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Research Article

A Study on Nutritional and Anti-nutritional Factors in Black Gram (*Vigna mungo*)

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Abstract

Black gram (Vigna mungo) is a significant pulse crop, valued for its nutritional benefits and role in sustainable agriculture. Black gram varieties may differ in physical and nutritional properties based on husk and processing. This study evaluates the nutritional compositions of four black gram varieties: whole with husk (WBGH), whole without husk (WBGoH), split with husk (SBGH), and split without husk (SBGoH), focusing on nutritional (moisture, ash, carbohydrates, protein, fat, dietary fiber) and anti-nutritional elements (oligosaccharides, phytic acid, tannins, and trypsin inhibitors). Samples were acquired from local markets in Tarnaka, Hyderabad, Telangana, cleaned, and prepared for analysis. The analysis revealed that black gram without husk exhibited the highest levels of ash, protein, and carbohydrates, while whole black gram with husk had the most dietary fiber. Tannin and phytic acid levels were elevated in black gram with husk, and the split black gram without husk contained the highest trypsin inhibitors. Verbascose was the predominant oligosaccharide across samples, followed by stachyose, sucrose, and raffinose. Understanding the nutritional differences among these black gram varieties is crucial for enhancing their application in food products and promoting their health benefits. Future research should further explore the nutritional and anti-nutritional profiles, as well as the prebiotic potential of whole black gram.

keywords

Black gram, *Vigna Mungo*, Anti-nutritional Factors, Proximate Analysis, Tannins, Phytic Acid, Oligosaccharides.

1. Introduction

Pulses have been consumed since ancient times and are widely used on a large scale worldwide. These legumes are used as a staple food by many people in various parts of the world [1]. The legume plant generates a pod with seeds inside and belongs to the family Leguminosae. As all pulses are considered legumes, but not all legumes are considered pulses, the terms “Legumes” and “Pulses” are used interchangeably [2]. As per the FAO definition, the term “pulses” is exclusively for crops harvested solely for the dry seed of Leguminous plants. They contain high nutritive value, and the protein content is double when compared to cereals [3]. Legumes play a prospective role in improving the nutritional status of malnourished persons [4]. Pulses occupy an important place in human nutrition. They are valuable sources of proteins, carbohydrates, and other nutrients for the majority of the world population

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(Wani et al, 2013) [5]. Legumes also contain certain phytochemicals like polyphenols, flavonoids, and phytosterols that provide various health benefits [6]. Legumes are also a valuable source of dietary fiber (5–37%), containing significant amounts of both soluble and insoluble dietary fiber. The monomers in legume dietary fibers include glucose, galactose, fructose, arabinose, rhamnose, xylose, and mannose. Legumes also contain significant amounts of resistant starch and oligosaccharides, mainly raffinose, which have been reported to possess prebiotic properties; these are fermented by probiotics to short-chain fatty acids, improving colonic health and reducing the risk of colon cancer. High dietary fiber diets are associated with many health benefits. These include the prevention and possible treatment of diseases and conditions like constipation, obesity, diabetes, heart complications, piles, and some cancers. Compared to animal proteins, plant proteins are relatively inexpensive and easy to obtain [7]. Non-availability and self-restrictions of animal proteins due to religious and cultural practices make some population groups prefer plant protein consumption [8].

