



Comparative Proximate Nutraceutical Study of Poor Man's Pulse, Horsegram [*Macrotyloma uniflorum*] with the Other Common Legume Crops: A Review

Sumeet Parkash Kaundal^{1*} and Rahul Kumar¹

¹Department of Agricultural Sciences, DAV University, Jalandhar-1440121, India.

Authors' contributions

This work was carried out in collaboration between both authors. Author SPK developed the analyses parameters, developed objectives and secured support. Author SPK also undertook analysis of the report, made detailed analysis and was involved in the write up and synthesis of the findings. Author RK has reviewed and standardized the study. Both authors read and approved the final manuscript.

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ABSTRACT

Horsegram is an underutilized drought hardy crop and mainly neglected by the farmers in Northern region of India. However, the present study reveals the hidden comparative analysis of nutraceutical use with well-known legumes like *Phaseolus vulgaris*, *Vigna mungo*, *Cicer arietinum*, *Vicia faba*, *Cajanus cajan*, *Vigna radiata*, *Pisum sativum* and *Lens culinaris*. This pulse crop is an excellent source of carbohydrate, protein and dietary fiber. This present study shows that amount of energy in horsegram falls in the range of 376.12-377.21 Kcal/100 g which is maximum than the other legumes. The ash, protein, dietary fibres, carbohydrates, fat and starch content of horse gram falls in the range (2.24% to 5.16%), (18.15% to 28.8%), (5% to 16.3%), (50% to 63.4%), (1.10 to 1.9%) and (31.86% to 47.5%) respectively. Horsegram is found to be less fat and more dietary food fibers than the most common legumes. Hence, it is an excellent source of food for diabetic patients and useful in weight management. The unique anti-urolithiatic activity of horsegram is well known against calcium oxalate crystals, calcium phosphate crystals and uric acid crystals. Anticholelithiatic, Anti-histaminic, Hemolytic, Larvicidal, Proteinase inhibition and Anti-HIV are among other unique medicinal properties of horsegram which are not reported in any other legumes.

*Corresponding author: Email: sp.kaundal143@gmail.com;

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1. INTRODUCTION

Legumes are ranked second after cereals which act as the main component of the human diet since times [1,2,3,4] and are considered to be the most important source of food for humans as well as an animal [5]. A variety of Legumes are grown worldwide particularly *Vigna mungo*, *Vicia faba*, *Cicer arietinum*, *Phaseolus vulgaris*, *Vigna radiata*, *Pisum sativum*, *Lens culinaris*, and *Cajanus cajan* etc. [6]. Among all legumes, Lentil is mentioned in the cropping system of ancient Egypt and faba beans are in Bible. Legumes are used by the Romans in pastures and for soil improvement dating 37 B [7]. The domestic consumption of pulses in India was 186.5 lakh tonnes and are all consumed by the peoples in various ways e.g. food [8,9] because of possessing high protein content, vitamins, amino acids, and pharmaceutical importance. It provides dry and green fodder for animals, producing green manure which improves soil health and adds nutrients into the soil [5,10]. Protein-energy malnutrition is a serious problem due to the increasing population, decrease of fertile land, and degradation of natural resources [11,12]. Legumes are an excellent source of protein and are emphasized as an active substitute for animal protein [13]. It has become a necessity in developing countries to overcome the problem of hunger and malnutrition by exploring the underutilized legumes [14,15,16]. Underutilized legumes are considered to be the source of dietary requirements of the rural peoples during drought and famine situations [17].

Horsegram is one of the underutilized and unexplored food legumes [18,19] with a good source of carbohydrates, protein, and energy [20]. This crop is highly adaptable to low fertility land [21], drought [22], salinity [23], and heavy metal stresses [24]. Beside all these useful benefits of horse gram, this food crop is being neglected by the farmers of Punjab in India due to the negative image attached to this crop as 'Poor man's food'. The main reasons for its underutilization are like forgetting its agronomic practices. However, numerous references are existing in the traditional medicinal system of horse gram showing its medicinal consequences like anti-diabetic [25,26], anticalcifying [27,28], anti-hypercholesterolemic [29,30], analgesics [31,32], antioxidant [33,34] and larvicidal properties [35] and hence it is all-important to investigate the comparative analysis of nutrient

compositions of underutilized food legume crop horse gram with other well-known legumes. The present population of the world is increasing at a rapid pace and hence, it is very difficult to fulfill the needs of daily energy consumption in upcoming years. The present study is useful to access the hidden value of nutraceutical components of horse gram and where it stands among the other unique well-known legumes. Every legume provides a good amount of energy which is useful to human beings for a living. The energy value in different legumes on a dry weight basis (Kcal/100 g) is shown in Table 1.

