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Physico-chemical and *in vitro* glycemic indices of popular pulse varieties grown in Sri Lanka

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Abstract

Pulses are rich in protein, fibre and minerals and performing unique role in human body. Present study produced proximate composition, mineral content, starch fractions and Glycemic Indices (GI) of popular pulses grown in Sri Lanka. The proximate composition; ash, protein, fat, crude fiber and carbohydrate were found to be 3.4-4.3%, 22.0-26.6%, 0.8-2.0%, 3.0-6.9% and 62.0-66.7%, (on db) respectively. The significantly highest ($p \leq 0.05$) content of iron and calcium were found to be in horse gram; variety ANK brown with 114.5 mg/kg and 1571.6 mg/kg respectively. Dietary Fibre (DF) and Resistant Starch (RS) contents showed the highest values for horse gram. All the pulses showed low Predicted Glycemic Index (PGI) values and ranged between 39 and 42 while Horse gram had the least value for PGI. In conclusion, pulses can be recommended as low GI food category ($GI \leq 55$). Therefore, Pulses can be recommended as a good source of healthy vegetable protein.

Keywords: pulses, proximate composition, predicted glycaemic index, resistant starch, mung bean, cowpea, horse gram

1. Introduction

Pulses are very important crop species coming under the family fabaceae. Among them cowpea (*Vigna unguiculata*), green gram (*Vigna radiate*) and horse gram (*Macrotyloma uniflorum*), are popular and important species in Sri Lanka. This study is focused mainly on physico-chemical properties of cowpea (five varieties), green gram (two varieties) and horse gram (two varieties). The terms “legumes” and “pulses” are used interchangeably because all pulses are considered as legumes, but not all legumes are considered as pulses. The term “pulse”, as described by the Food and Agriculture Organization definition, is exclusively for crops harvested solely for the dry seed of leguminous plants [1]. Cowpea and green gram are grown in large scale by farmers whereas horse gram is limited to very specific agro- ecological region, hence, the popularity and the usage are very low among Sri Lankans. The land extent of pulses was 34,546 ha and the annual production was approximately 39128 MT [2]. However, Sri Lanka is not self sufficient with pulses and spend a large volume of foreign exchange on importation.

Pulses are also known as annual leguminous crops yielding from pods, used as food for both humans and other animals in the world. Pulses are used as high-protein crops that play a secondary role to cereal or root crops. They have the ability of fixing nitrogen and so often lead to soil improvement, and in developed countries they play an important role as a break crop [3]. Since animal proteins are more expensive and scarce than protein from plant sources, pulses are commonly used by vegetarians as a substitute for meat.

Although legumes generally have high protein content the utilization of available protein in legume feedstuffs are much less than that calculated from the chemical composition [4, 5], because of the presence of various antinutritional factors (ANFs). Processes such as dehulling, dry heating, roasting, boiling, soaking (in water, alkali and acid), solvent extraction, germination and fermentation can reduce the presence of, or inactivate, some anti-nutritional factors [6, 7].

Protein content in legume is ranged from 17-40%, compared to that of cereals 7-13% and to meat 18-25% [8, 4]. Pulses are renowned as poor man’s meat due to higher protein content and have the potential to combat the problems of protein energy malnutrition, especially in developing countries [9]. Compared to cereals, pulses are rich in proteins and essential amino acids**.**

It is well documented that cereal proteins are deficient in certain essential amino acids, particularly in lysine [10] whereas they are rich in cysteine. Pulses such as red kidney bean proteins are the superior source of certain indispensable amino acids particularly lysine which is undersupplied by the cereals. Therefore, the combined consumption of beans and cereals can ensure a balanced protein diet due to the nutritional complementation of essential amino acids [11, 12].

In the present study, pulses were evaluated for proximate composition, mineral content, starch fractions, dietary fiber content and Predicted Glycemic Index (PGI). This information will be helpful to the food technologists, nutritionists and breeders in their programs while consumers also could make use for their dietary plans.

2. Materials and Methods

2.1 Sample collection and preparation

Cowpea varieties (Waruni, MICP01, Bombay, Dhawala and ANKCP01), green gram varieties (MI5 and MI6) and horse gram varieties (ANK Black and ANK Brown) were used for this study. All the samples were grown in Randomized Complete Block Design (RCBD). Dried grain samples were collected randomly from Grain Legume and Oil Crops Research and Development Centre (GLOCRDC), Angunakolapelessa, Sri Lanka.