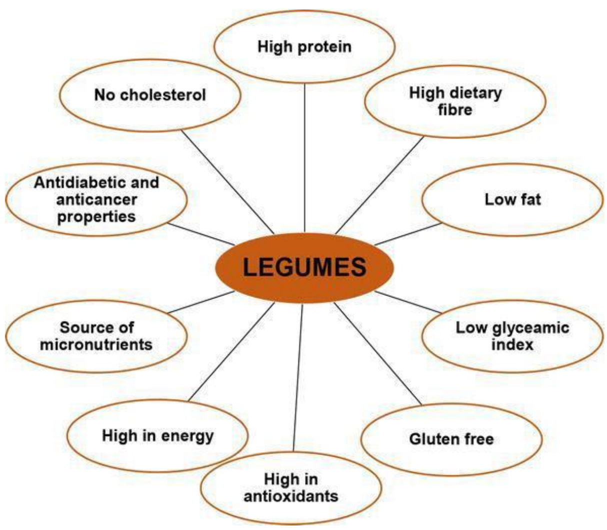


Figure 1. *Desirable attributes of legumes. Source: Maphosa and Jideani, 20171.*

There is convincing evidence that people who consume plant protein have lower rates of coronary heart disease [9]. Due to this, low-fat, high-protein pulses are used extensively in South East Asia in numerous food products and remain largely unexplored in the Western world. However, grains contain relatively low amounts of lysine, whereas pulses contain an appreciable quantity [10]. Legumes lack sulfur-containing amino acids. When pulses are combined with cereals, the content of essential amino acids increases in the consumer's diet (Boye et al, 2010). The nutritive value of pulses depends upon the presence of the anti-nutritional factors, which are responsible for the decreased availability of certain nutrients to the body [49].

Black gram is a tropical Leguminosae family plant product, which belongs to the Asiatic Vigna species. Black gram (*Phaseolus mungo / Vigna mungo*), also known as Mash bean or Urad bean, belongs to the Leguminosae family [12]. It has been cultivated largely in tropical and sub-tropical countries. In India Black gram is very popularly grown in many states. It is grown in Kharif and Zaid seasons [13]. Black gram seeds contain a moderately high number of calories (350cal/100g), carbohydrates (56.6%), protein (26.2%), and fat (1.2%). In addition, Additionally, it is high in vitamins like niacin, vitamin B1, and vitamin B2, as well as minerals like calcium, iron, and phosphorus. [14]. Nutrient availability is hampered by antinutritional substances such as a-galactosides, trypsin, chymotrypsin inhibitors, phytates, lectins, and polyphenols. [15].

Origin, Production Status, Nutritional Composition, and Utilization: Black Gram (Vigna mungo L.)

Black gram (*Phaseolus mungo L. or Vigna mungo L*) is commonly known as urad bean or mash [12]. The name 'Black gram' was given to it due to the color of its seed coat [16]. Vigna mungo, commonly known as black gram, is a highly valued legume primarily found in the Indian subcontinent, originating from Central Asia and India. India is the largest producer and consumer, accounting for 70% of the global production, yielding about 24.5 lakh tonnes annually from 4.6 million hectares, with a productivity of 533 kg/ha in 2020-21. Black gram makes up 23% of India's total pulse production, predominantly grown in Madhya Pradesh, Uttar Pradesh, Andhra Pradesh, and Tamil Nadu. The national yield average is 585 kg/ha, with Bihar recording the highest yield at 898 kg/ha. [17]. The lowest yield was recorded in the state of Chhattisgarh (309kg/ha), followed by Odisha (326kg/ha) and Jammu and Kashmir (385kg/ha) [18]. In Tamil Nadu, 573 thousand tonnes of pulses are produced across 927 thousand hectares. India cultivates various pulses, including black gram, green gram, chickpea, and lentil. It is a tropical annual herb that grows throughout the country. The mature pods are brown, 6-8 mm long, and covered in long hairs, while the seeds are black with a white hilum and smooth coats. This crop enhances soil fertility by fixing atmospheric nitrogen and is resilient to adverse climatic conditions. Various commercial varieties have been developed based on their nutritional value, as black gram is a significant protein source in the Indian diet [19]. It contains on average 10.9% moisture, 24% protein, 1.4% fat, 0.9% fiber, and 55.6% carbohydrates [20] and it also contains calcium (145mg/100g), Iron (7.8mg/100g), a small amount of vitamin B1 (0.58mg/100g), vitamin B2 (0.26mg/100g), vitamin-A (300 IU), vitamin C (5.0mg/100g) and Niacin (2.0mg/100g) [21].

In the Indian diet, black gram is vital as it provides about 26% protein, nearly three times that of cereals, along with essential vitamins and minerals. It also serves as nutritious fodder for milch animals [20]. Black gram is used for the preparation of different food products. It is utilized in different forms, like whole, boiled, or split into dhal. It is also used for making papad and curries and for supplementing wheat flour in different products [22]. Dehusked cotyledon is used for the preparation of fermented foods such as idli, and dosa, and non-fermented foods like cooked dhal, hopper, papad, and waries (spicy hollow balls) [23]. Whole black gram flour and jaggery are used to prepare sweets, which were regarded as nutritious in India. It has been reported that the quality of Buffalo meat burgers improved when black gram flour was included in the preparation [24] and of beef sausages [25], and the nutritional quality of biscuits [26].

