder as compier to 8% and 12% concentration of tarwad seed powder.

Keywords: Tarwad, solubility, seed power, tensile strength, Engineering and chemical properties

Introduction

Green revolution has helped in increasing the crop production but for ever growing population more and more food is necessary to be made available from the continuously decreasing land due to urbanization and industrialization. Although high yielding crop varieties and new technologies are being invented but already available natural resources in the form of weeds is yet to be exploited as food and medicine. Indigenous food systems offer a plethora of biodiversity for the diet and are good with respect to nutrition, positive dietary behaviors and other perspectives related to human well-being. However, many indigenous leafy vegetables are neglected and despised in the urban areas of India, despite their nutritional richness and potential to contribute to healthier diets in the country. Scientific studies to determine the role of indigenous leafy vegetables in the formulation of healthy diets in India are imperative considering the high level of obesity in the country. There are many plants (shrubs and creepers) grown in the farm and in fallow land, are treated as weeds but can be used as vegetables e.g. Tarwad (*Cassia tora* L.), Sarata (*Tribulus terrestris*), Chakwat (*Chenopodium album*), *cassia*

auriculata etc. and also for industrial purpose. *Cassia tora* Linn. is legume annual plant of species in which the seeds grow to develop into pods. It is also known as sickle pod, tora, coffee pod, tovara, chakvad, thakara in Malayalam foetid cassia and Tarwad in Marathi (Anonymous, 2015) ^[3]. Tarwad is a *Leguminosae* crop in the subfamily *Caesalpinioideae*. It grows wild in most of the tropics and is considered as a rainy season weed native to South Asia. It's most common English name is sickle senna (Anonymous, 2015) ^[3] or sickle wild sensitive-plant (Anonymous, 2007) ^[2]. Tarwad with high nutritive value is available abundantly in India. It is an "Underutilized Vegetable", plant resistant to pests, diseases and thrives well in minimally nutritive soils. It is an annual foetid herb, 30-90 cm high. Leaves are green in colour, pinnate, up to 6-8 cm long, leaflets are in 3 pairs, distinctly petioled, opposite, conical at one end, ovate, oblong and base oblique. Flowers are pale yellow in color usually in nearly sessile pairs in the axils of the leaves with five petals, upper one are very crowded. Pods are substrate or 4 angled, very slender, 6-12- inch-long, incompletely septet, membranous with numerous brown oblong, rhombohedral seeds (Bhandirge *et al.*, 2016) ^[5]. The main useful parts of tarwad are leaves, roots and seeds. Tarwad seed contains a gum of commercial interest in addition to protein (Victor and Abbott, 2005) ^[21]. Nowadays a natural gelling agent like guar gum, having industrial and food applications is also being made from the tarwad seeds. Seed gum can be used in food, feed, paper, textile, petroleum recovery and pharmaceutical industries.



Plate 1: Tarwad seed

Roasted tarwad seeds have a special flavour and color, and most of it is conventionally consumed as a healthy tea beverage in China. It is known as Juemingzi in China. Methanol extract from tarwad seeds has demonstrated inhibitory effect on lipid peroxidation (Zhenbao *et al.*, 2006) ^[23]. Currently tarwad seeds are being used as a source of galactomannan gums in the food industry. Tarwad seed meal is a protein rich by-product of gum extraction industry and its major protein consists of in germ and husk. It is a good source of protein (20-24%) and essential amino acids which can be used as a valuable feed ingredient in the diets of livestock, avians and fish, under Indian feeding conditions (Patel *et al.*, 2016) ^[16].

