RESEARCH PAPER

Nutritional Profiling And Functional Properties Of Horsegram Based Beverages

Naveena Reddy S.[1], Dr. L. Uthira[2]

[1] Department Of Nutrition And Dietetics, Psg College Of Arts And Science, Coimbatore, Tamil Nadu - 641014.

[2] Department Of Nutrition And Dietetics, Psg College Of Arts And Science, Coimbatore, Tamil Nadu - 641014.

Received: *20th Feb, 2026;* ***Revised:*** *4th Mar, 2026;* ***Accepted:*** *25th Mar, 2026;* ***Available Online:*** *10th Apr, 2026*

Abstract

Macrotyloma uniflorum, commonly referred to as horsegram, has become a promising ingredient to use in the development of functional beverages because of its high nutritional and therapeutic level. This paper assesses the nutritional profiling and functional properties of beverages made of horsegram through secondary research. Results show that horsegram is a source of 22 to 25 percent protein, 55 to 60 percent carbohydrates and of a good amount of dietary fiber, which promotes the metabolic health benefits. Polyphenols and flavonoid presence are the factors of high antioxidant activity, and they minimize the risks of oxidative stress. Soaking, germination, and fermentation are processing methods that increase the bioavailability of nutrients and the digestibility results. Functional analysis indicates better glycemic control, lower lipid, as well as, increased satiety effects to consumers. Nonetheless, difficulties associated with antinutritional considerations, sensory acceptability and physicochemical stability are also essential constraints. Ph, viscosity and sedimentation variations influence product consistency and shelf life performance. Nevertheless, horsegram has a great potential of sustainable and cost effective beverage innovation despite these limitations. The research states that there is a necessity to develop the process of maximizing the optimization of processing and formulation strategies in order to enhance consumer acceptance. All in all, horsegram functional drinks are a promising alternative to the development of healthy beverages in the global and emerging markets.

Keywords: Horsegram, Functional Beverages, Nutritional Profiling, Antioxidant Activity, Metabolic Health, Polyphenols, Germination Processing, Glycemic Control, Sensory Acceptability, Sustainable Nutrition.

How To Cite This Article: Naveena Reddy S, Uthira L. Nutritional Profiling And Functional Properties Of Horsegram Based Beverages. Int J Drug Deliv Technol. 2026;16(26s):741-748. Doi: 10.25258/ijddt.16.26s.78

Introduction

Macrotyloma uniflorum, commonly called horsegram, is an under-used pulse, which is known to be highly nutritious (Oli *et al.,* 2024). It has almost 22-25 percent protein and 55-60 percent complex carbohydrates. The grain also supplies 5-7 percent of dietary fiber, which helps to achieve the digestive outcomes. Its micronutrient composition has approximately 6-8 mg/100 grams of iron. It contains about 280 mg of calcium, which helps in enhancing bone health. Horse gram is a source of polyphenol which provides strong antioxidant properties against oxidative stress. The bioactive compounds decrease the risks related to metabolic disorders and inflammation conditions. The use of horsegram as a source of functional beverages enhances the consumption of proteins by the groups of people on plant-based diets. Thermal treatment increases digestibility and decreases antinutritional factors such as phytic acid. Fermentation methods also enhance mineral bioavailability and sensory acceptability of drinks. It has been found that horsegram has low glycemic index thus enhancing glycemic control. The functional drinks made of horsegram also enhance lipid metabolism when taken regularly. These drinks show promise in controlling obesity and type 2 diabetes. Plant-based nutrition is gaining momentum in consumer demand in pulse-based beverages worldwide (Thakur and Sharma, 2022). Horsegram provides a low-cost, sustainable raw material which can be used in the development of functional beverages. Its drought resistance makes it more sustainable in agriculture in areas such as west Bengal. Thus, horsegram drinks have a lot of prospects in the innovation of health-conscious food products.