1.1. Structure Of Black Gram

Legumes belong to the family Leguminosae, with Black gram being a notable example. The mature seeds comprise three main components: the seed coat (7-15% of the mass), cotyledons (about 85%), and the embryo (1-4%). The seed coat, or testa, covers the seed and features the hilum (an attachment scar), micropyle (an opening), and raphe (a ridge opposite the micropyle). When the seed coat is removed, the embryonic structure remains, consisting of two cotyledons connected at the axis. The seed is vulnerable to breakage due to weak protection from the coat. The species is an annual bush that can grow 30–100 cm tall, with hairy leaves and narrow cylindrical pods up to 6 cm long [19]. The general structure of black gram fruit

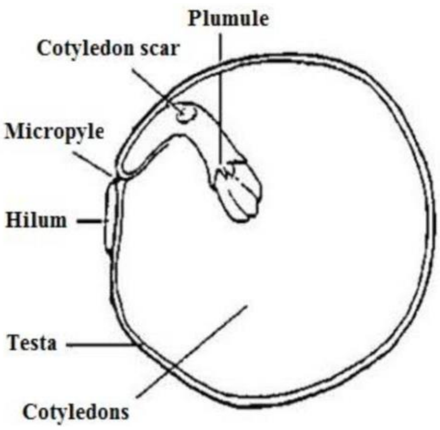


Figure 2. *Structure of Black gram seed.*

1.2. Nutritional Composition of Black Gram

Black gram seeds have a high caloric value (350 cal/100 g), with carbohydrates (56.6%), protein (26.2%), and low fat (1.2%). They are rich in minerals like calcium, iron, and phosphorus, and vitamins such as B1, B2, and Niacin [15]. The mashed seeds are ideal for energy, particularly to prevent marasmus in infants. Rich in dietary fiber, they help prevent diseases like diabetes and cardiovascular issues [27] and contribute to lower obesity and cancer risks. With a high protein and lysine content—both of which are usually scarce in cereals—black gram provides a well-balanced amino acid profile. [28]. Combining pulses with cereals enhances essential amino acid intake [11]. Their digestibility and other health advantages, such as cholesterol reduction, further bolster the quality of their protein. [17]. Black gram can be used in a variety of nutrient-dense food products, such as baked goods. [28]. Rich in magnesium and potassium, they enhance digestion, lower cholesterol, and support heart health. Black gram also works well for liver stimulation and colic issues. [29].

1.3. Anti-nutritional Reasons in Black Gram

The black gram also contains bioactive substances called “anti-nutritional factors” [47]. They contain several toxic constituents such as flatulence-causing raffinose-family oligosaccharides, protease inhibitors, tannins, saponins, phytic acid, etc. Anti-nutritional components like tannins, phytates, and trypsin inhibitors, and the structural distinctiveness of storage proteins, slow down the digestibility of legume proteins. Saponins, naturally occurring surface-active glycosides, are dangerous compounds as they show serious effects on all metabolism pathways [30]. These are secondary plant metabolites found in pulses that include an aglycone, which can have a steroidal or triterpenoid structure, attached to a carbohydrate moiety (mono/oligosaccharide). Even if the presence of saponins lowers the nutritional content of pulses, they still seem to be advantageous because they lower cholesterol in the body and are essential for human nutrition, lowering the risk of heart disease and preventing colon cancer. Processing methods such as soaking, germination, and boiling can lower the saponin level. Soaking the pulses lowers their saponin concentration by 5 to 20% [31, 32]. Increasing the soaking time significantly lowers the pulses' saponin content. The leaching of saponins into the soaking media may be the cause of the drop in saponin content in pulse seeds during soaking [32]. The saponin content of different pulses is decreased during germination. Saponins in urd beans are reduced by 22% after 48 hours of sprouting [31, 32]. The loss of saponins rises as the germination period lengthens.