Tarwad is well known medicinal plant commonly found in India and other tropical countries. Various medicinal properties of tarwad have been mentioned in the Indian Ayurvedic and Chinese traditional system such as a laxative, antiseptic, antioxidant, antiperiodic and useful in treatment of leprosy, ringworm, bronchitis, cardiac diseases, hepatic disorder, liver tonic, hemorrhoids, and ophthalmic, skin diseases. It also possesses antimicrobial, antihepatotoxic, hepatoprotective antidiuretic, antidiarrhoeal, anti-mutagenic, anti-inflammatory,

antidiabetic, hypolipidemic, anti-proliferative, antigenotoxic, immuno-stimulatory activities, etc. (Shukla *et al.*, 2013) ^[19]. Tarwad seeds contain antinutritional factors such as total free phenolic tannins and trypsin inhibitors. However, these antinutritional factors probably have little nutritional significance if the seeds are properly processed (Vadivel and K. Janardhanan, 2005) ^[20]. Proteins were also found in good proportion and they were important and act as enzyme, hormones and antibodies, proteins also helps in the formation of bones, hair and it contributes less energy than 30 calories and thus prevent obesity and other related disease. A diet of fat providing 1-2 per cent is sufficient for a human being. High amount of carbohydrates was essential for maintenance of life in plant and animals and also provide raw material for many industries (Oke, 2014) ^[12].

Shaikh and Syed (2015) ^[18] studied phytochemical proximate and nutrient analysis of cassia tora seeds and reported that the seeds sample contained tannin, saponin, protein, steroids, terpenoids, carbohydrate, alkaloids, flavonoids and glycosides. Proximate analysis of moisture, ash, fat and mineral analysis of calcium, magnesium, iron, nitrogen and solubility were checked. The value of it is moisture (56 per cent), cold water (52 per cent), hot water (54 per cent), 1 per cent NaOH (43 per cent), 1 per cent HCl (61 per cent), benzene + alcohol (35 per cent), ash content (17 per cent). These results indicate that the seeds of tarwad contain mineral and nutrients elements that will be useful in nutrition. Also the existence of some phytochemicals like tannin, saponin and steroids illustrated medicinal action of the plant in its therapeutic uses.

The engineering properties of tarwad seed are important for designing of equipment and machines for storage, grading, sorting, dehulling, grinding etc. Engineering properties of tarwad seed namely size dimensions (length, width, seed mass) thousand seed mass, density, bulk density, true density, shape, angle of repose, colour and chemical properties namely moisture, ash content, crude fiber, crude protein, carbohydrate, crude fat, true protein, content are important for nutritional study and product development.

Materials and Methods

Tarwad seed 5 kg was procured from the local market of Nashik. It was cleaned manually to remove all foreign matter, dust and dirt, broken and immature seeds. The cleaned seed was dried at 55 °C temperature in cabinet dryer.

Milling Tarwad Seed

Well dried tarwad seed was collected from the dryers, cooled to room temperature and then milled in to powder in box type flour mill available in the laboratory of Dept. of APE, Dr. A.S.C.A.E.&T., Rahuri. Powder was packed in polyethylene bags of 50µ thickness and stored at room temperature.



Plate 2: Tarwad Seed Powder

Engineering properties of tarwad seed powder

Engineering properties of food materials are of great relevance in characterization, processing, and packaging of foods as well as monitoring and maintaining the eating quality

Average particle size

The average particle size of a powder, or granular material, or particles dispersed in the particle-size distribution of a material can be important in understanding its physical and chemical properties. To determine the particle size distribution of tarwad seed powder in analytical sieve shaker (equipped with 30, 60, 80, 100 and 150 mesh sieves) method was used. 100 gm of sample placed on top of sieve shaker for 20 minutes. The material retained on each sieve was weighed carefully and expressed in percent of original sample. Then Fineness modulus was determined by adding weight fractions retained above each sieve and dividing the sum by 100. The average particle size D was determined by following expression.

$$\text{Average particle size (mm)} = 0.135(1.366) \text{ FM} \quad (1)$$

Where

FM - Fineness modulus

Bulk density

Bulk density is the weight of a unit volume of a loose material to the same volume of water. It is expressed in grams per ml. Bulk density is an important primary measurement for determining the quality of incoming raw material. The bulk density of tarwad seed powder was determined by bulk density apparatus. The weight of the tarwad seed powder was measured by using electronic weighing balance.

Volume of tarwad seed powder was measured by pouring the powder into the measuring cylinder. Bulk density was calculated weight of tarwad seed powder divided by volume of tarwad seed powder and then observations are noted in Table 2 (Emeje et al., 2009) [7].

$$\text{Bulk density, (g/ml)} = M/V \quad (2)$$

Where

M = bulk weight of tarwad seed powder, g

V = apparent volume of tarwad seed powder, ml

Tapped density

The tapped density is obtained by mechanically tapping a graduated cylinder containing the sample until little further volume change is observed. The tapped density of tarwad powder was determined by using the tapped volume of tarwad seed.