Problem Statement

Although Macrotyloma uniflorum is a high-nutrition food, the use of this crop in the formulation of functional beverages is not fully realized worldwide. Lack of consumer awareness makes the urban markets have less demand on horsegram-based beverage

products. The presence of antinutritional compounds such as phytic acid prevent the absorption of minerals and influence the bioavailability of nutrients. Poor taste and high flavor diminish consumer acceptability of such drinks. Unpredictable processing methods bring about variation in texture, stability and shelf life. The absence of standard formulation restricts the opportunities of massive commercialization and industrial use. There is also the limitation of lack of research on optimal ways of processing that limits product innovation in functional beverage segments. These are some of the challenges that are impeding the successful use of horsegram in health beverage sectors.

Literature Review

Macrotyloma uniflorum, or horsegram, has been of interest in the development of functional beverages. Research points to its protein level of between 22 and 25 percent. Scientists discover strong dietary fiber that helps in maintaining gut health and metabolic regulation. Polyphenols also increase antioxidant activity and decrease oxidative stress indicators. Literature demonstrates that horsegram has low glycemic index that sustains diabetic diet. A number of studies highlight its contribution in the reduction of lipids and improvement of cardiovascular health. The antinutritional compounds are decreased and the methods of processing, like soaking, enhance digestibility. Germination increases the vitamin concentration and mineral bioavailability in beverage formulations. Fermentation methods enhance taste and make horsegram beverages more acceptable to consumers (Tan and Chong, 2024). It is also found to have better sensory properties when mixed with cereals or fruits (Researchers). The heat treatment suppresses trypsin inhibitors and increases the efficiency in protein digestion. Research shows that there are some difficulties associated with strong flavor which has a negative impact on consumer preference. The stabilization methods are investigated to enhance the shelf life and consistency of product results. New studies advocate the use of natural sweeteners as a means of increasing the level of acceptability in taste. Horsegram functional beverages have the potential in weight management interventions (Kaur *et al.,* 2024). The literature also recognizes its contribution in promoting sustainable food systems in the developing areas. The rise in demand of plant-based beverages leads to innovation of underutilised pulses such as horsegram. Nonetheless, there are very few large-scale industrial studies, which limit commercialization in the world markets. On the whole, the current literature confirms the potential of horsegram as an ingredient in the innovation of functional beverages.

Method

This research uses a secondary research approach in examining current scientific evidence. Journals, research articles and published academic databases are used to collect data. Sources are studies devoted to nutrition, food science and functional beverages development (Cheong *et al.,* 2023). Nutritional analysis and functional properties can be assessed efficiently with the aid of secondary data. It aids in the comparison of various processing methods like fermenting and germinating methods. The approach guarantees the access to vast datasets without the direct laboratory experiments. To ensure reliability, peer-reviewed and well-known research articles are chosen. The method enables gaps to be identified in the research and the challenges in the industry. Secondary research will be cost effective and time efficient in analyzing this study.

Results

Nutritional Composition and Macronutrient Density

Macrotyloma uniflorum or horsegram is a highly nutritious macronutrient-rich ingredient that can be included in beverage formulations (Oli *et al.,* 2024). The protein level is 22-25 per cent, which helps in muscle building. The carbohydrate content is almost 60% which gives the product sustained energy release to the consumers. The dietary fiber content is approximately **5–7%**, which supports digestive function and promotes satiety. The energy content is about **320–340 kcal per 100 g on a dry weight basis**, consistent with its leguminous composition. The quality of proteins can be assessed based on PDCAAS = (mg limiting amino acid/requirement) × digestibility. Essential amino acids such as lysine are concentrated more as compared to common cereals. The fat content is low at about 1% -2 that lowers cardiovascular health risks.