2.2 Determination of physical and morphological characteristics of selected pulse varieties

The following specific morphological characteristics of selected pulses were assessed.

Seed weight: based on their 100 seed weight

Seed size: Small, medium, large and very large

Legume varieties were categorized as reported Henshaw, 2008 [13] into size based on their 100-seed weight. Varieties with seed weight < 15 g were described as small; 15.1-20 g were medium size-seed while large seed >20.1-25 g. Seed weight over 25 g were described as very large seeds.

Seed shape: Variation from the typical kidney shape to oblong, spherical and rhomboid shapes

Seed coat color: Variation from Green, brown, cream and black

Seed coat texture: Smooth/ wrinkled

2.3 Compositional analysis of pulses

Pulse samples were tested for proximate composition, major mineral content, dietary fibre content, starch fractions; soluble and resistant starch and Predicted Glycemic Index (PGI) with acceptable standard testing procedures.

Clean and dry whole pulse seeds were ground with a RETSCH S/S CROSS BEATER Hammer Mill Sk1 to pass a 0.5mm (500µm) sieve prior to composition analysis.

2.3.1 Proximate composition

The moisture content was determined by oven drying method at 130ºC for 2h [14]. Ash content was determined by igniting the sample at 550ºC until white ash is formed [14]. Protein content was determined by the method described in UDK 139 operating manual of Velp Scientifica which was adapted from AOAC 2000 945.18-B' Kjeldhal method[15]. The sample was hydrolyzed with Concentrated Sulphuric acid followed by steam distillation. Liberated ammonia was trapped in Boric acid and titrated with HCL. The calculation was carried out using the factor; N x 6.25 for all pulses. Fat content was determined by the method described in operating manual of the Gerhardt fat extractor (Soxtherm unit) using petroleum ether as solvent; Bp 40-60ºC [15]. Crude fiber content was determined by the method described in the operating manual of the Foss Fibertec system which was adapted from AOAC, 2000, 962.09 [15] by hydrolysis with acid and alkali followed by determination of ash contents of the residue. Carbohydrate content was calculated in terms of dry basis value by subtracting the percentage values obtained for protein, fat, ash and crude fiber from hundred.

2.3.2 Mineral and phosphorous content

Mineral; basically iron, zinc, calcium and potassium and phosphorous content of pulse varieties were determined on dry ashed material, followed by dissolving in HCl and the determination of absorbance by aspiration of the sample into the Atomic Absorption Spectrophotometer [15]. Phosphorus content in pulse varieties was determined on dry ashed material, followed by dissolving in HCl and the determination of absorption spectrophotometrically, using ammonium molybdate as a color reagent [15].

2.3.3 Determination of total DF content

Total DF contents of pulse samples were determined by the enzymatic gravimetric method as described by Asp *et al*. 1983[16]. In this method, starch and protein are digested using enzymes into small fragments. Ethanol is added to the filtrate to precipitate the soluble fiber and both soluble and insoluble fiber is recovered by filtration.

2.3.4 Determination of resistant starch (RS) content

The RS content of the pulses were determined using an enzymatic assay using megazyme assay kit [17]. This method allows the measurement of RS, solubilised starch and total starch content of samples. The procedure has been subjected to inter laboratory evaluation under the auspices of AOAC International and AACC international and accepted by both associations; AOAC Official Method 2002.02; AACC Method 32-40.01.

2.3.5 Determination of *in vitro* starch digestibility of pulses

In vitro starch digestibility of ground samples of pulses was determined using the modification of the method described by Thompson *et al*. 1987 [18].

Available carbohydrate content of pulses was calculated using the 'by difference' method.

Available carbohydrate content = 100 - (% crude protein + % crude fat + % moisture + % ash + % total dietary fiber).

2.3.6 *In vitro* starch digestion

Portions of available carbohydrate (1.000 g) of the test sample, human saliva (5ml) and distilled water (10 ml) were placed in to a dialysis bag (13 cm length, 4.5 cm width, 4.8 nm pore diameter with molecular weight cut off: 10,000-12,000 Daltons). Dialysis bags were previously warmed in 40% ethanol solution at 60ºC for 10 min and they were stored in 0.001 M $NaHCO_3$ solution at 4ºC prior to dialysis. Contents of dialysis tubing were gently massaged to mix. Then dialysis tubing was suspended in 800 mL of distilled water at 37ºC with continuous agitation. 1 mL of dialysate was pipetted into screw cap tubes in triplicates at time intervals 1, 2, and 3 h after hydrolysis. Same procedure was followed for white bread which was used as the reference food.