Phytic acid decreases the nutrient absorption and ingestion of food. Divalent and trivalent cations form insoluble complexes with phytic acid and make them unavailable for intestinal absorption [33]. It reduces the bioavailability of nutrients by binding and forming insoluble complexes with proteins and starches [34]. Soaking, cooking presoaked beans, or germination may cause the phytic acid content to drop because this compound leaches out into water. In a similar vein, it has been noted that roasting and autoclaving reduce phytic acid in black beans [36] and black gram [35]. The bioavailability of minerals is thought to be reduced by phytates. The tannin content was considerably raised as a result of various treatments, in contrast to trypsin inhibitory activity and phytic acid level. Soaking, autoclaving, and roasting of presoaked beans demonstrated a moderate increase, while germination and cooking showed the greatest increase. Some authors have reported a similar trend [3]. Different process methods, including soaking, cooking, roasting, and autoclaving, significantly reduced the amount of phytic acid while also significantly reducing the amounts of tannins. The roasted sample showed a somewhat greater reduction in phytic acid content than the other samples [37]. The de-phenols. Tannin (polyphenols) is known to form complexes with proteins under certain pH conditions. According to reports, tannin-protein complexes can dissociate and be eliminated along with feces. The black gram, or urad bean, has the highest tannin content in its seeds. It seems that the color of the seed coat affects the amount of tannin in pulses. In general, light-colored seeds have fewer tannins than dark-colored brown pulses. Phaseolus vulgaris with white seeds has very little tannin, whereas those with colored seeds have a lot of tannin. [38, 39].

Beans' tannin content varies as the seeds mature [40]. The amount of tannin in the urad bean's cotyledon (16-33 mg/g) and entire seed (540–1197 mg/g. Tannins combine with certain ions like iron as well as proteins, carbohydrates, and other biomolecules in food. The hydrogen bonding affinity of the peptide group's carboxyl oxygen is responsible for tannins' higher propensity to form complexes with proteins than with carbohydrates and other food polymers. Two or more peptide group carboxyl oxygens are bound by a single tannin molecule, potentially creating cross-links between the protein chains [41]. Dehulling, or milling and separating hulls, reduces the tannin content of pulses and enhances their nutritional quality. Tannins are primarily found in the seed coat. About 68 to 99 percent of a seed's tannins are removed by dehulling. A common household practice is to soak seeds before cooking to speed up the cooking process and soften the texture. The digestive enzymes are impacted and the digestibility of proteins is decreased when tannins (polyphenols) interact with both enzyme and non-enzyme proteins to form a tannin-protein complex [42]. The dark color of black gram seeds is caused by the presence of tannins and polyphenols in their seed coat. The absorption and bioavailability of nutrients in the human diet are decreased by these anti-nutritional factors. Thus, numerous attempts have been made to reduce the amount of these anti-nutritional factors; soaking black gram was found to reduce the amount of polyphenol and phytic acid by 25% [43].

Black gram, like other legumes, contains raffinose family oligosaccharides, which make up 31–76% of soluble sugars and can induce flatulence. This is primarily due to the colonic fermentation of undigested carbohydrates in the absence of the enzyme α-galactosidase in humans. This fermentation produces gases such as carbon dioxide, hydrogen, and methane, leading to bloating and discomfort. Despite these negative effects, oligosaccharides have beneficial properties, acting as prebiotics that promote the growth of healthy gut bacteria like Bifidobacteria spp. In Japan, soybean oligosaccharides are even considered a sugar substitute. Various practices such as malting, dehulling, and cooking can reduce the oligosaccharide content in legumes. Additionally, black grams require processing techniques like soaking and cooking to minimize their anti-nutrient factors before consumption [44]. The most effective processing treatment methods are pressure cooking and germination. Combining dehulling and soaking reduces the toxins in black gram. Techniques like roasting, autoclaving, and cooking can improve legume protein digestibility. Legumes' high amylase content makes starches less digestible, which helps control blood glucose levels, benefiting diabetic patients. This may explain why traditional healers prescribe mash beans for diabetes [43].