The amount of energy in horsegram falls in the range of 376.12-377.21 Kcal/100 g [36] followed by Chickpea (347 Kcal/100 g) which is more than many other legumes and less is present in the Pea is 93 Kcal/100g. The amount of energy amount in different ranges in different legumes i.e. 120.35-125.45 Kcal/100 g in Kidney bean [37], 211 Kcal/100 g in Black gram [38], 320 Kcal/100 g in Faba bean, 301 Kcal/100g in Pigeon pea, 310 Kcal/100 g in Mung bean and 302 Kcal/100 g in Lentil [39,40].

Each legume is known for the presence of different nutraceutical contents that play various roles in the metabolic activities of humans and animals. Each component fulfills the energy requirement of all human beings and acts as the energy fodder source for animals also. The nutraceutical contents of most important pulses i.e. Black gram [*Vigna mungo*], Faba bean [*Vicia faba*], Chickpea [*Cicer arietinum*], Kidney bean [*Phaseolus vulgaris*], Mung bean [*Vigna radiata*], Pea [*Pisum sativum*], Pigeon pea (*Cajanus cajan*), Lentil [*Lens culinaris*] and Horse gram [*Macrotyloma uniflorum*] vary in different concentrations concerning ash, protein, dietary fiber, fat, carbohydrates and starch content, vitamins (Fat-soluble and water-soluble) and minerals (micronutrients and macronutrients) respectively.

2. ASH

The residues especially minerals are left after the substance is completely burnt called ash. These minerals are very useful in the various metabolic and biological reactions such as growth, development, flowering, and reproduction, etc. take place in the plant metabolic machinery as well as useful for human beings and environment also. Ash content of horsegram varies among all pulses shown in Table 2.

The ash content of horse gram falls in the range from 2.24% [49] to 5.16% [47]. The maximum amount of ash content is 4.47% in kidney bean [52], 3.67% in black gram [53], 4.2% in chickpea [58,59], 7.4% in faba bean [68], 5.8% in pigeon pea [74,75,76], 3.9% in mung bean [78], 4.15% in pea [41] and 5.7% in lentil [86] respectively. It is noticed that the ash content of horsegram is more than that of kidney bean, black gram, chickpea, mung bean, and pea but it is found to be less than faba bean, pigeon pea, and lentil.

3. PROTEIN

The storage protein inside the various pulses acts as the biological reserve of various metal ions as well as amino acids which is later on used by the organisms or plant itself. The dry seeds of leguminous plants contain the high concentrations of storage proteins up to the amount of 25%. The variance of protein content in all the legumes is shown in Table 3.

The maximum amount of protein content is found to be 39% in faba bean [106,64] followed by 38.3% in pea [117], 36.4% in lentil [122], 31.4% in chick pea [105] and 31.32% in mung bean [116] respectively. The maximum protein content in horsegram is found to be 28.8% [97] which is maximum than kidney bean (25.23%) [99,98], black gram (27.87%) [53], Pigeon pea (26.38%) [74,75,76,114].

4. DIETARY FIBERS

Dietary fibers play an important role in the digestive system of human beings. These fibers are present in the various cereals, fruits, seeds, and vegetables contain the indigestible parts of the plant's material which keep the digestive system healthy. The dietary fibers details of all these legumes are shown in Table 4. The maximum amount of dietary fibers is found to be 22.7% [58] in chickpea followed by horsegram [16.3%] [44]. Horsegram is a good source of dietary fibers in the human diet and noticed that it has more dietary amounts of food than the other legumes excluding Chickpea. Kidney bean, black gram, and mung bean have a minimum amount of fibers with 3.6% [51], 3% [54], and 2.2% [129] respectively. Faba bean, pigeon pea, pea and lentil is also a good source of dietary fibres with 13.49% [63], 8.1% [128], 10.30% [83] and 5.9% [86] respectively.