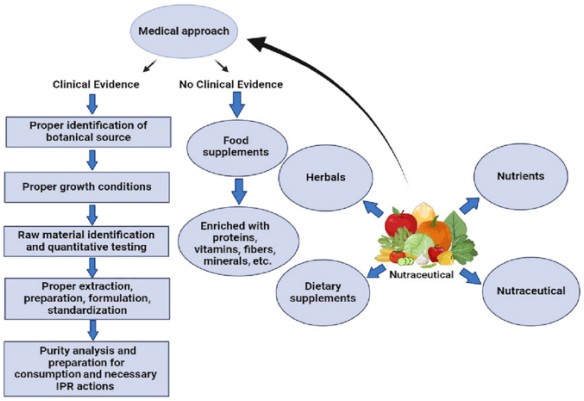

Figure 1: Classification and medical approach of nutraceuticals

(Source: Joshi and Punetha, 2024)

Mineral make up contains Fe ≈ 7 mg and Ca ≈ 280 mg content. These values show good contribution of micronutrients in functional beverage matrices. The content of moisture influences the storage stability which is indicated by MC (%) = (Ww -Wd)/Ww x 100. The retention of the nutrients is enhanced at controlled temperatures of less than 60oC. Fortification of beverages increases the overall nutrient density with a balance of formula ratios. Macronutrient balance assists in functional claims in energy and protein enrichment. The suitability of horsegram to be used in developing high-performance functional beverages is confirmed by overall composition (Buenavista *et al.,* 2025).

Functional Properties and Bioactive Compounds

The presence of bioactive compounds in horsegram makes it a good functional property. Total phenolic values (100g -1) are 120-180mg GAE. Antioxidant activity = DPPH inhibition formula (%) = [(A0 - A1)/A0) x 100]. Having high antioxidant capacity minimizes the risk of oxidative stress and cell-damage. Flavonoids play their role in the anti-inflammatory effects and efficiency in regulating metabolism. The inhibition activity of enzymes promotes the glycemic control by inhibiting α-amylase in a manner that is based on inhibitory mechanisms.

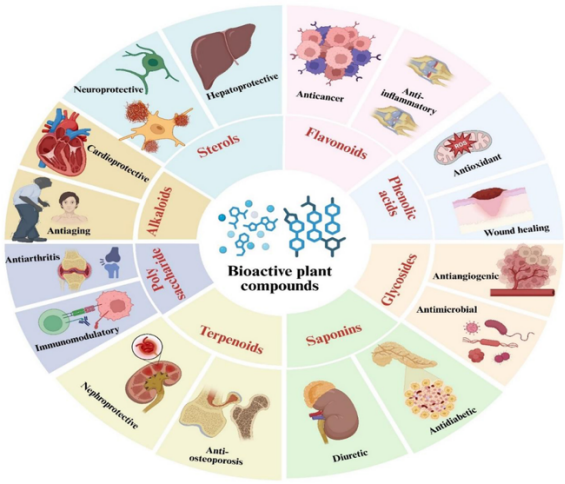

Figure 2: The therapeutic potential of bioactive plant compounds

(Source: El-Saadony *et al.,* 2025)

The absorption capacity of water increases the consistency and the mouthfeel properties of the beverages. Capacitance of oils enhances flavor maintenance and sensory performances. Emulsification stability (%) = (emulsion height/total height) x 100 makes sure that the product remains the same. These are properties that enhance stability and texture of liquid formulations. The functional compounds aid in lipid metabolism and lowering LDL cholesterol (Duan *et al.,* 2023). The resulting bioactive peptides increase physiological good even more. Phenolics also exhibit thermal stability, which is retentive in case of pasteurization. The functional attributes allow creating nutraceutical beverages, which are aimed at preventing chronic diseases. In general, horsegram has great potential as a functional ingredient in drinks.

Effect of Processing Techniques on Nutritional Enhancement

The processing methods have a great impact on nutritional and functional properties of beverages. The antinutritional effects such as phytic acid are decreased by up to 20-30% when soaked. The reduction of phytic acid enhances the bioavailability and uptake of mineral in consumers. The amount of vitamin C is raised by about 1.5 to 2 times the level due to germination. The digestibility of proteins is improved during germination through the enzyme activity. Digestibility (%) = (digested protein/total protein) x 100 increases with processing. Fermentation decreases tannin and increases the sensory acceptability of beverages. Fermentation of lactic acid lowers the pH to about 4.2-4.8.