2.3.7 Reducing sugar assay

Reducing sugar was assayed in solutions as methods described by Miller 1959 and Saqib *et al*. 2011[19, 20].

1 mL of sugar solution from series of standard D-Glucose solutions of 0.1, 0.2, 0.3, 0.4, 0.5, 0.6 and 0.7 mg/mL concentrations was added to tube containing 4 mL of dinitrosalicylic (DNS) reagent and mixed well. Tubes were placed in boiling water bath for 5 min, transferred to ice to cool down rapidly and brought to room temperature by placing them in water bath. Absorbance was measured at 540 nm, using spectrophotometer (UV-1601, Japan). Standard curve for standard D-glucose was plotted concentration *vs*. absorption.

1 mL of dialysate from each *in vitro* digested samples of pulse varieties was pipetted out in to a screw cap tube containing 4 mL of DNS reagent and the same procedure at 1h, 2h and 3h was followed as previously described for standard D -glucose. The reducing sugar content with respect to each absorbance value was obtained from a standard curve which was previously prepared for D-glucose. Hydrolysis curve was plotted % starch hydrolysis *vs* time for samples.

2.3.8 Estimation of GI

GI calculations were done according to Goni *et al*. 1997 and Germinie *et al*. 2008 [21, 22].

The area under the hydrolysis curves of the test food and the reference food were calculated and Hydrolysis Index for products was calculated.

$$\text{Hydrolysis Index (HI)} = \frac{\text{Area under the curve of test food}}{\text{Area under the curve of reference food}} \times 100$$

$$\text{Predicted GI value } (GI_{HI}) = 39.71 + (0.549 \times HI)$$

Since above equation is developed for values reported based on the GI of glucose=100, it should be converted to a value based on bread by multiplying by 0.7.

$$\text{Adjusted predicted GI value} = GI_{HI} \times 0.7$$

2.3.9 Phytate content

Phytate content in pulse varieties was determined on eluted acid extracted fraction from anion exchange chromatographic technique followed by wet digestion and quantification by spectrophotometrically, using ammonium molybdate (as a colour reagent) [15].

2.3.10 Statistical analysis

Analysis of variance was performed by completely randomized design with three replicates by Statistical Analysis Software (SAS) 9.1.3 and the comparison of the means was performed by using Least Significant Difference (LSD).

3. Results and discussion

3.1Physical and morphological characteristics of pulse varieties

Physical and morphological characteristics of 100 seed mass, seed size, seed shape, seed coat color and seed coat texture have been visually observed in this study in nine legume varieties from mung bean, cowpea and horse gram were given in the Table 1.

Table 1: Physical and morphological characteristics of Mung bean, cow pea and horse gram

Pulse	Variety	Seed weight (g)	Seed size	Seed shape	Seed coat color	Seed coat texture
Cowpea	Bombay	15.3	Medium	Kidney	Speckled grey brown	Wrinkled
	Waruni	14.5	Small	Rhomboid	Reddish brown	Smooth
	Dhawala	17.2	Medium	Rhomboid	Cream color with black eyed	Wrinkled
	MICP1	13.8	Small	Kidney	Cream	Smooth
	ANKCP 1	13.4	Small	Rhomboid	Pale brown	Smooth
Mung bean	MI 5	5.8	Small	Oblong	Green	Smooth
	MI 6	6.5	Small	Oblong	Green	Smooth
Horse gram	ANK Black	3.3	Small	Rhomboid	Jet black	Smooth
	ANK Brown	3.1	Small	Rhomboid	Light brown	Smooth

Seed weight refers to the weight (g) of 100 seeds.

Seed size is defined as varieties with seed weight < 15 g as Small size; 15.1-20g as Medium size; >20.1-25g as Large.

Seed weight is mostly contained in the kernel (Cotyledons and embryo). The cotyledons, which make up about 88.8% and seed coat takes about 11.1% of the seed weight [23]. The characteristics of seed size and texture of mung bean and horse gram are similar within their species whereas same characteristic are of largely differ within cowpea. Horsegram is the smallest seed among mung bean and cowpea varieties. Seed coat colour is widely differing with in varieties except in Mung bean.