Tapped volume of tarwad seed powder was obtained pouring the seed powder into measuring cylinder then tapping 50 times on the table and observation noted in Table 2 (Emeje et al., 2009) [7].

$$\text{Tapped Density, (g/ml)} = M/V_t \quad (3)$$

Where,

M = bulk weight of tarwad seed powder, g

V_t = volume of tarwad seed powder after tapping, ml

Angle of Repose

The angle of repose is a parameter commonly used for the evaluation of interparticle force. Briefly, the powder was poured through a glass funnel from a definite distance to the

smooth horizontal surface until a heap of maximum height was formed in a conical form. It was determined by heap method reported by Martin et al., (1991).

The diameter and the height of the heap were determined and observations are noted in Table 2. The tangent of the angle was determined by following expression,

$$\text{Angle of Repose } (\theta) = \tan^{-1} [h/r] \quad A = \pi r^2 \quad (4)$$

Where

h = the height of heap

r = the radius of heap made by powder.

Compressibility (Carr's) index

Carr's index is an indication of the compressibility of a powder. The simplest method of measurement of free flow of powder is compressibility, an indication of the ease with which material can be induced to flow is given by compressibility index (I) which is reported in literature and the observations are given in Table 2 (Joshi and Biyani, 2015) [10].

Where

ρ_t = indicates the tapped density, (g/ml) ρ_b = indicates the bulk density, (g/ml)

Hausner's ratio

The Hausner ratio is a number that is correlated to the flowability of a powder or granular material. The Hausner ratio is used in a wide variety of industries as an indication of the flowability of a powder. To measure the hausners ratio following formula was used and the observations are given in Table 2 (Joshi and Biyani, 2015) [10].

$$\text{Hausner's ratio} = \rho_t / \rho_b \quad (5)$$

Where

ρ_t = indicates the tapped density of gum, (g/ml) ρ_b = indicates the bulk density of gum, (g/ml)

Table 1: Specifications for Carr's index and Hausner's ratio

Sr. No	Flowability	Carr's index (%)	Hausner's ratio
1.	Excellent	0-10	1.00-1.11
2.	Good	10-15	1.12-1.18
3.	Fair	16-20	1.19-1.25
4.	Possible	21-25	1.26-1.34
5.	Poor	26-31	1.35-1.45
6.	Very Poor	32-37	1.46-1.59
7.	Very, Very poor	>38	>1.60

(Source: Lebrun et al. 2012)

Colour

Aspect and colour of the food surface is the first quality parameter evaluated by consumers and is critical in the acceptance of the product, even before it enters the mouth. Colour of this surface is the first sensation that the consumer perceives and uses as a tool to accept or reject food.

Observation of colour thus allows the detection of certain anomalies or defects that food items may present. The change in the colour (ΔE) was observed using a Hunter Lab Colourimeter and the values of L, a, b was used to measure the colour change and the microbial load was analyzed using the plate count method. The delta values (ΔL, Δa, and Δb) indicate how much a standard and sample differ from one another in L, a, and b. The ΔL, Δa, and Δb values are often used for quality control or formula adjustment. Tolerances may be set for the

delta values. Delta values that are out of tolerance indicate that there is too much difference between the standard and the sample. The L value for each scale therefore indicates the level of light or dark, the value indicates redness or greenness, and the b value indicates yellowness or blueness. All three values are required to completely describe an object's colour.

Surface colour was assessed with a Premier Colour scan Instruments of make: BYK Gardner Instruments, Germany. The colour of dried Tarwad seed powder was expressed as L* (lightness), a* (redness), b* (yellowness) Hunter scale parameters.

L scale: Light vs. dark where a low value (0-50) indicates dark and a high value (51-100) indicates light.

a scale: Red vs. green where a positive value indicates red and a negative value indicates green. b scale: Yellow vs. blue where a positive value indicates yellow and a negative value indicates blue.