1.4. Importance of Black Gram

Black gram is the third most important legume in South Asia. It originated in India, where it has been in cultivation since ancient times. Total black gram production is 2 million tonnes, which is the cheapest source of protein in many communities. It is consumed in the form of dal (whole or split, husked or unhusked or parched). In India, in particular, and in Asia in general, black gram is a significant component of many Cultural dishes. There are various side dishes, such as bread, soups, Stews, curries, and more. Exotic cuisines heavily rely on it as an essential component. The nutrients, especially protein, various vitamins, essential minerals, fiber, and antioxidants that help improve hair, skin, and internal health in various ways are all abundant in this excellent bean. Black Gram gradually becomes popular in dishes all over the world due to these nutritious contents. Our diet and animal feed heavily rely on protein and phosphoric acid, which play a crucial role in maintaining soil fertility. This is achieved by enhancing soil physical characteristics and addressing atmospheric nitrogen levels, making it a crucial component [44]. Rheumatic pains, stiff should ers, and contracted knees can all be treated with black gram's medical properties. In addition, high levels of magnesium and Folate help to lower cholesterol, which ultimately improves cardiovascular health and supports blood circulation.

Some health benefits of black gram are the following:

1) It improves digestion.
2) It is good for diabetics.
3) It reduces pain.
4) It is good for the skin and heart.
5) It boosts bone mineral density.
6) It is a diuretic.
7) Energy booster [44].

2. Materials and Methods

Four varieties of black gram samples were obtained: Whole black gram with husk, whole black gram without husk, split black gram with husk, and split black gram without husk. After thorough cleaning, the samples were ground into flour and stored at -20 ℃. If fat content exceeded 10%, defatting with petroleum ether was performed, followed by homogenization and drying.

The AOAC method 934.01 was used to measure the moisture content, and the AOAC method 942.05 was used to determine the ash content. The Kjeldahl method was used to estimate protein [45].

For glucose determination, a standard curve is plotted using absorbance at 620 nm (A620) against glucose concentration. The gravimetric chloroform method was employed to estimate total fat by extracting lipids with a chloroform-methanol solution after acidifying the sample. Dietary fiber content was estimated using the AOAC method 962.09, which involves gelatinizing fat-free samples and precipitating soluble dietary fibers with ethanol [45].

Essential apparatus for the dietary fiber assay includes fritted crucibles, a vacuum source, an air oven, a desiccator, a muffle furnace, beakers, an analytical balance, and a calibrated pH meter. Crucibles must be washed, heated at 525 ℃, soaked in water, and dried. Necessary reagents include enzymes from a Total Dietary Fiber Assay Kit, buffer solutions, and specific NaOH and HCl solutions [45].

The procedure for analyzing dietary fiber involves mixing a moisture and fat-free sample with phosphate buffer, incubating, and adding α-amylase and protease. For soluble dietary fiber, additional filtration and alcohol treatments are performed. Tannin content is determined using a colorimetric method with 1% HCl in methanol, followed by measurement with a vanillin reagent [45].

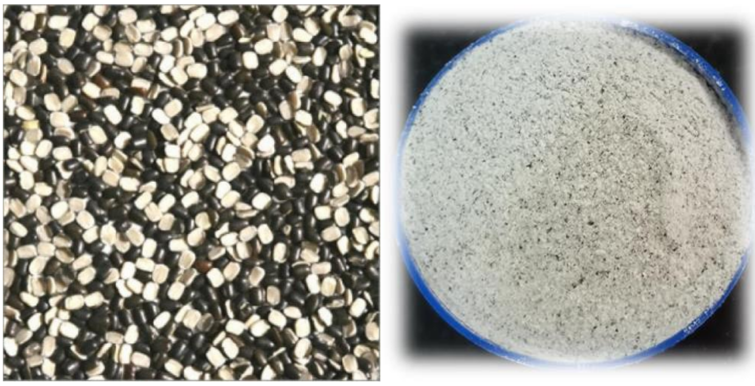
2.1 Materials Required

This document details methodologies for determining phosphorus levels, estimating trypsin inhibitor content, and oligosaccharide analysis. It includes the preparation of various reagents such as HCl solutions for extraction, vanillin reagents for tannin detection, and calibration curves for quantifying phosphorus. Key protocols involve sample extraction, enzymatic reactions at controlled temperatures, and colorimetric determinations at specific wavelengths (e.g., 510 nm for tannins, 655 nm for phosphorus). The procedures also cover trypsin inhibitor activity assays, utilizing acetic acid and absorbance measurements to compare samples against references, and the use of Thin Layer Chromatography (TLC) for oligosaccharide quantification, where black gram flour extracts are analyzed against sugar standards. Stability conditions for reagents and the importance of accuracy in measurements are emphasized throughout the document.