Seed weight is important criterion for selecting variety for processing into different end products [13]. Most of cowpea varieties were small in size and Dhawala and Bobay were medium in size. However the sizes of observed in cowpea seed varieties are larger than seeds of mung bean. Large seeds would be preferred for canning purposes, since this would mean less quantity of beans would be required to attain a high cooked bean weight. Furthermore, classification based on seed weight is maybe used to determine conformity to standards during quality control of raw materials.

3.2 Proximate composition and moisture content of pulse varieties

Proximate composition of pulses was given in Table 2.

Table 2: Proximate composition of mung bean, cow pea and horse gram

Pulse	Variety	Ash %	Protein %	Fat %	Fibre %	CHO %
Cowpea	Waruni	3.8^{d}	25.0^{c}	$1.5b^{c}$	6.8^{a}	62.8^{d}
	MICP01	4.3^{a}	25.2^{c}	$1.9a^{b}$	3.0^{e}	65.6^{b}
	Bombay	3.4^{f}	24.9^{c}	$1.8a^{b}$	4.4^{d}	65.4^{b}
	Dhawala	3.6^{e}	22.8^{e}	1.7^{ab}	5.1^{c}	66.8^{a}
	ANKCP01	4.1^{b}	24.9^{c}	2.0^{a}	5.7^{b}	63.2^{d}

Mung bean	MI 5	3.9c	25.9b	1.5bc	5.5b	62.9d
	MI 6	3.9c	26.6a	1.2c	5.0c	63.2d
Horse gram	ANK Black	3.6e	21.9f	0.8d	6.9a	66.7a
	ANK brown	3.6e	24.2d	0.8d	6.7a	64.8c
CV		1.16	1.05	14.98	3.83	0.61

Values are presented on % dry weight basis

Means within a column with different letters are significantly different ($p \leq 0.05$)

According to the proximate composition, it was observed that ash content was significantly higher ($p \leq 0.05$) in MICP01 and ANKCP01 compared to other cowpea varieties, mung bean and horse gram varieties. Ash content ranged from 3.4-4.3%. Ash content of MICP 01 showed significantly higher value and followed by ANKCP 01 amounting to 4.3% and 4.1% respectively [8]. However, the coefficient of variation was very low, resulting in very low variation among the tested varieties. Same range of ash content recorded for red kidney bean by Hayat *et al*. 2014 [24]. Crude protein content was significantly higher in mung bean compared to cowpea and horse gram. Protein content ranged between 22.0-26.6%. Among mung bean, MI6 showed the highest value followed by MI5 amounting 26.6% and 26.0% respectively. According to Begum *et al*. 1977 [25] and Murthy 1980 [26], those observations were comparable to commonly consumed pulses like chickpeas, pigeon pea, green gram and black gram, where due to the varietal differences large variability can be observed in protein content ranging from 18.5-31.16% in those groups. Venkatesha 1999 [27], stated that horse gram protein contained higher lysine content than pigeon pea and chick pea making it a good complement to a cereal based diet.

Crude fat content was similar for all the varieties ranged between 0.8-2.0%, and cowpea variety ANKCP01 showed the highest crude fat content compared with all other pulses. According to Sreerama *et al*. 2010 [28], crude fat content of horse gram ranges from 0.6-2.6%. Mishra and pathan 2011 [29] stated that in horse gram, 27.5% saturated fatty acids and 72.49% unsaturated fatty acid reported, in which, 42.78% linoleic, 16.15% oleic and 13.56% linolennic acid reported. Among unsaturated fatty acids linoleic acid was useful for treatment of diabetes and cardiovascular diseases. Crude fiber content of pulses ranged between 3.0-6.9%. Among two horse gram varieties and cowpea variety “Waruni” showed higher values for crude fibre compared to other varieties. Carbohydrates showed significant differences among the varieties and all the varieties contained over 60%. Previous studies showed that commonly consumed pulses contained between 50 to 60% [30, 31]. Carbohydrates of raw horse gram contained 36 g of starch per 100g dry matter in which approximately 85% digestible, 14.47% resistant and 3.38% resistant starch associated to insoluble dietary fibers [32].

3.3 Mineral and phosphorous content of pulses

Mineral and phosphorous content of pulses were presented in Table 3.