The desired Hunter scale parameters colour change ΔE^* is calculated from L*, a* and b* values

$$\Delta L^* = L^* \text{ sample} - L^* \text{ standard}$$

$$\Delta a^* = a^* \text{ sample} - a^* \text{ standard}$$

$$\Delta b^* = b^* \text{ sample} - b^* \text{ standard}$$

$$\text{Colour change, } \Delta E^* = [(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2]^{1/2}$$

Chemical Properties of Tarwad seed powder Mineral composition

Minerals have specific chemical compositions, with a characteristic chemical structure. Minerals are solids that are formed naturally through inorganic processes. Mineral composition of tarwad seed powder was determined by atomic absorption spectrometry after acid digestion of the samples. Approximately 3g of the sample in a crucible was subjected to 550 °C for 4 hours, cooled and 2.5mL HNO₃ was added. The solution was filtered and diluted up to 100 ml with distilled water. The solution was analyzed for Ca, Mg, Fe, Cu, Zn by using atomic absorption spectrophotometer and flame absorption spectrometry. The results obtained while using a working standard of 1000 ppm for each of the species and the observations are given in Table 3.

Chemical Properties

A chemical property is a characteristic or behavior of a substance that may be observed when it undergoes a chemical change or reaction. Chemical properties are seen either during or following a reaction since the arrangement of atoms within a sample must be disrupted for the property to be investigated. This is different from a physical property, which is a characteristic that may be observed and measured without changing the chemical identity of a specimen. Tarwad seed powder was prepared by drying after drying grained the seed. Fresh and stored powder was used for the chemical properties viz. crude protein, crude fats, carbohydrates, moisture, ash content was done in accordance with the "Association of Official Analytical Chemists" (AOAC, 1995) [4] methods. Nitrogen was analyzed by Micro-Kjeldahl method (AOAC, 1995) [4] and was multiplied by 6.25 for converting into crude protein and the observations are given in Table 4.

Results and Discussion

Engineering Properties of Tarwad Seed Powder

Colour: From Table 2 it is observed that the average of colour value of L*, a*, b* was found to be 71.25, - 0.4015, 34.0825. From these values it is observed that the colour of tarwad seed

powder was found to be brown or yellowish. Similar results are reported by (Joshi and Biyani, 2015) [10].

Angle of repose: From Table 2 it is observed that the average of angle of repose of tarwad seed powder was found to be 35.01±0.46 degree. Angle of repose of tarwad seed powder was found in the range of 34.14 to 35.53 degree. Similar results are reported by (Joshi and Biyani, 2015) [10].

Bulk and tapped density: From Table 2 it is observed that the average of bulk density of tarwad seed powder was found to be 0.608±0.019 g/ml. Bulk density of tarwad seed powder was found in the range of 0.58 g/ml to 0.62 g/ml. From table 2 the average of the tapped density value of tarwad seed powder was found to be 0.690±0.023 g/ml. Tapped density of tarwad seed powder was found in the range of 0.66 g/ml to 0.71 g/ml. Similar results are reported by (Joshi and Biyani, 2015) [10].

Compressibility (Carr's) index: From Table 2 it is observed that the average of the compressibility (Carr's) index of tarwad seed powder was found to be 11.70±3.38 per cent. Compressibility index of tarwad seed powder was found in the range of 6.27 to 17.69 per cent. Similar results are reported by (Joshi and Biyani, 2015) [10].

Hausner's ratio: From Table 2 it is observed that the average of hausner's ratio was found to be 1.12±0.03. Hausner's ratio of tarwad seed powder was found in the range of 1.07 to 1.21. Similar results are reported by (Joshi and Biyani, 2015) [10].

Average Particle Size

From Table 2 it is observed that the average of the average Particle size of tarwad seed powder was found to be 0.33±0.1mm. Average particle size of tarwad seed powder was found in the range of 0.31 mm to 0.34 mm.