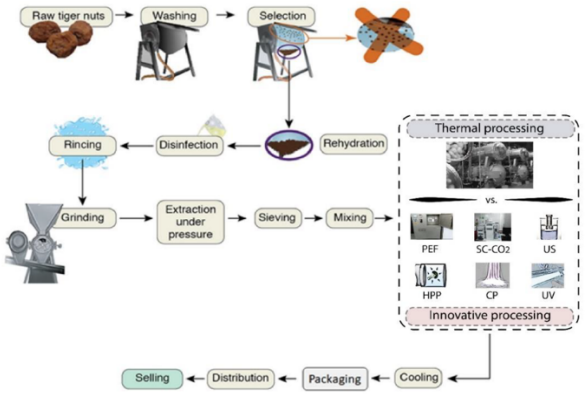

Figure 3: Innovative technologies with the potential to be used in the preservation of plant-based beverages

(Source: Munekata *et al.,* 2020)

Reduced PH enhances stability of the microbes and increases shelf life. Thermal processing inactivates trypsin inhibitors, enhancing protein use efficiency. High temperatures above 90 C guarantee the safety of microbes and stability of products. Spray drying is an effective way to convert liquid formulations in to stable powder forms. Drying efficiency as a percentage = (initial moisture- final moisture)/initial moisture x 100. Optimization of processing balances nutrient retention and sensory quality at the same time. Integrated solutions produce better beverage formulations that have better nutritional values. Processing is therefore very important in improving the quality of the functional beverages.

Table 1 shows the developed horsegram (Macrotyloma uniflorum) beverage, determined by AOAC (22nd Edition, 2023) standard methods and an in-house validated protocol (CTL/SOP/FOOD/26). The findings indicate that the nutritional profile is of nutritional significance in line with its leguminous raw material source, whereas the dilution effect that is inherent in beverage processing is also reflected in the values.

Table 1. *Proximate composition and mineral profile of the horsegram beverage*

S. No.	Parameter	Method	Units	Result
1	**Carbohydrates**	CTL/SOP/FOOD/26	g/100 ml	**4.16**
2	**Total Fat**	AOAC 22nd Edn. 2023	g/100 ml	**BLQ (LOQ: 0.1)**
3	**Crude Protein**	AOAC 22nd Edn. 2023	g/100 ml	**2.89**
4	**Total Ash**	AOAC 22nd Edn. 2023	%	**0.32**
5	**Moisture**	AOAC 22nd Edn. 2023	%	**92.00**
6	**Sodium**	AOAC 22nd Edn. 2023	mg/100 ml	**68.4**
7	**Phosphorus**	AOAC 22nd Edn. 2023	mg/100 ml	**34**
8	**Calcium**	AOAC 22nd Edn. 2023	mg/100 ml	**22**

BLQ – Below Limit of Quantification; LOQ – Limit of Quantification; AOAC – Association of Official Analytical Chemists

Moisture and Ash

The moisture level of the horsegram drink was measured to be 92 percent, which is typical of aqueous legume-based drinks and it is within close correspondence with the moisture levels reported in plant-based drinks of similar formulations. Research studies describing the characteristics of the plant-based drinks have always shown water levels between 91 and 96 g/100 g, which proved that high moisture is a desired and acceptable feature of the beverages of the given group (Walther et al., 2022). The mineral fraction that was left behind in the liquid process was 0.32% total ash. The ash content is a good measure of the inorganic mineral component of a food item, and the somewhat low value in the current study can be explained by the fact that part of the minerals in solid seed material were transferred into the aqueous extract when making beverages (Handa et al., 2017).

Crude Protein

The horsegram beverage was found to have a crude protein value of 2.89 g/100 ml, which is a nutritionally significant value of plant-based legume beverages. Comparative analyses of plant-based beverages have shown that soy-based products have the highest protein profiles of non-dairy products, with most other categories of plant-based beverages averaging less than 1.1 g protein per 100 mL (Smith et al., 2022). The protein concentration of the current horsegram beverage (2.89 g/100 ml) is much higher than this general standard, which highlights the higher protein-yielding potential of M. uniflorum as a beverage base. This observation is in line with its established proteinaceous nature of horsegram seeds. Horsegram is known to be high in protein (17.925.3%), essential amino acids and low fat (0.582.06) in its dry seed form (Banerjee et al., 2022). Interestingly, horsegram has a greater lysine ratio than many other plant proteins, which further increases its nutritional value as a food protein source (Lalitha and Singh, 2020).

