



## Research Article

# STUDY OF ENGINEERING AND CHEMICAL PROPERTIES OF TARWAD (*CASSIA TORA* L.) SEED POWDER

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**Abstract:** The Study of engineering and chemical properties of *Cassia tora* L. seed powder was conducted and observed that colour values  $L^*$ ,  $a^*$ ,  $b^*$  were found to be 71.25, -0.4015, 34.0825, respectively. Average particle size was found to be  $0.33 \pm 0.1$  mm, bulk density  $0.608 \pm 0.019$  g/ml, tapped density  $0.690 \pm 0.023$  g/ml, angle of repose  $35.01 \pm 0.46$  degree, compressibility index  $11.70 \pm 3.38$  degree and Hausner's ratio  $1.12 \pm 0.03$ . The Calcium, Magnesium, Iron Copper and Zinc was found to be  $70.522 \pm 0.791$ ,  $11.122 \pm 0.350$ ,  $0.4596 \pm 0.123$ ,  $0.003 \pm 0.001$  and  $0.8483 \pm 0.105$  mg/100g, respectively. Protein, fibre, Ash, fat and carbohydrates were found to be 15.72%,  $4.07 \pm 0.03\%$ ,  $3.57 \pm 0.01\%$ ,  $1.06 \pm 0.02\%$  and  $70.03 \pm 0.49\%$ , respectively.

**Keywords:** Legume plant, Milling Tarwad Seed, Chemical Properties, Seed Powder

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## Introduction

There is 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. 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. Tarwad is a Leguminosae crop in the subfamily *Caesalpinioideae*. It grows widely in most of the tropics and is considered as a rainy season weed native to South Asia. Its most common English name is sickle senna or sickle wild sensitive-plant [1]. 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 is very crowded. Pods are substrate or 4 angled, very slender, 6-12-inch-long, incompletely septet, membranous with numerous brown oblongs, rhombohedral seeds [2]. The main useful parts of tarwad are leaves, roots and seeds. Tarwad seed contains a gum of commercial interest in addition to protein [22]. Nowadays a natural gelling agent like guar gum, having industrial and food applications is also being made from the tarwad seeds.

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 [3]. Annual production of tarwad seeds in India is about 30,000 tonnes [4]. 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 [5].



Fig-1 Tarwad seed

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, antidiarrheal, anti-mutagenic, anti-inflammatory, antidiabetic, hypolipidemic, anti-proliferative, antigenotoxic, immuno-stimulatory activities, etc. [6]. 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 [7]. 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 percent 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 [8]. It is also reported that the seeds sample contained tannin, saponin, protein, steriods, terpenoids, carbohydrate, alkaloids, flavonoids and glycosides. Proximate analysis of moisture, ash, fat and mineral analysis of calcium, magnesium, iron, nitrogen and solubility were check. The value of it is moisture (56 percent), cold water (52 percent), hot water (54 percent), 1percent NaOH (43 percent), 1percent HCl (61 percent), benzene +alcohol (35 percent), ash content (17 percent). These results indicate that the seeds of tarwad contain mineral and nutrients elements that will be useful in nutrition[9]. 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 [17-23].

### Material 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-1 Tarwad Seed Powder

### Engineering Properties of Tarwad Seed Powder

Engineering properties of tarwad seed may have a great relevance in characterization, processing and packaging as well as monitoring and maintaining the quality of seeds to be used for various purposes.

#### Average Particle Size

Particle size distribution of tarwad seed powder was determined by the analytical sieve shaker (equipped with 30, 60, 80, 100 and 150 mesh sieves) method. A tarwad seed sample of 100 gm was 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.

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

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-1] [10].

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

Where,

M = bulk weight of tarwad seed powder, g

V = apparent volume of tarwad seed powder, ml

#### Tapped density

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-1] [10].

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

Where,

M = bulk weight of tarwad seed powder, g

V<sub>t</sub> = 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-1]. The tangent of the angle was determined by following expression,

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

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 compressibility of tarwad seed powder (given by compressibility index-I) was determined by equation 5 and the observations are given in [Table-1].

$$\text{Compressibility index, I (\%)} = [(p_t - p_b) / p_t] \times 100 \quad (5)$$

Where,

p<sub>t</sub> = indicates the tapped density, (g/ml)

p<sub>b</sub> = indicates the bulk density, (g/ml)

#### Hausner's ratio

The Hausner's ratio is a number that is correlated to the flowability of a powder material. Hausner's ratio was calculated by following the formula given in equation 6 and observations are given in [Table-1].

$$\text{Hausner's ratio} = p_t / p_b \quad (6)$$

Where,

p<sub>t</sub> = tapped density of gum, (g/ml)

p<sub>b</sub> = bulk density of gum, (g/ml)

#### Colour

The colour of tarwad seed powder was observed using a Hunter Lab Colourimeter and the values of L, a, b were used to measure the colour change. 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 colour change ΔE\* was calculated from and results are given in [Table-1].