Table 2: Engineering Properties of Tarwad Seeds Powder

Sr. No	Parameters	Minimum	Maximum	TSP (Average value)
1.	Colour	Yellowish	Yellowish	Yellowish
2.	Angle of Repose (Degree)	34.14	35.53	35.01±0.46
3.	Bulk Density (g/ml)	0.58	0.62	0.608±0.019
4.	Tapped Density (g/ml)	0.66	0.71	0.689±0.023
5.	Carr's Index (%)	6.27	17.69	11.70±3.38
6.	Hausner's Ratio	1.07	1.21	1.12±0.03
7.	Average Particle Size (mm)	0.31	0.34	0.33±0.1

Values are mean ± S.D

Chemical Properties of Tarwad Seeds Powder

Minerals Content

From Table 4 it is observed that the mineral content of tarwad seed powder was found to be Ca (70.522± 0.791), Mg (11.122± 0.350), Fe (0.4596± 0.123), Cu (0.003± 0.001) and Zn (0.8483± 0.105). Similar results are reported by Olapade *et al.*, 2012, 2014 [14, 15], El-Adawy and Taha (2001) [6], Olaniyi *et al.*, 1993 [12] and Adejumo *et al.*, 2009 [1].

Table 3: Mineral Content of Tarwad Seeds Powder

Sr. No.	Mineral element	Average Value (mg/l)
1.	Ca	70.522± 0.791
2.	Mg	11.122± 0.350
3.	Fe	0.4596± 0.123
4.	Cu	0.003± 0.001
5.	Zn	0.8483± 0.105

Values are mean ± S.D

Chemical properties**Moisture content**

From Table 4 it is observed that the average of the moisture content of tarwad seeds powder was found to be 5.55 ± 0.03 per cent. Similar results are reported by Olapade *et al.*, 2012, 2014^[14, 15], Adejumo *et al.*, 2009^[1].

Ash content

From Table 4 it is observed that the average of ash content of tarwad seeds powder was found to be 3.57 ± 0.01 per cent. Similar results are reported by Olapade *et al.*, 2012, 2014^[14, 15], Adejumo *et al.*, 2009^[1].

Carude fat

From Table 4 it is observed that the average of fat content of tarwad seeds powder was found to be 1.06 ± 0.02 per cent. Similar results are reported by Olapade *et al.*, 2012, 2014^[14, 15], Adejumo *et al.*, 2009^[1].

Crude protein

From Table 4 it is observed that the average of the crude protein content of tarwad seeds powder which was found to be 15.72 ± 0.18 per cent. Similar results are reported by Olapade *et al.*, 2012, 2014^[14, 15], Adejumo *et al.*, 2009^[1].

Crude fiber

From Table 4 it is observed that the average of crude fiber content of tarwad seeds powder was found to be 4.07 ± 0.03 per cent. Similar results are reported by Olapade *et al.*, 2012, 2014^[14, 15], Adejumo *et al.*, 2009^[1].

Carbohydrates

From Table 4 it is observed that the average of carbohydrates content of tarwad seed powder was found to be 70.03 ± 0.49 . Similar results are reported by Olapade *et al.*, 2012, 2014^[14, 15], Adejumo *et al.*, 2009^[1].

Non-protein nitrogen (NPN)

From Table 4 it is observed that the average of NPN content of tarwad seeds powder was found to be 0.25 ± 0.030 per cent. Similar results are reported by Meghval, 2012^[11].

True protein

From Table 4 it is observed that true protein content of tarwad seeds powder was found to be (12.37 ± 0.32) per cent. Similar results are reported by Meghval, 2012^[11].

Table 4: Chemical Properties of Tarwad Seed Powder

Sr. No	Parameters	Tarwad Seed Powder(Average)
1.	Moisture (%)	5.55 ± 0.030
2.	Ash (%)	3.57 ± 0.010
3.	Crude fat (%)	1.06 ± 0.020
4.	Crude protein (%)	15.72 ± 0.180
5.	Crude fiber (%)	4.07 ± 0.030
6.	Carbohydrates (%)	70.03 ± 0.490
7.	Non-protein nitrogen (%)	0.25 ± 0.030
8.	True protein (%)	12.37 ± 0.320
9.	Free amino acids (%)	0.99 ± 0.036

Values are mean \pm S.D

References

- Adejumo OE, Ajayi IA. Phytochemical and elemental analysis of some Nigerian herbal plants with known diarrhea properties. *International Journal of Chemistry* 2009;19(1):25-30.
- Anonymous. What's in a cup of coffee, Tea and Coffee Trade Journal 2007

http://goliath.ecnext.com/coms2/gi_0199-6570938/What-s-in-a-cup-of-coffee.

