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RESEARCH ARTICLE

Quantitative Estimation and Comparative Analysis of Polysaccharides and Proteins in Common Dietary Pulses

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ABSTRACT

Pulses are edible seeds from legume plants and are a rich source of polysaccharides and proteins. Estimating the polysaccharide and protein content in pulses provides valuable insights into their nutritional composition. Polysaccharides, primarily in the form of starch and dietary fiber, contribute to the energy content and functional properties of pulses. Proteins, as a major macronutrient in pulses, play a crucial role in human nutrition, particularly as a plant-based protein source.

In the present study, there are four main pulses has been selected for the estimation of polysaccharides and proteins such as *Vigna mungo* (Black gram), *Pisum sativum* (Green peas), *Trigonella foenum graecum* (Fenugreek), and *Cicer arietinum* (Bengal gram) using standardized methods. The dried pulse seeds were powdered and extracted with water to obtain gum.

Total polysaccharides were significantly higher in *Trigonella foenum-graecum* and *Vigna mungo*, while total protein content was highest in *Trigonella foenum-graecum*, followed by *Cicer arietinum*. In both analyses, *Trigonella foenum-graecum* showed the highest levels of estimated phytochemicals, indicating that it contains the highest amounts of bioactive primary metabolites (polysaccharides and proteins). This research report suggested that mung dal and chickpea may also offer significant health benefits. The study recommends including *Trigonella foenum-graecum*, followed by *Vigna mungo* and *Cicer arietinum*, in regular diet to obtain both medicinal and nutritional health benefits.

Keywords: Pulses, Polysaccharides, Proteins, Fenugreek, Bengal gram, Black gram, Green pea

1. Introduction

Plants synthesize a wide array of primary metabolites that serve as essential nutritional resources for humans and herbivorous animals. These compounds not only provide the energy necessary for survival but also contribute significantly to human health by supporting physiological processes and offering various medicinal benefits [1]. Primary metabolites are also involved in the synthesis of essential nutrients and signaling molecules that regulate plant growth and development.

An important application of primary metabolism in food systems is fermentation, a process widely utilized in the production of foods such as bread, yogurt, and alcoholic beverages. During fermentation, microorganisms—particularly yeasts and bacteria—convert carbohydrates into metabolic products like alcohol, carbon dioxide, and organic acids. These by-products influence the texture, flavor, and preservation of food, making fermentation a cornerstone in food processing and preservation [2]. Central metabolic pathways, such as glycolysis and the citric acid cycle, are vital in converting nutrients into ATP, which fuels essential cellular functions across organisms.

Among the primary metabolites, polysaccharides play diverse and critical roles. Biologically, they are involved in cell signaling, adhesion, immune responses, and structural integrity. Industrially, polysaccharides are widely applied in food, pharmaceutical, and biotechnology sectors [3]. Their estimation in food grains is of significant scientific, nutritional, and economic importance. For instance, polysaccharides such as chitosan and alginate are valued for their biocompatibility and are utilized in drug delivery systems, wound healing, and as excipients in pharmaceutical formulations [4]. Hyaluronic acid and heparin serve in tissue engineering, medical implants, and as anticoagulants due to their biological functionality and safety [2].

In the food industry, polysaccharides such as starch, pectin, and carrageenan are employed as thickening agents, stabilizers, and emulsifiers, contributing to improved texture, water retention, and shelf life of food products [5]. Pectin, found abundantly in fruit cell walls, functions as a gelling agent and plays a role in cellular adhesion [6]. Hemicelluloses, including xylans and mannans, interact with cellulose and lignin to confer structural integrity to plant cell walls [7].

Proteins are another fundamental nutrient class, crucial for tissue repair, enzyme and hormone production, and immune function. Adequate intake from diverse sources—including

legumes, fish, eggs, and plant-based proteins—supports overall health and immune resilience. Notably, legumes like beans contain not only high-quality protein but also antioxidants and resistant starches that enhance gut health and modulate inflammation [8].