1) Whole black gram with husk

2) Whole black gram without husk

3) Split black gram with husk



4) Split black gram without husk

Figure 3. *Different forms of Black gram samples.*

3. Results

3.1. Moisture Content

The moisture content of the four forms of black gram ranged from *9.18 to 11.48 g/100 g*.

1) Whole black gram with husk (WBGH): *9.18 g%*
2) Whole black gram without husk (WBGWH): *9.72 g%*
3) Split black gram with husk (SBGH): *11.48 g%*
4) Split black gram without husk (SBGWH): *11.00 g%*

Among all samples, *split black gram with husk* exhibited the highest moisture content (11.48 g%), whereas *whole black gram with husk* had the lowest (9.18 g%). No significant differences were observed among the moisture contents of the four forms.

3.2. Ash Content

The ash content ranged from *3.4 to 3.5 g/100 g*.

1) Whole black gram without husk showed the highest ash content (*3.5 g%*).
2) The remaining samples recorded approximately *3.4 g%*.

3.3. Protein Content

Protein content ranged from *25.3 to 27.1 g/100 g*.

1) Whole black gram without husk: *27.1 g%*
2) Whole black gram with husk: *25.3 g%*

Whole black gram without husk had the highest protein content, while whole black gram with husk had the lowest.

3.4. Total Fat Content

The crude fat content ranged from *2.7 to 3.5 g/100 g*.

1) Split black gram with husk: *3.5 g%*
2) Split black gram without husk: *3.5 g%*
3) Whole black gram without husk: *3.3 g%*
4) Whole black gram with husk: *2.7 g%*

The split forms exhibited comparatively higher fat content.

3.5. Available Carbohydrate Content

Available carbohydrate content ranged from *37.8 to 42.7 g/100 g*.

1) Split black gram without husk showed the highest carbohydrate content (*42.7 g%*).
2) Whole black gram with husk had the lowest (*37.8 g%*).

3.6. Total Dietary Fiber

Dietary Fiber content ranged from *13.0 to 20.1 g/100 g.*

1) Whole black gram with husk: *20.1%*
2) Split black gram with husk: *17.7 g%*
3) Whole black gram without husk: *14.9 g%*
4) Split black gram without husk: *13.0 g%*

Whole black gram with husk contained the highest dietary Fiber, whereas split black gram without husk had the lowest.

3.7. Anti-nutritional Factors

3.7.1. Tannins

Tannin content ranged from *0.08 to 0.53 mg CE/g.*

Split black gram with husk exhibited the highest tannin content.

3.7.2. Phytic Acid

Phytic acid content varied among the four forms of black gram, with comparatively higher concentrations observed in samples containing husk.

3.7.3. Trypsin Inhibitor

Trypsin inhibitor activity ranged from *11.3 to 13.76 TIU/g.*

1) Highest: Split black gram without husk (*13.76 TIU/g*)
2) Lowest: Whole black gram without husk (*11.3 TIU/g*)

3.7.4. Oligosaccharides

The oligosaccharides identified included verbascose, stachyose, raffinose, and sucrose.

The concentration ranges were:

1) Verbascose: *1.2–3.3 g%*
2) Stachyose: *0.25–0.80 g%*
3) Raffinose: *0.27–0.76 g%*
4) Sucrose: *0.57–1.66 g%*

Verbascose was the predominant oligosaccharide, followed by stachyose, sucrose, and raffinose.

4. Discussion

4.1. Moisture

The moisture content obtained in the present study (9.18–11.48 g%) is comparable with the findings of [46], who reported 11.41 ± 0.08 g%. Similar moisture values (10.3–11.6 g%) were also reported by [3]. The present results fall within the range reported by [47] (9.2–11.56 g%). The moisture content of the seed coat (11.03 ± 0.49 g%) reported by [48] closely agrees with the present findings. Lower values were reported by [49] (8.70 ± 0.33 g%) and [43] (5.47–6.27 g%). The relatively low moisture content observed in the present study indicates good storage stability and reduced susceptibility to microbial spoilage.