- Anonymous. "Senna tora", Natural Resources Conservation Service Plants Database USDA, Retrieved 10 November 2015
- AOAC. Official methods of analysis, Association of Official Analytical Chemists, Washington, D.C 1995.
- Bhandirge SK, Patel V, Patidar A, Pasi A, Dr. V Sharma. An overview on phytochemical and pharmacological profile of *Cassia tora* Linn, *International Journal of Herbal Medicine* 2016;4(6):50-55.
- El-Adawy TA, Taha KM. Characteristics and composition of different seed oils and flours. *Food Chemistry* 2001;(53):173-175.
- Emeje M, Nwabunike P, Isimi C. Isolation, Characterization and Formulation Properties of a new Plant Gum Obtained from *Cissus* references. *Int. J. Green Pharmacy* 2009;3(1):16-23.
- Farooq U, Malviya R, Sharma PK. Extraction and Characterization of Artocarpus Integer Gum as Pharmaceutical Excipient. *Polim. Med* 2014;44(2):69-74.
- Ghadge PN, Prasad K. Some Physical Properties of Rice Kernels: Variety PR- 106. *J. Food Proce. & Technol* 2012;3(8):01-05.
- Joshi, U. M. and K. R. Biyani. 2015. Extraction of a novel seed gum from cassia tora seeds and its characterization, (4) 1: 244- 251.
- Meghval, M. 2012. The fenugreek seed (*Trigonella foenum-graecum*) exhibits marked unpredictability in major engineering properties owing to its varying moisture content (mc%).
- Oke DG. *Chemical Science Transactions* 2014;3(3):1172-1178
- Olaniyi AA, Aiyin JSK, Ogundainii AO, Olugbade TA. Essential Inorganic and Organic Pharmaceutical Chemistry. Shaneson C.I Ltd., Ibadan, Nigeria 1993, 27-90.
- Olapade AA, Akinoso R, Oduwaye AO. Changes in some physicochemical properties of *Cassia sieberiana* seed during roasting. *Nigerian Food Journal* 2012;30(1):26- 34.
- Olapade A. Physical and chemical properties of *Cassia sieberiana* seeds, *International Food Research Journal* 2014;21(2):767-772.
- Patel VSK, Bhandirge A, Patidar A Pasi, Dr. V Sharma. An overview on phytochemical and pharmacological profile of *Cassia tora* Linn, *International Journal of Herbal Medicine* 2016;4(6):50-55.
- Sahay KM, Singh KK. Unit operations of agricultural processing 2012.
- Shaikh R, Syed I. Proximate and phytochemical analysis of *Cassia Tora* Leaf, *Journal of Research in Pharmaceutical Science* 2015;(2):1-3.
- Shukla, S. K., A. Kumar, M. Terrence, J. Yusuf, V. P. Singh and M. Mishra. 2000. The probable medicinal usage of *cassia tora*: an overview. *Online Journal of biological sciences*, 13(1):13.
- Vadivel V, Janardhanan K. Nutritional and antinutritional characteristics of seven South Indian wild legumes. *Plant Foods in Human Nutrition* 2005;60(2):69-75.
- Victor YW, Abbott TP. Gum and protein enrichment from sicklepod (*Cassia obtusifolia*) seed by fine grinding and sieving, *Industrial Crops and Products* 2005;21:387- 390.
- Yadav S, Sharma PK, Goyal NK. Comparative study of Mucilage Extracted from Seeds of *Cassia fistula* and Gum Karaya. *Advances in Biological Res* 2015;9(3):177-181.
- Zhenbao J, Tao F, Guo L, Tao G, Ding X. Antioxidant properties of extracts from juemingzi (*Cassia tora* L.) evaluated *in vitro*, *Swiss Society of Food Science and Technology* 2006;(40):1072-1077.