Rural and traditional diets often emphasize plant-based and legume-rich foods, which are naturally high in fiber, vitamins, and minerals. Such diets are associated with a diverse gut microbiome, reduced systemic inflammation, and improved gastrointestinal health, reflecting benefits similar to those observed in Mediterranean and other plant-based dietary patterns [9].

Among legumes, pulses—the dry edible seeds of the Fabaceae family—have been a cornerstone of global diets for millennia. Rich in plant protein, polysaccharides, dietary fiber, micronutrients, antioxidants, and bioactive compounds, pulses offer substantial nutritional and functional benefits. Numerous studies have highlighted their role in cardiovascular health, glycemic control, and prevention of chronic diseases, underscoring their potential in promoting sustainable and health-conscious diets [10].

Quantifying polysaccharides and protein contents in plants are essential for understanding their nutritional value, monitoring physiological responses, and conducting various biochemical analyses. Accurate estimation of these macromolecules aids in enhancing the utilization of pulses in food and feed industries. Hence, commonly consumed pulses such as *Vigna mungo*, *Pisum sativum*, *Cicer arietinum*, and *Trigonella foenum-graecum* were selected for this study. The research focuses on estimating the polysaccharide and protein contents of these pulses to evaluate their nutritional potential.

2. Materials and Methods

2.1 Collection of Pulses and Isolation of gum

The pulses such as *Vigna mungo, Pisum sativum, Trigonella foenum graecum,* and *Cicer arietinum* are purchased from market. These pulses are belonging to the family Fabaceae. The selected dried pulses of 50g were subjected to dry milling in a mixer and obtained as powder. The obtained powder is soaked in distilled water and shaken frequently for 4-5 hrs. The viscous solution obtained was passed through muslin cloth. The mucilage was precipitated out by adding of 95% ethanol in the ratio of 1:1 by continuous stirring. This solution is dried in oven at moderate temperature and powdered and stored.

2.2 Quantitative Estimation of total Polysaccharides

About 10 mg of gum was dissolved in 100 ml of distilled water. From this 1 ml is used for polysaccharides analysis. To estimate the polysaccharides content in pulses, 1ml of 5% phenol was added to the 1 ml gum solution, followed by 5 ml concentrated H_2SO_4. The absorbance was measured after 10 minutes at 488nm against blank. Aliquots (60-90 µg/ml) of glucose was used as standard [11].

2.3 Quantitative Estimation of total Protein (Lowry's method) [12]

500 mg of gum powder is taken in a mortar and pestle which was added with 10 ml of 0.2M phosphate buffer and ground well, and then it was centrifuged at 2000 rpm for 10 minutes. A clear supernatant is obtained and 1 ml of supernatant is taken and dissolved in 9 ml distilled water. Took 0.5 ml of the unknown protein sample in separate test tubes as triplicates. Added 5 ml of reagent C (Reagent C was obtained from reagent A -2% sodium carbonate in 0.1 N Sodium hydroxide solution and reagent B- 0.5 % of copper sulphate in 1% Potassium sodium tartrate as 50 ml from A is dissolved in 1 ml of B) to each test tubes (aliquot standard-0.2, 0.4, 0.6, 0.8, 1.0ml & samples). Mixed well and incubated at room temperature for 10 minutes. Added 0.5 ml of 50% Folin-ciocalteu reagent to each test tubes. Mixed thoroughly and incubated for 30 minutes at room temperature in the dark. Measured the absorbance at 660 nm using spectrophotometer. Distilled water of 1ml along with all the reagents used as blank.

2.4 Statistical Analysis

The experiments were made as triplicates and calculate Mean ±Standard deviation for each sample. Results were expressed as equivalents of standard per sample.