Table 3: Mineral and phosphorous content of mung bean, cow pea and horse gram

Pulse	Variety	Fe (mg/kg)	Ca (mg/kg)	Zn (mg/kg)	K (%)	P (mg/kg)
Cowpea	Waruni	38.9c	336.1c	29.6a	1.4ab	477b
	MICP01	24.6e	315.5e	22.0c	1.1bc	473b
	Bombay	39.8c	312.5ef	31.7a	1.5a	405d
	Dhawala	26.4e	257.5g	24.3b	1.2abc	411d
	ANKCP01	31.8d	168.5h	25.8b	1.4ab	445c
Mung bean	MI 5	30.6d	329.5d	19.0d	1.1bc	448c
	MI 6	32.0d	309.5f	19.3d	1.3abc	495a
Horse gram	ANK balck	104.0b	1286.8b	30.6a	1.0c	361f
	ANK brown	114.5a	1571.6a	30.6a	1.0c	369e
CV		2.23	0.45	4.86	14.57	0.93

Values are presented on dry weight basis

Means within a column with different letters are significantly different ($p \leq 0.05$)

As per statistical analysis of minerals content and phosphorous content showed statistical differences. The Fe content of pulses ranged between 24-114mg/kg and horse gram showed the comparatively higher value. Horse gram variety ANK brown recorded the highest value, followed by ANK black, amounting 114.5 and 104.0 mg/kg respectively. Cowpea variety MICP01 showed the lowest Fe content compared to all pulses. Khatun *et al*. 2013 [33] stated that Fe content of pulses ranged from 5.89 to 7.44 mg/100g. Calcium content also showed similar behaviour and ANK brown contained significantly higher amount compared to ANK black, amounting 1571.6 and 1286.8 mg/kg respectively. Cowpea variety ANKCP01 showed the lowest calcium content among all pulses. Previous research finding showed the comparatively higher value for Ca ranged from 244 to 312mg/100g [33]. Zinc content revealed significant differences among the varieties and ranged between 19.0-31.7 mg/kg. K content ranged between 1.0-1.5%. Amoung all pulse varieties horse gram contained the lowest K content and cowpea varieties (Bombay, ANKCP01 and Waruni) showed the highest value. Phosphorous content showed significant differences and ranged between 361-495mg/kg. Mungbean variety MI6 showed the highest amount and it was 495mg/kg.

3.4 Dietary fibre, starch fractions and Predicted Glycemic Index of pulses

Dietary fibre, starch fractions and predicted Glyemic Index of pulses were presented in Table 4.

Table 4: Starch fractions and Glycemic Index of mung bean, cow pea and horse gram

Pulses	Variety	Total DF	RS	Non-RS	Total starch	PGI
Cowpea	Waruni	13.62^{d}	9.1^{b}	34.1^{ed}	43.2^{b}	41.7^{a}
	MICP01	15.33^{b}	3.6^{d}	35.9^{cd}	39.5^{c}	42.2^{a}
	Bombay	13.1^{e}	9.0^{b}	39.0^{ab}	48.0^{a}	41.7^{a}
	Dhawala	14.6^{cd}	3.2^{d}	38.0^{bc}	41.3^{bc}	41.9^{a}
	ANKCP01	16.1^{b}	9.6^{ab}	38.7^{ab}	48.3^{a}	41.4^{a}
Mung bean	MI 5	15.3b^{c}	5.9^{c}	40.4^{a}	47.3^{a}	41.5^{a}
	MI 6	13.7^{ed}	5.7^{c}	37.1^{bc}	42.8^{b}	42.0^{a}
Horse gram	ANK Black	21.1^{a}	10.5^{a}	36.3^{c}	46.9^{a}	39.8^{b}
	ANK brown	21.2a	10.5^{ab}	32.7^{e}	43.1^{b}	39.8^{b}
	CV	4.67	11.13	3.49	4.09	1.55

Values are presented on % as dry weight basis.
Means within a column with different letters are significantly different ($p \leq 0.05$)
DF Dietary Fibre, RS- Resistant Starch, PGI - Predictable Glycemic Index