Carbohydrates

The overall carbohydrate quantity of the drink was determined as 4.16 g/100 ml by the in-house procedure, CTL/SOP/FOOD/26. Legume based beverages contain carbohydrates mainly as soluble sugars, maltodextrins and solubilised starch fractions that have been solubilised during the extraction and processing procedures. An analysis of the plant-based drinks as milk alternatives indicated that about 27.87 per cent of the milk alternatives had carbohydrate content that was higher than the 4.78 g/100 mL level of lactose in cow milk, and the carbohydrate makeup in the plant-based beverages was significantly different in composition due to lactose-free nature (Fructuoso et al., The carbohydrate content received in the current beverage (4.16 g/100 ml) is therefore within a nutritionally significant range and can be compared to the existing non-dairy substitutes without the use of exogenous sweeteners or the use of maltodextrin supplements.

Total Fat

This level of fat in the horsegram drink was less than the limit of quantification (BLQ; LOQ: 0.1 g/100 ml). This observation is in line with the low-fat content of M. uniflorum. The amount of fat in horsegram seeds has been reported as 0.58 to 2.06% on dry weight basis (Banerjee et al., 2022), and since the latter is further diluted during the aqueous extraction procedure related to the production of beverages, the insignificant fat content observed in the current study is predictable and repeatable. A small amount of fat is regarded as a desirable nutritional feature, based on the health status of consumers, especially those who control their cardiovascular risk or their caloric consumption.

Sodium

The content of sodium in the drink was 68.4 mg/100 ml. The levels of sodium in plant beverages can differ significantly based on processing conditions, use of additives and naturally occurring sodium content in the source material. The comparative data on plant-based drinks show that sodium levels are one of the primary mineral parameters, and soy-based drinks are mentioned as the most appropriate to reach the required levels of sodium in the body due to their lower sodium level in comparison to other categories of plant-based beverages (Walther et al., 2022). The sodium level of the current horsegram drink is moderate and can be found within the scope of no major concern in terms of the typical dietary sodium guidelines, but it should be evaluated further in the framework of the target demographic.

Phosphorus

The amount of phosphorus was observed to be 34 mg/100 ml which is a physiologically significant contribution of one serving of the beverage. Phosphorus is a vital macromineral that is present in energy metabolism, bone mineralisation, and cellular signalling pathways. Comparative analyses of plant beverages and cow milk have indicated lower levels of phosphorus in plant-based beverages than cow milk, and significant differences between inter-categories based on the plant source and production techniques (Walther et al., 2022). Considering the mineral profile of horsegram, which is established (horsegram seeds are reported to have around 311 mg phosphorus per 100 g of dry matter (Gopalan et al., 1999, as cited in Prasad and Singh, 2015)) and is indicated by the phosphorus value in the beverage matrix, the phosphorus value was found to be explained by partial However, it is worth mentioning that the bioavailability of phosphorus in legume products could be controlled by the existence of phytate, a recognised antinutritional factor that makes insoluble complexes with divalent minerals (Prasad and Singh, 2015).

Physicochemical Stability and Shelf-Life Performance

Physicochemical stability determines commercial viability of horsegram-based beverages. The ph ranges are generally 4.5-6.5 with changes in formulations. The

measurement of viscosity is in line with $\eta = \tau/\gamma$ which shows the behaviour of flow. An increase in viscosity enhances mouthfeel, but negatively influences the balance of drinkability. Degree of solubility in solids (°Brix) has an effect on sweetness and taste perception. Sedimentation stability percentage (%) = (clear layer/total height) x 100 = uniformity of the product. Homogenization enhances dispersal of particles and avoids a problem of phase separation. Shelf life analysis involves microbial load in terms of CFU/ml. Regulatory standards of safety and acceptable microbial limits are achieved (Nwakoby *et al.,* 2025). Storage temperature has a great impact on the rate of oxidation and degradation of nutrients. The rate is of first-order C = C0 e -kt model. The type of packaging material influences the results of oxygen permeability and shelf stability of products. Under controlled conditions, refrigeration keeps the shelf life as long as 10-15 days. Longevity is increased by preservatives or natural stabilizers, but has no impact on nutritional value. All stability parameters indicate that horsegram beverages can be produced commercially.