5. CARBOHYDRATES

The amount of carbohydrate content, sugar, fat, and starch are also varying among all the pulses

at different concentrations. This content plays an important role in seed dormancy and protects the young embryo from environmental shocks and later on nourishes it in unfavorable conditions. The details of their carbohydrate amount in different legumes are shown in Table 5.

The carbohydrate content of horsegram varies from range 50% [91] to 63.4% [131]. The maximum amount was noticed in pea with 74% [82] followed by pigeon pea with 65% [77]. Black gram and kidney bean have 63.7% carbohydrate content [133]. The maximum amount of carbohydrate content in chickpea, faba bean, mung bean and lentil is 56.30% [60], 57.30% [133], 61.2% [133] and 59.7% [133] respectively. Horsegram is a good source of the carbohydrate content on a dry weight basis and having more amount than chickpea, faba bean, mung bean, and lentil.

6. FAT

Plants store their energy in the form of carbohydrates, but at the time of ripening, they change these oxygen-rich components into carbon-rich triglycerides i.e. lipids and fat. These are both useful for the seeds at the time of germination by providing energy. The amount of fat varies in large amount in among all the pulses and the maximum amount of fat found in pea from the collected data. The details of fat in different legumes are shown in Table 6.

A huge variation of fat is noticed among the legumes and it varies from a range of 1.10 % [46] to 1.9% [96]. The maximum amount of fat is noticed in chickpea with 10.20 % [137] followed by pea with 6.1% [82] respectively. The fat content of horsegram is found to be less than that of black gram, chickpea, faba bean, pigeon pea, mung bean, pea and lentil with 2.94% [56], 10.20% [137], 2.2% [68], 3.1% [74,75,76,114], 6.1% [82] and 4.3% [87] except kidney bean and mung bean respectively.

7. STARCH

Plants convert the carbon dioxide from the atmosphere, sunlight, and water into oxygen and glucose. Glucose is stored in plant tissue for food and energy principally by photosynthesis. Starch is the reserve food material of the plant mainly composed of glucose molecules linked in long chains. The details of starch in different legumes are shown in Table 7.

Table 1. Energy value in different legumes on a dry weight basis (Kcal/100 g)

Horsegram	Kidney bean	Black gram	Chickpea	Faba bean	Pigeon pea	Mung bean	Pea	Lentil
376.12-377.21 [36]	120.35-125.45 [37]	211 [38]	347 [39,40]	320 [39,40]	301 [39,40]	310 [39,40]	93 [41]	302 [39,40]

Table 2. Comparative details of ash (%) in different legumes

Horsegram	Kidney bean	Black gram	Chickpea	Faba bean	Pigeon pea	Mung bean	Pea	Lentil
3.8 [42]	3.67 [50]	3.67 [53]	4.2 [58,59]	3.97 [63]	4.02 [71]	3.27 [53]	2.74 [80]	5.7 [86]
4.5 [43]	4.4 [51]	3.1 [54]	3.43 [60]	3.6 [64]	5 [72]	3.9 [78]	3.52 [81]	2.7 [87]
2.7 [44]	4.47 [52]	3 [55]	3.53 [61]	2.81 [65]	4 [73]	2.91 [54]	4.1 [82]	
3.34 [45,46]		3.12 [56]	3.2 [62]	3.6 [66]	5.8 [74,75,76]	2.97 [79]	4.08 [83]	
5.16 [47]		3.47 [57]		3.03 [67]	3.8 [77]		4.15 [41]	
5 [48]				7.4 [68]			3.44 [84]	
2.24 [49]				3.6 [69]			4.0 [85]	
				4.21 [70]				