3. Results and Discussion

3.1 Isolation of gum

The selected pulses such as *Vigna mungo, Pisum sativum, Trigonella foenum graecum,* and *Cicer arietinum* (Figure 1) were powdered. The mucilaginous gum was extracted from each pulse has been oven dried and powdered for the further experiments as an initial step in this study (Figure 2). In a previous study, Camelina (*Camelina sativa* L. Crantz) seeds, especially their bran, contain a significant quantity of monosaccharides and polysaccharides (gums). A decortication procedure was used for improving gum isolation as well as increasing the efficiency of camelina protein isolation and protein quality [13]. Similarly, a new gum was isolated from the roots of *Acanthophyllum bracteatum* (ABG) by warm-water extraction [14].

3.2 Estimation of total Polysaccharides

The extracted gum powder was subjected to polysaccharides estimation (Figure 2 & Table 1). The fenugreek botanically *Trigonella foenum graccum* shows highest polysaccharides as 66.17 µg equivalence Glucose/100 µg followed by Mung dhal (*Vigna mungo*) reported as 61.73 µg equivalence Glucose/100 µg.

Pectic polysaccharides were isolated from the husks of field bean (*Dolichos lab lab*), cowpea (*Vigna sinensis*) and pea (*Pisum sativum*), using HCl (pH 2.0) and 0.5% EDTA at extractants at 70°C, in yields varying from 1.43 to 5.37% [15]. *Kalanchoe pinntum* and *Kalanchoe crenata* (crassulaceae family) leaves and stems of these plants were collected for the gum preparation. According to study, *K. pinnatum* leaves have high content of polysaccharides followed by *K. crenata* leaves as 2.21 and 2.04 (%w/w) respectively [16,17]. In our present study, by comparing the results concluded that *Trigonella foenum graccum*, and *Vigna mungo* have high polysaccharide content than *Cicer arietinum* and *Pisum sativum.*

Table 1: Estimation of total Polysaccharides and total Protein

S.No.	Name of the Pulses	Total Polysaccharides (µg equivalence Glucose/100 µg)	Total Protein (µg BSA equivalence /100 µg)
1.	*Cicer arietinum*	42.06±8.81	**52.61±8.2**
2.	*Pisum sativum*	38.73±6.66	46.81±5.78
3.	*Trigonella foenum graccum*	**66.17±13.56**	**59.11±11.87**
4.	*Vigna mungo*	**61.73±11.46**	24.49±2.44

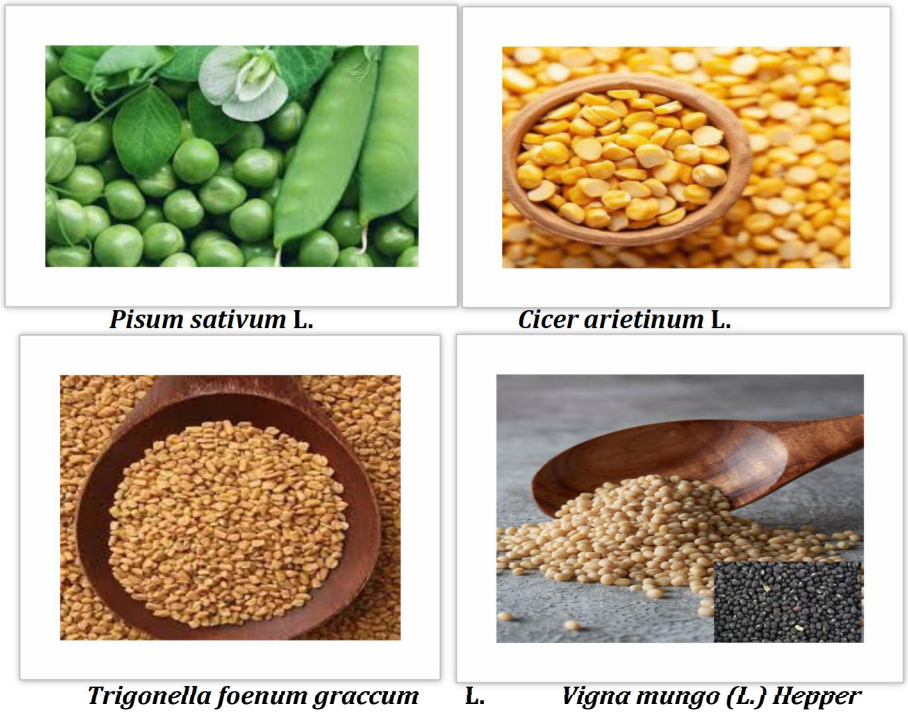
Values are Mean ±Standard Deviation estimated for pulses gum