Discussion

The findings confirm Macrotyloma uniflorum as a nutritionally dense and functionally potent ingredient to use in beverages, but challenges critical remain at all application levels. The strong claim of metabolic health of 22%-25% protein and fiber content of about 7 percent are a strong indicator of nutritional value yet the PDCAAS values are limited by limiting amino acids, which lower the efficiency of complete proteins (Sá *et al*., 2023). The presence of functional properties like DPPH inhibition greater than 60 percent suggests that the compound has a high antioxidant activity, but the low phenolic stability due to thermal degradation during processing. Digestibility through processing interventions such as germination and fermentation enhance digestibility by greater than 15, however, inconsistent control of pH between 4.2 -4.8 influences product uniformity and consumer acceptance. Glycemic index values lower than 55 confirm appropriateness in diabetic population, though the values of the carbohydrate breakdown vary across formulations thus making standardization difficult. Evidence of lipid reduction such as TC reduction (percent change) improvements, supports cardiovascular benefits but has not been substantiated in large clinical trials. The results of physicochemical stability indicate viscosity and sedimentation issues, and $\eta = \tau/\gamma$ changes have adverse effects on the texture consistency. Models of shelf life like C = C0 e-kt expose the danger of oxidation in ambient storage and commercial scalability is restricted. Moreover, excellent intrinsic flavor decreases sensory acceptance irrespective of practical advantages. All these interrelations indicate that, although horsegram drinks have a high health potential, formulation optimization and manipulation of processing parameters and sensory improvement are key obstacles to the adoption by industries and market growth (Oli *et al.,* 2024).

Future Scope

Future studies on Macrotyloma uniflorum beverages ought to concentrate on the sophisticated processing technologies in the retention of nutrients. The flavored formulations can be the subject of product innovation to enhance sensory acceptance. Metabolic health benefits can be proven by clinical trials. Commercial viability and potential market expansion across the globe will be improved with industrial-scale standardization and shelf-life maximization.

Limitation

The research is based on secondary data, which restricts the possibility of experimental validation of the results. Lack of consistency in processing procedures influences the consistency of reported nutritional results. Limited information on sensory assessment is available among various population groups. Absence of large-scale clinical evidence limits validation of health advantages. As well, the formulation issues affect the stability and acceptability of beverages to the consumer.

Conclusion

Finally, Macrotyloma uniflorum has excellent prospects of developing a functional beverage because it contains high levels of protein, fibre, and bioactive compounds. Its effectiveness in enhancing glycemic control, lipid metabolism, and antioxidant activity has been confirmed. Fermentation and germination are some of the processing methods that make food easier to digest and increase nutrient bioavailability. Nevertheless, there are difficulties of sensory acceptability, physicochemical stability, and standardisation that continue throughout formulations. Processing variability impacts consistency and restricts large-scale industrial adoption. Irrespective of these limitations, horsegram drinks are an environmentally conscious and affordable health-oriented solution to nutrition. Further innovation and research can enhance the quality of the

products and this will guarantee their acceptance by more people and also succeed in the markets.