4.2. Ash

The ash content (3.4–3.5 g%) closely agrees with previous reports of [50] (3.4 g%) and [51] (3.2 g%). Similar ranges have also been reported by [5] and [52]. Minor variations may be attributed to cultivar differences, environmental conditions, and processing losses of minerals as suggested by [43]. Ash content serves as an indicator of total mineral composition and overall food quality.

4.3. Protein

The protein content (25.3-27.1 g%) agrees well with previous studies reporting values between 23.91 and 28.4 g% [46, 53]. Higher protein content in dehulled samples indicates that the cotyledons contain a greater proportion of proteins than the seed coat. The comparatively lower protein content of the husk reported by [48] further supports this observation.

4.4. Fat

The crude fat content (2.7–3.5 g%) was higher than values reported by [46, 49, 54, 55]. The higher fat content observed in split black gram may be attributed to varietal differences and processing methods. Since lipids contribute to the energy density and sensory characteristics of foods, split black gram may possess slightly higher caloric value.

Available Carbohydrates

The carbohydrate content (37.8–42.7 g%) was lower than that reported by [53] and [5] but comparable to [49]. The lower carbohydrate content may reflect differences in genotype, growing conditions, and analytical methods. Higher carbohydrate content in dehulled samples indicates concentration of starch-rich cotyledons after husk removal.

4.5. Dietary Fiber

Whole black gram with husk contained considerably higher dietary fiber than dehulled forms. These findings agree with those reported by [49, 53]. The higher fiber content can be attributed to the presence of the seed coat, which is rich in insoluble dietary fiber. Increased dietary fiber intake has been associated with reduced risks of obesity, cardiovascular disease, diabetes, and gastrointestinal disorders. Therefore, whole black gram with husk may provide greater functional health benefits.

4.6. Anti-nutritional Factors

The current study confirmed that these compounds are mostly concentrated in the seed coat by showing higher tannin and phytic acid contents in samples containing husk. Prior studies have emphasized phytic acid's antioxidant and possible anticancer qualities, despite the fact that it can decrease mineral bioavailability by creating insoluble complexes. Tannins and phytic acid are known to be reduced by processing methods like soaking, germination, fermentation, and cooking. The split black gram without a husk had the highest trypsin inhibitor activity. By blocking digestive enzymes like trypsin and chymotrypsin, these protease inhibitors decrease the digestibility of proteins. However, because these proteins are heat-labile, thermal processing effectively reduces trypsin inhibitor activity.

4.7. Oligosaccharides

Verbascose was the predominant oligosaccharide, followed by stachyose, sucrose, and raffinose. The values found were equivalent to those reported by [56]. Oligosaccharides serve as prebiotics at moderate concentrations by promoting beneficial intestinal microbiota. However, excessive intake may lead to flatulence because of microbial fermentation in the large intestine. The balance between sucrose and α-galactosides observed in this study is consistent with previous reports indicating an inverse relationship between their metabolic activities.