Adequate DF is required for proper functioning of the gut and has also been related to risk reduction for a number of chronic diseases, including heart disease, certain cancers and diabetes [34]. Total DF content of pulses ranged between 13-21% as reported by Eashwarage *et al*. 2017 [35]. DF content was higher in horse gram compared to the cowpea and mung bean varieties. Horse gram variety ANK brown showed higher value compared to ANK black which were 21.2 % and 21.1% respectively. In most grain legumes consumed as pulses by humans, the fiber content ranges from 8.0 to 27.5%, with soluble fiber in the range 3.3-13.8% [36]. Previous findings on horse gram reported 28.8% total dietary fibers, mainly insoluble dietary fiber 27.82% and soluble dietary fiber 1.13% [37]. High content of dietary fiber in horse gram might be helpful in terms of maintaining positive effect on intestine and colon physiology, beside other homeostatic and therapeutic functions in human nutrition [28]. Resistant starch (RS) content ranged from 3-10.5% and higher values were recorded in horse gram. Non- resistant starch content showed a significant difference between the tested samples and ranged from 32-40%. Total starch content ranged between 39-48 %.

Legumes are rich in low glycemic carbohydrates, resistant starch, oligosaccharides (OS) and fiber [12]. The RS, OS and fibers pass undigested form through the stomach and small intestine until they reach the colon, where they act as probiotics or food for the prebiotic or beneficial bacteria residing there. Their bacterial fermentation leads to the formation of short-chain fatty acids, such as butyrate, which may improve colon health by promoting a healthier gut micro-biome reducing the risk of colon cancer [38]. The predicted glycaemic Index showed significant differences and the lowest value recorded in horse gram. PGI values ranged between 39 and 42. Presence of high proportion of resistant starch and dietary fibers resulted in low GI values. Low GI foods slow the digestion and absorption of carbohydrates and show a gradual rise in blood glucose and insulin level, which have many positive health benefits such as reducing the incidence and prevalence of heart disease, diabetes, obesity [39].

3.6 Anti- nutritive factor "Phytate" content

Phytate content of pulses was presented in Table 05.

Table 5: Phytate content of mung bean, cow pea and horse gram

Varieties	Waruni	MICP01	Bombay	Dhawala	ANKCP01	MI5	MI6	ANK balck	ANK brown
Phytate content (mg/g)	3.2^{de}	5.7^{ab}	3.3^{de}	6.3^{a}	4.9^{bc}	3.9^{cd}	3.5^{de}	2.3^{e}	4.0^{cd}

Values are presented on dry weight basis (mg/g)
Means within a column with different letters are significantly different ($p \leq 0.05$)

Pulses contained several anti-nutritional factors that reduce the bioavailability of nutrients [40]. Phytic acid, Stachyose and raffinose are some of the antinutritive factors found in the pulses. The phytic acid had been shown to posses rich in antioxidant, anticarcinogenic and hypoglycemic activities, therefore, depending upon consumer preferences retaining or elimination of these compounds could be facilitated [41]. Phytic acid acts as the primary phosphorous reservoir up to 85% of total phosphorus in cereals and legumes. The antioxidant property of phytic acid in pulses exhibits positive role as protection against a variety of cancers, coronary heart disease, diabetes mellitus and renal stones [42]. As per statistical analysis, phytate content was significantly different for tested varieties. Cowpea varieties showed comparatively higher values and variety Dhawala showed the highest value followed by MICP 01 amounting 6.2 and 5.6 mg/g respectively. Horse gram variety ANK black reported the least value for phytate content. According to Sreerama *et al*., 2012 [27] in horse gram reported 10.2mg/g of phytic acid.

4. Conclusion

Pulses in Sri Lanka contained 3.4-4.3% ash, 20-25% Crude protein, 3-7% Crude fiber, 62-66% carbohydrates and 0.8-2% crude fat in its composition. Horse gram is a good source of most of the mineral such as Fe, Zn and Ca. Mung bean variety "MI6" contained the highest phosphorus content compared to the all other pulse varieties in Sri Lanka. Moreover, horse gram shows good functional properties such as highest total dietary fibers, resistant starch and lowest predicted glycaemic index. All the pulse varieties PGI value were lesser than 50. This was a very good indicator of functional properties of pulses. Glycaemic value 55 and below considered low GI food category, hence pulses can be recommended under low GI food category. Generally cowpea varieties showed high phytate content and variety Dhawala contained considerably higher phytate content over other varieties. Horse gram variety ANK black contained the lowest amount of phytate. It can be concluded that pulses are a good sources of crude fiber, protein and mineral and low glycaemic indexing food for a healthy life.

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