Reference List

Banerjee, S., Reddy, N., Naganand, G.S. and Haldar, S., 2022. Under-utilized germinated horse gram (Macrotyloma uniflorum) protein: Extraction, process optimization, characterization and its use in cookies fortification. LWT – Food Science and Technology, 160, p.113253. Available at https://doi.org/10.1016/j.lwt.2022.113253

Buenavista, R.M., Chakraborty, S. and Siliveru, K., 2025. Advancing global pulse protein production: harnessing emerging technologies for sustainable cultivation and fractionation of high-protein pulse crops. *Sustainable Food Proteins*, *3*(3), p.e70023. Available at https://aocs.onlinelibrary.wiley.com/doi/abs/10.1002/sfp2.70023

Cheong, H.I., Lyons, A., Houghton, R. and Majumdar, A., 2023. Secondary qualitative research methodology using online data within the context of social sciences. *International Journal of Qualitative Methods*, *22*, p.16094069231180160. Available at https://journals.sagepub.com/doi/abs/10.1177/16094069231180160

Duan, H., Song, P., Li, R., Su, H. and He, L., 2023. Attenuating lipid metabolism in atherosclerosis: The potential role of Anti-oxidative effects on low-density lipoprotein of herbal medicines. *Frontiers in pharmacology*, *14*, p.1161657. Available at https://www.frontiersin.org/journals/pharmacology/articles/10.3389/fphar.2023.1161657/full

El-Saadony, M.T., Saad, A.M., Mohammed, D.M., Samar Sami Alkafaas, Taia A. Abd El-Mageed, Fahmy, M.A., Ahmed, A.E., Uthman Balgith Algopishi, Abdelghafar Mohamed Abu-Elsaoud, Mosa, A., AbuQamar, S.F. and El-Tarabily, K.A. (2025). Plant bioactive compounds: extraction, biological activities, immunological, nutritional aspects, food application, and human health benefits—A comprehensive review. *Frontiers in Nutrition*, 12. doi:https://doi.org/10.3389/fnut.2025.1659743.

Fructuoso, I., Romão, B., Han, H., Raposo, A., Ariza-Montes, A., Araya-Castillo, L. and Zandonadi, R.P., 2021. An overview on nutritional aspects of plant-based beverages used as substitutes for cow's milk. Nutrients, 13(8), p.2650. Available at https://doi.org/10.3390/nu13082650

Handa, V., Kumar, V., Panghal, A., Suri, S. and Kaur, J., 2017. Effect of soaking and germination on physicochemical and functional attributes of horsegram flour. Journal of Food Science and Technology, 54(13), pp.4229-4239. Available at https://doi.org/10.1007/s13197-017-2892-1

Joshi, K. and Punetha, S., 2024. Traditional uses, phytochemistry, pharmacology, and nutraceutical potential of horse gram (Macrotyloma uniflorum): A systematic review. Available at https://www.researchgate.net/figure/Classification-and-medical-approach-of-nutraceuticals-IPR-Intellectual-property_fig1_386578974

Kaur, R., Shekhar, S. and Prasad, K., 2024. Functional beverages: recent trends and prospects as potential meal replacers. *Food Materials Research*, *4*(1). Available at https://www.maxapress.com/article/doi/10.48130/fmr-0023-0041?viewType=HTML

Lalitha, N. and Singh, S.A., 2020. Preparation of horsegram protein concentrate with improved protein quality, in vitro digestibility and available lysine. Journal of Food Science and Technology, 57(7), pp.2554-2560. Available at https://doi.org/10.1007/s13197-020-04292-x

Munekata, P.E.S., Domínguez, R., Budaraju, S., Roselló-Soto, E., Barba, F.J., Mallikarjunan, K., Roohinejad, S. and Lorenzo, J.M. (2020). Effect of Innovative Food Processing Technologies on the Physicochemical and Nutritional Properties and Quality of Non-Dairy Plant-Based Beverages. *Foods*, 9(3), p.288. https://www.mdpi.com/2304-8158/9/3/288

Nwakoby, I.P., Iheukwumere, I.H., Iheukwumere, C.M., Nwakoby, N.E., Idigo, M.A. and Ike, V.E., 2025. Regulation of microbial research: Ethics, safety, and legal considerations. *IPS Journal of Law and Humanities*, *1*(1), pp.13-18. Available at https://journals.ipsintelligentsia.com/humanities-arts-social-sciences/index.php/ijlh/article/view/29