Table 3. Comparative details of protein (%) in different legumes

Horsegram	Kidney bean	Black gram	Chickpea	Faba bean	Pigeon pea	Mung bean	Pea	Lentil
18.15 [45]	25.23 [98]	27.87 [53]	23.40 [103]	31.31 [63]	18.8 [110]	23.96 [53]	20.80 [80]	35.5 [86]
22 [88,89,90]	25.23 [99]	21.3 [54]	20.92 [60]	30.1 [68]	21.07 [71]	23.7 [78]	24.31 [81]	24.1 [87]
21.45 [91]								
22.5 [44]	15.3 [51]	22.51 [100]	30 [104]	39 [106,64]	18.8 [111]	24.0 [115]	38.3 [117]	31.3 [121]
22.05 [47]								
22.57 [92]								
23.1 [93]	22.26 [52]	25.1 [101]	21.27 [61]	33.69 [107]	25.45 [72]	22.5 [54]	29.3 [118]	36.4 [122]
23.6 [94]								
23 [95]								
24.24 [46]		23.22 [102]	31.4 [105]	28.4 [70]	25 [112]	31.32 [116]	31.0 [119]	
25 [48]			25.4 [62]	29.1 [108]	23 [73]		26.32 [120]	
25.3 [42]								
26.1 [96]				27.5 [109]	25 [113]		25.41 [85]	
28.8 [97]				30.63 [65]	26.38 [74,75,76,114]			
					22 [77]			

Table 4. Comparative details of dietary fibers (%) in different legumes

Horsegram	Kidney bean	Black gram	Chickpea	Faba bean	Pigeon pea	Mung bean	Pea	Lentil
16.3 [44]	3.91 [126]	4.90 [53]	22.7 [58]	13.49 [63]	6.6 [110]	4.12 [53]	9.9 [82]	5.9 [86]
5.63 [46,47]	3.6 [51]	3.0 [54]	16.91 [60]	8.08 [66]	7.52 [71]	6.8 [78]	7.10 [81]	4.7 [87]
12.14 [49]		3.67 [57]	9.89 [61]	9.03 [64]	8.1 [128]	4.1 [115]	10.30 [83]	
5 [123]		3.2 [127]	11.2 [62]		6.6 [111]	2.9 [54]	4.49 [41]	
5.7 [42,124]					5 [73]	2.2 [129]	8.29 [85]	
5.3 [125]						8.9[130]		

Table 5. Comparative details of carbohydrate (%) in different legumes

Horsegram	Kidney bean	Black gram	Chickpea	Faba bean	Pigeon pea	Mung bean	Pea	Lentil
58.32 [49]	57.19 [126]	63.70 [133]	47.42 [103]	57.3 [133]	58.7 [133]	58.9 [77]	56.6 [133]	59.7 [133]
55 [123]	63.7 [133]	58.73 [57]	56.30 [60]	53.58 [63]	60.48 [72]	61.2 [133]	74.0 [82]	55.0 [87]
63.4 [131]	49 [51]	63.60 [102]	42.2 [105]	48.3 [64]	62.63 [74,75,76]	56.7 [115]		
61 [132]			55 [62]	54.8 [68]	65 [77]			
50 [91]				50.8 [70]	58.8 [134]			
57.2 [125]				48.12 [66]				

Table 6. Comparative details of fat (%) in different legumes

Horsegram	Kidney bean	Black gram	Chickpea	Faba bean	Pigeon pea	Mung bean	Pea	Lentil
1.10 [46]	1.33 [98]	1.54 [53]	7.42 [58]	1.58 [63]	1.9 [110]	1.60 [53]	6.1 [82]	3.7 [139]
1.30 [45]	1.01 [52]	1.01 [54]	7.01 [60]	2.2 [68]	2.3 [111]	1.90 [78]	1.18[80]	4.3 [87]
1.4 [44]		2.94 [56]	5.1 [62]	0.7 [67]	2.93 [72]	1.30 [115]	2.79 [83]	
1.25 [49]		1.77 [57]	6.48 [137]	1.08 [64]	2 [73]	1.35 [54]		
1.32 [135,131]		1.30 [136]	8.83 [137]	1.61 [70]	3.1 [74,75,76,114]	1.24 [138]		
1.9 [96]			10.20 [137]	1.2 [108]	1.2 [77]	1.12 [79]		
				1.70 [65]				

Table 7. Comparative details of starch (%) in different legumes

Horsegram	Kidney bean	Black gram	Chickpea	Faba bean	Pigeon pea	Mung bean	Pea	Lentil
31.86 [47]	42.21 [50]	41.72 [53]	83.9 [103]	52.7 [133]	48.2 [133]	56.87 [53]	48.6 [133]	52.8 [133]
31.86 [46]	56.5 [133]	47.9 [133]	56.3 [58]	44.16 [63]	53 [111]	53.6 [133]	40.31 [80]	
47.5 [140]			50.0 [133]		55 [73]		40.95 [81]	
							46.04 [141]	