L\*, a\* and b\* values

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

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

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

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

## Chemical Properties of Tarwad seed powder

### Mineral composition

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 HNO<sub>3</sub> 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-2].

### Chemical Properties

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" methods [11]. Nitrogen was analyzed by Micro-Kjeldahl method [11] 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-1] 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 *et al.*, 2015.

#### Angle of repose

From [Table-1] 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 [12].

#### Bulk and tapped density

From [Table-1] 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-1] 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 [12].

#### Compressibility (Carr's) index

From [Table-1] it is observed that the average of the compressibility (Carr's) index of tarwad seed powder was found to be 11.70±3.38 percent. Compressibility index of tarwad seed powder was found in the range of 6.27 to 17.69 percent. Similar results are reported by Joshi and Biyani, 2015.

#### Hausner's ratio

From [Table-1] 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.

#### Average Particle Size

From [Table-1] 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 0.31mm to 0.34 mm.

Table-1 Engineering Properties of Tarwad Seeds Powder

S	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-2] 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.*, 2014, El-Adawy and Taha [13], 2001, Olaniyi *et al.*, 1993 [14] and Adejumo *et al.*, 2009 [15].

Table-2 Mineral Content of Tarwad Seeds Powder

SN	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-3] it is observed that average moisture content of tarwad seeds powder was found to be 5.55 ± 0.03 percent. Similar results are reported by Olapade *et al.*, 2014 [16], Adejumo *et al.*, 2009.

#### Ash content

From [Table-3] it is observed that average ash content of tarwad seeds powder was found to be 3.57 ± 0.01 percent. Similar results are reported by Olapade *et al.*, 2014, Adejumo *et al.*, 2009.

#### Fat

From [Table-3] it is observed that average fat content of tarwad seeds powder was found to be 1.06 ± 0.02 percent. Similar results are reported by Olapade *et al.*, 2014, Adejumo *et al.*, 2009.

#### Protein

From [Table-3] it is observed that average protein content of tarwad seeds powder was found to be 15.72 ± 0.18 percent. Similar results are reported by Olapade *et al.*, 2014, Adejumo *et al.*, 2009.

#### Fiber

From [Table-3] it is observed that the average of crude fiber content of tarwad seeds powder was found to be 4.07 ± 0.03 percent. Similar results are reported by Olapade *et al.*, 2014, Adejumo *et al.*, 2009.

#### Carbohydrates

From [Table-3] 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.*, 2014, Adejumo *et al.*, 2009.

#### Non-protein nitrogen (NPN)

From [Table-3] it is observed that the average of NPN content of tarwad seeds powder was found to be 0.25 ± 0.030 percent. Similar results are reported by Olapade *et al.*, 2014, Adejumo *et al.*, 2009.

**True protein**

From [Table-3] it is observed that true protein content of tarwad seeds powder was found to be  $(12.37 \pm 0.32)$  percent. Similar results are reported by Olapade *et al.*, 2014, Adejumo *et al.*, 2009.

Table-3 Chemical Properties of Tarwad Seed Powder

SN	Parameters	Tarwad Seed Powder(Average)
1	Moisture (%)	$5.55 \pm 0.030$
2	Ash (%)	$3.57 \pm 0.010$
3	Fat (%)	$1.06 \pm 0.020$
4	Protein (%)	$15.72 \pm 0.180$
5	Fiber (%)	$4.07 \pm 0.030$
6	Carbohydrates (%)	$70.0.3 \pm 0.490$
7	Non-protein nitrogen (%)	$0.25 \pm 0.030$
8	True protein (%)	$12.37 \pm 0.320$
9	Free amino acids (%)	$0.99 \pm 0.036$

Values are mean  $\pm$  S.D

**Application of research:** This research is useful for controlling the malnutrition of children and women by incorporating *Cassia tora* in the diet. It may also be helpful in controlling the deficiency diseases of human being. As it is a cheaper, safer and easily available source of quality protein, it will be a new source to be used in food products and in food fortification.

**Research Category:** Food technology

**Abbreviations:** NPN: Non-protein nitrogen, CTSP: *Cassia tora* seed powder,

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**Conflict of Interest:** None declared

**Ethical approval:** This article does not contain any studies with human participants or animals performed by any of the authors.

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