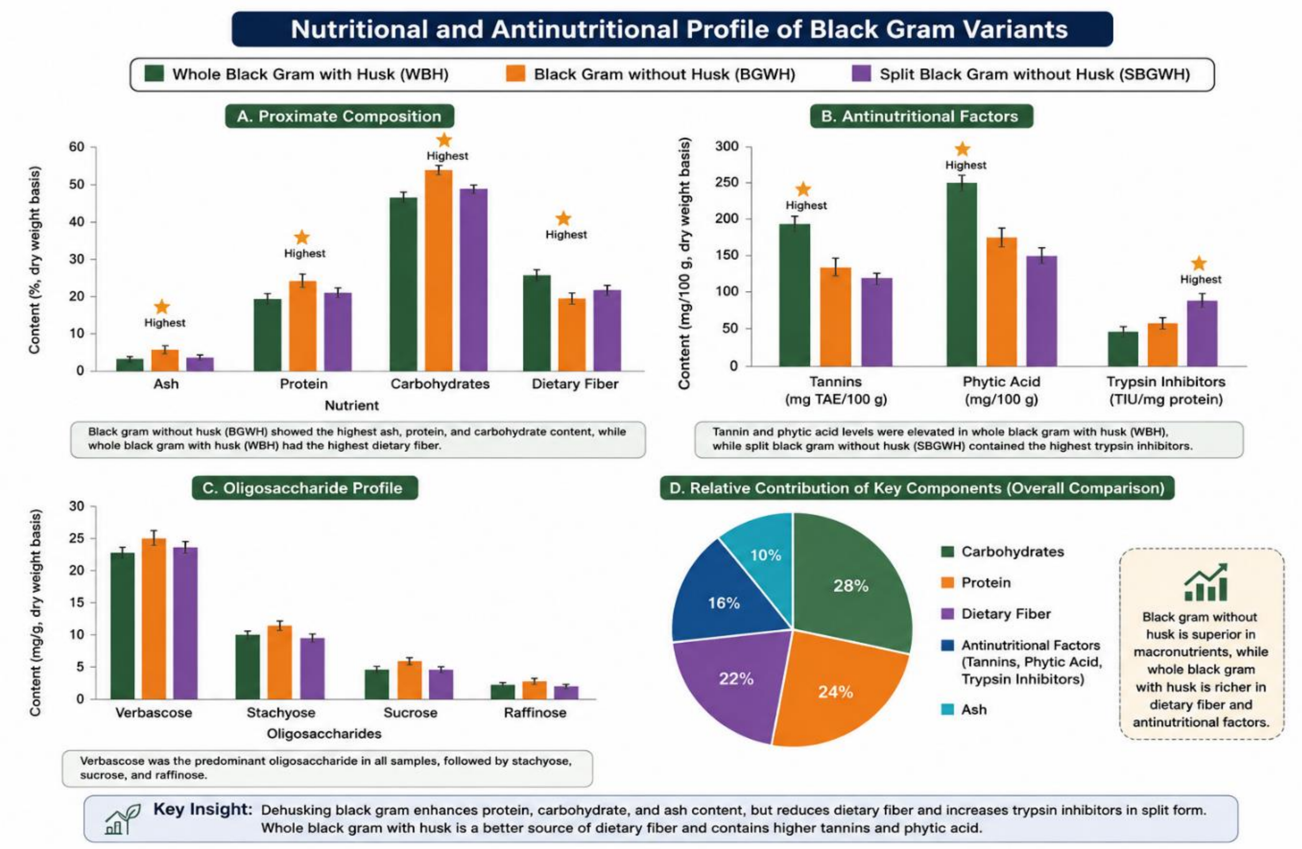


Figure 4. Graphical Summary of Nutritional and Antinutritional Components of Different Black Gram Forms.

5. Conclusion

The current study assessed the proximate and anti-nutritional characteristics of four distinct varieties of black gram. Ash, protein, and carbohydrate contents were highest in black gram samples without husk, according to the results of the proximate composition of four different types of black gram samples. Whole black gram with husk had the highest total dietary fiber content. The factors that prevent nutrition, i.e., the e. The black gram with husk sample had the highest levels of tannins and phytic acid. The split black gram without husk showed the highest content of trypsin inhibitors. Among the four different oligosaccharides, verbascose content was highest in all black gram samples, followed by stachyose, sucrose, and raffinose. The prebiotic potential and other health benefits of black gram can be explored in future work since the current study has revealed the high content of raffinose family oligosaccharides in black gram.

Abbreviations

AOAC	Association of Official Agricultural Chemists
ANF	Anti-Nutritional Factors
BRGR	Black Gram Rich in Germ and Aleurone
BAPNA	N-a-benzoyl-DL-arginine-p-nitroanilide
FAO	Food and Agriculture Organization
IDF	Insoluble Dietary Fiber

SDF	Soluble Dietary Fiber
SBGH	Split Black Gram with Husk
SBGoH	Split Black Gram without Husk
TLC	Thin Layer Chromatography
WBGH	Whole Black Gram with Husk
WBGoH	Whole Black Gram without Husk

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Author Contributions

Jatavath Lavanya: Conceptualization, Formal Analysis, Investigation, Methodology, Project administration, Resources, Writing – review & editing

Devindra Shakkapa: Conceptualization, Data curation, Formal Analysis, Investigation, Methodology, Writing – review & editing

Chitram Umashankar: Data curation, Formal Analysis, Investigation, Resources, Writing – original draft, Writing – review & editing

Data Availability Statement

The data is available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare no conflicts of interest.

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