Table 8. List of unique pharmaceutical use of horsegram with references

Sr. No.	Pharmacological use	Plant part used	References
1	Anti-urolithiatic against calcium oxalate crystals	Seeds	[27]
2	Anti-urolithiatic against calcium phosphate crystals	Seeds	[148]
3	Anti-urolithiatic against uric acid crystals.	Seeds	[149]
4	Proteinase inhibition.	Seeds	[150]
5	Anticholelithiatic activity.	Seeds	[151]
6	Larvicidal and Anorectic Activities:	Seeds	[152]
7	Anti-HIV Activity:	Seeds	[153]

The starch content of horse gram varies from range 31.86 [47] to 47.5% [141]. The maximum amount of starch is noticed in chickpea with 83.9% [103] followed by mung bean with 56.87% [53], kidney bean with 56.5% [133], pigeon pea with 55% [73], lentil with 52.8%, faba bean with 52.7%, pea with 48.6% and black gram with 47.9% [133] respectively.

8. PHARMACEUTICAL IMPORTANCE OF HORSEGRAM

According to Ayurveda, Siddha, and Unani, the various parts of the horsegram are used in medicinal use for thousands of years for various disorders [46]. Traditionally, It is used as a medicinal herb for amenorrhoea, bile and kidney stones, conjunctivitis, piles, diabetes mellitus, dysuria [142]. The boiled concentrated liquor of seeds is also useful in the management of postpartum syndrome and promote the discharge of lochia [143]. Infusion of seeds with cow's milk is useful in the management of helminths disorders [144]. The seeds powder is consumed with curd for gastric ulcers [145]. A decoction of the root is given for leucorrhoea and its plant juice provides a good cure in diarrhea [146]. The seeds of *M. uniflorum* are used to prepare drugs such as Kulaththadi Pralepa [paste], Kulaththadi Gruta [ghee], Kulattha Yusha, Dhanyamla [sour gruel] and Dantimuladi Kwatha [46]. The pharmaceutical important properties include anti-microbial, anti-obesity, analgesic, anti-inflammatory, anti-diabetic, anti-histaminic, anti-oxidant, anti-obesity, diuretic, hemolytic, hepatoprotective, anti-diabetic and anti-hypertensive properties like the others legumes [147] however this crop has many unique medicinal properties which makes it more unique than the others legumes and these are shown in Table 8.

9. CONCLUSION

Worldwide, food insecurity and its low supply cause migration of species from infertile to

fertile land for the agricultural practices to overcome this limitation. Due to this, several crop species are becoming inexistent from our agricultural and forest fields, while some others are falling both in cultivation and utilization. The production and management of food are under threat for survival due to the population explosion. If survival strategies are not created, the catastrophe will be happening in the upcoming years. Global food security directs re-managing crop genetic improvement and production agronomy toward grain legumes to identify climate-hardy species varieties with improved grain features. Grain legumes play significant roles in the food cultures around the world as genuine sources of quality protein, animal fodder, natural fertilizers, natural medicine, and environmental repair products, together with the fixed soil enrichment property of symbiosis with nitrogen-fixing bacteria. Legumes are an excellent source of food providing various nutraceutical elements that play a very crucial role in living. With time, some of the legumes become forgotten and underutilized due to the limited knowledge of its nutraceutical importance and agricultural practices. Horsegram is usually neglected by the farmers and this present study accessed that it is the richer source of nutritional and unique pharmaceutical importance like other well-known legumes. Horsegram is a richer source of energy, dietary fiber, and protein like the other legumes. It contains less fat and starch which is the most useful food for diabetic patients. Its pharmaceutical use like anti-urolithiatic activity against calcium oxalate crystals, calcium phosphate crystals, and uric acid crystals makes it more unique than the other legumes. This crop is also a drought hardy crop and capable to live in water deficit areas. These all properties of horsegram is capable to decrease the problem of food insecurity reflecting the whole economy of the country and prevent us from many medical problems. To meet the global food demands, the focus should be on promoting

the cultivation and utilization of this crop by agricultural researchers, plant breeders, extension services, donors, technology providers, policy and decision-makers, as well as consumers which has been neglected and underexploited but have the potential to enhance food and nutrition security especially in India

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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