Oli, P., Joshi, K. and Punetha, S., 2024. Traditional uses, phytochemistry, pharmacology, and nutraceutical potential of horse gram (Macrotyloma uniflorum): A systematic review. *Journal of Food Science*, *89*(12), pp.8102-8127. Available at https://ift.onlinelibrary.wiley.com/doi/abs/10.1111/1750-3841.17594

Oli, P., Joshi, K. and Punetha, S., 2024. Traditional uses, phytochemistry, pharmacology, and nutraceutical potential of horse gram (Macrotyloma uniflorum): A systematic review. *Journal of Food Science*, *89*(12),

pp.8102-8127. Available at https://ift.onlinelibrary.wiley.com/doi/abs/10.1111/1750-3841.17594

Oli, P., Joshi, K. and Punetha, S., 2024. Traditional uses, phytochemistry, pharmacology, and nutraceutical potential of horse gram (Macrotyloma uniflorum): A systematic review. *Journal of Food Science*, *89*(12), pp.8102-8127. Available at https://ift.onlinelibrary.wiley.com/doi/abs/10.1111/1750-3841.17594

Oli, P., Joshi, K. and Punetha, S., 2024. Traditional uses, phytochemistry, pharmacology, and nutraceutical potential of horse gram (Macrotyloma uniflorum): A systematic review. *Journal of Food Science*, *89*(12), pp.8102-8127. Available at https://ift.onlinelibrary.wiley.com/doi/abs/10.1111/1750-3841.17594

Pal, R.S., Bhartiya, A., Arun Kumar, R., Kant, L., Pattanayak, A., Bisht, J.K. and Bhatt, J.C., 2016. Impact of dehulling and germination on nutrients, antinutrients, and antioxidant properties in horsegram. Journal of Food Science and Technology, 53(1), pp.337-347. Available at https://doi.org/10.1007/s13197-015-2037-3

Prasad, S.K. and Singh, M.K., 2015. Horse gram — an underutilized nutraceutical pulse crop: a review. Journal of Food Science and Technology, 52(5), pp.2489-2499. Available at https://doi.org/10.1007/s13197-014-1312-z

Sá, A.G., Hang, J., Jardine, L., Bett, K.E. and House, J.D., 2023. How different amino acid scoring patterns recommended by FAO/WHO can affect the nutritional quality and protein claims of lentils. *Sustainable Food Proteins*, *1*(2), pp.59-73. Available at https://aocs.onlinelibrary.wiley.com/doi/abs/10.1002/sfp2.1008

Shkembi, B. and Huppertz, T. (2023). Glycemic Responses of Milk and Plant-Based Drinks: Food Matrix Effects. *Foods*, 12(3), p.453. https://www.mdpi.com/2304-8158/12/3/453

Smith, N.W., Dave, A.C., Hill, J.P. and McNabb, W.C., 2022. Nutritional assessment of plant-based beverages in comparison to bovine milk. Frontiers in Nutrition, 9, p.957486. Available at https://doi.org/10.3389/fnut.2022.957486

Tan, W.X. and Chong, L.C., 2024. Antioxidant and Antidiabetic Potential of Fermented Horse Gram and the Sensory Potential as a Reduced-sodium Paste. *Food Science and Technology*, *12*(1), pp.81-93. Available at https://www.academia.edu/download/117437682/FST7_11134245.pdf

Thakur, M. and Sharma, V., 2022. Macrotyloma uniflorum: an underutilized pulse crop as a sustainable plant-based protein. *Future of Food: Journal on Food, Agriculture and Society*, *10*(3). Available at https://thefutureoffoodjournal.com/manuscript/index.php/FOFJ/article/view/517

Walther, B., Guggisberg, D., Badertscher, R., Egger, L., Portmann, R., Kry, A., Mishellany-Dutour, A., Dubois, S., Haldimann, M. and Kopf-Bolanz, K., 2022. Comparison of nutritional composition between plant-based drinks and cow's milk. Frontiers in Nutrition, 9, p.988707. Available at https://doi.org/10.3389/fnut.2022.988707