3.3 Estimation of total Protein

The extracted gum powders were subjected to protein estimation where the fenugreek (*Trigonella foenum graccum*) reported highest protein content followed by chickpea (*Cicer arietinum*) (59.11 and 52.61 µg BSA equivalence /100 µg respectively) (Figure 2 & Table 1). In a previous study, the protein content was estimated for Mung bean which shown the range of 25.8–27.5 % is the highest in the pulse protein after Lupin (32–55.3 %) [18].

From the results, it has been found that under tree category, fruits of *Psidium guajava* shows the highest (98.51 mg BSA Equivalent/ g of Fresh Weight) and *Dillenia indica* shows the lowest (13.73 mg BSAE/ g of FW) amount of protein content. In case of shrubs, *Justicia adhatoda* showed the maximum (86.37 mg BSAE/ g of FW) and *Ocimum canum* shows the minimum (10.59 mg BSAE/ g of FW) amount of protein content. Among the herbs, red *Amaranthus viridis* contains highest (97.43 BSAE/ g of FW) and *Marsilea quadrifolia* contains the lowest (15.04 mg BSAE/ g of FW) content of protein. The study findings conclude that the protein content obtained from the leaves of different plant categories varies in their quantity [19]. In present study, the *Trigonella foenum graccum* (59.11 µg BSA equivalence /100 µg**)** reported as highest among selected pulses which may vary when estimate directly from powder sample of pulses.

Figure 1: Selected Pulses from Legume family



***Pisum sativum* L.** ***Cicer arietinum* L.**

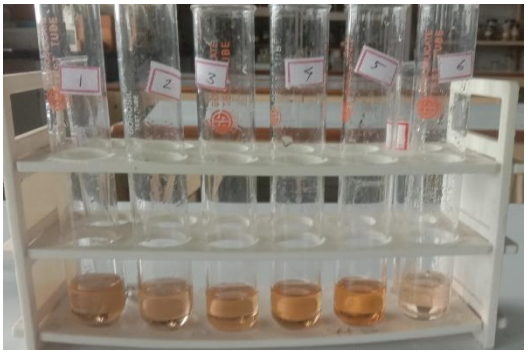
Trigonella foenum graccum* L.** ***Vigna mungo (L.) Hepper

Figure 2: Extraction of gum and Quantitative Estimation for selected Pulses

Pulses powder

Powder mixed with distilled water

Gum Powder of selected Pulses



Estimation of Total Polysaccharides

Estimation of Total Protein

4. Conclusion

Pulses are edible seeds from legume plants and are a rich source of polysaccharides and proteins. Estimating the polysaccharide and protein content in pulses provides valuable insights into their nutritional composition. Polysaccharides, primarily in the form of starch and dietary fiber, contribute to the energy content and functional properties of pulses. Proteins, as a major macronutrient in pulses, play a crucial role in human nutrition, particularly as a plant-based protein source. In the present study, total polysaccharides and proteins were significantly higher in *Trigonella foenum-graecum*. *Vigna mungo* and *Cicer arietinum* contain more polysaccharides and protein, respectively. Regular consumption of these legumes can contribute to balanced nutrition, particularly in plant-based and rural diets, and may play a role in the prevention of chronic diseases such as diabetes, cardiovascular conditions, and obesity. Therefore, promoting the dietary inclusion of these pulses can support both public health and sustainable food systems.

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Conflict of interest

The author declares no conflict of interest.

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