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Research Article

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Nutrients and functional properties of horse gram (*Macrotyloma Uniflorum*), an underutilized south Indian food legume

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ABSTRACT

The nutrient composition and flour functionality of horse gram seeds were evaluated of their flour characteristics. The objective of the present study was to evaluate horse gram seed with the aim of quantifying physiochemical and functional properties information that might serve as a guide to exploit its potential and benefits for human and animal nutrition. The proximate compositions (%) were determined as moisture content (6.72 ± 0.02), ash (2.24 ± 0.12), total dietary fibre (12.14 ± 0.35), crude carbohydrate (58.32 ± 0.10), crude fat (1.25 ± 0.15), crude protein (22.12 ± 0.18) and resistant starch (2.15 ± 20). The functional properties of , swelling capacity(ml), Water solubility index(%), oil absorption capacity(%) and water absorption capacity(g/100g),swelling index are 1.43 ± 0.12, 7.56 ± 0.15, 80.76 ± 0.10, 142.14 ± 0.20%, 0.46 ± 0.15% respectively. Foaming capacity, foaming stability and emulsifying capacity, emulsion stability were investigated as 38.16 ± 1.0, 35.12 ± 0.11 and 52.15 ± 0.25, 50.32 ± 0.41% respectively. The present study may provide a guideline for the use of horse gram seed flour are good functional foods for nutrition, food formulation and utilization.

Key words: Nutrients, Proximate composition, Functional properties, Starch isolate, Horse gram.

INTRODUCTION

Legumes are good sources of cheap and widely available proteins for human consumption. They are staple foods for many people in different parts of the world [1]. Legume seeds have an average of twice as much protein as cereals and the nutritive value of the proteins are usually high [2]. Legumes seeds are of prime importance in human and animal nutrition due to their high protein content [3] (20- 50%) and have historically been utilized mainly as the whole seeds [4]. Recently, they are now being fractionated into their main constituents which are starch and protein. Starch, the principal carbohydrate constituent of majority of plant materials, merits a detailed investigation to understand better its biochemical and functional characteristics as well as variations [5]. Starch is considered of commercial importance due to its high industrial demand as an ingredient for a variety of processed foods [6]. The growing demand for starches for the modern food industry has created interest for new sources of the polysaccharides [7]. Applications of starch in food systems are primarily governed by gelatinization, pasting, solubility, swelling and digestibility properties.

The horse gram, *Macrotyloma uniflorum* (Fabaceae) is normally used to feed horses, though it is also commonly used in dishes. In traditional ayurvedic cuisine, horse gram is considered a food with medicinal qualities. It is prescribed for persons suffering from jaundice or water retention and as part of a weight loss diet. Although rich in proteins (20 %), due to less acceptable taste and flavor of cooked products, it is consumed only by the farming community and low-income groups. Thus, it has remained an underutilized food legume [8]. Such grain legumes are however, potential sources for preparation of protein products like concentrates and isolates. The residue left over after separation of proteins can be further processed to obtain starch. The isolated legume starches have variety of applications in food industry. Consumption of seeds and sprouts has become increasingly popular among people interested in improving and maintaining their health status by changing dietary habits. The seeds and sprouts are excellent examples of 'functional food', lowering the risk of various diseases and exerting health promoting effects in addition to its nutritive value [9].The aim of the present study was to evaluate physicochemical and functional Properties of starches from South Indian horse gram.

EXPERIMENTAL SECTION

Sample collection
Natural strands of mature pods of *Macrotyloma uniflorum* (Horse gram) were purchased from local grocery markets of Madurai, Tamil Nadu, India.

Sample preparation
The separated, dehulled cotyledons were ground using a coffee bean grinder, to obtain a fine powder that passed through a 60 mesh sieve. All samples were defatted by blending with hexane (1:5 w/v, 5 min, three times) in a Waring blender at ambient temperature and air-dried for 12 h. Defatted flours were vacuum-packed in polythene pouches and stored in the dark, at 4^oC, until used.

Nutrient composition
Analyses of horse gram flour for crude protein, fat, ash and moisture contents were carried out essentially according to the standard method [10].The carbohydrate content was determined as the weight difference using moisture, crude protein, lipid and ash content data.

Total dietary fibre (TDF) was determined by rapid enzymatic assay [11]. Resistant starch was isolated and determined by an enzymatic method [12].The analytical values were evaluated from the mean of three determinations for each sample.

Functional properties
Water and oil absorption capacity
Flour water absorption capacity (WAC) was determined according to the method[13]. Flour water solubility index (WSI) was determined from the amount of dried solids recovered by evaporating the supernatant from the flour water absorption test [13]. Flour oil absorption capacity (OAC) was estimated by centrifuging a known quantity of flour saturated with peanut oil after the procedure [14]. The amount of oil retained was calculated by measurement of difference in the weights of the sample before and after equilibration with oil.

Foaming and emulsifying properties
Foaming capacity (FC) and foaming stability (FS) were determined according to the method [15]. Emulsion activity (Ea) and emulsion stability (Es) were evaluated essentially according to the method [16].

Swelling capacity and Swelling index
Swelling capacity and swelling index were determined by the method [17].

Amylose content
Amylose content was estimated by the method [18].

RESULTS AND DISCUSSION

Nutrients and proximate composition of Horse gram
The profiles of nutrient characteristics and proximate composition in raw horse gram seed samples are showed in Table 1. Significant variation in the levels of proximate composition was observed. The content of moisture, ash, total dietary fibre, crude carbohydrate, crude fat, crude protein and resistant starch are, 6.72 ± 0.02%; 2.24 ± 0.12%; 12.14 ± 0.35%; 58.32 ± 0.10%; 1.25 ± 0.15%; 22.12 ± 0.18%; 2.15 ± 0.20% , respectively.

Functional properties of Horse gram
The functional properties of seed flour of Horse gram are showed in Table 2. Legume starches have been characterized by a high amylose content of 24-65% [19]. Starch paste behavior in aqueous system depend on the physical and chemical characteristics of the starch granules, such as mean granule size, granule size distribution, amylose/amylopectin ratio and mineral content [20]. The amylose content of the starch varies with the botanical

source of the starch and is affected by the climatic conditions and soil type during growth [21]. The amylose content of the South Indian horse gram is 32.14 ± 0.10%.

Swelling power and solubility provide evidence of the strength of interaction between starch chains within the amorphous and crystalline domains [22]. The swelling power of starch has been reported to depend on water holding capacity of starch molecules by hydrogen bonding [23]. Hydrogen bonds stabilizing the structure of the double helices in crystallites are broken during gelatinization and are replaced by the hydrogen bonds with water, and swelling is regulated by the crystallinity of the starch [24]. Swelling capacity and Swelling index of horse gram were found to be 1.43 ± 0.12ml and 0.46 ± 0.15% respectively. The swelling power of horse gram starches may be attributed to the presence of a large number of crystallites formed by the association between long amylopectin chains.

The water and oil absorption capacities are essential functional properties of protein which may be defined as the amount of water or oil retained by a known weight of flour under specific conditions. The water absorption capacity depends on capillary, pore size and the charges on the protein molecules. This is due to strong correlation of extent of protein hydration with polar constituents along with the hydrophilic interaction through hydrogen bonding. The higher protein content in the flour might be responsible for high hydrogen bonding and high electrostatic repulsion [25]. The oil absorption capacity is also due to enhanced hydrophobic character of proteins in the flours. WAI of legume starches is inversely related to solubility and directly related to swelling [26]. The WAI is a useful indication of whether flours or isolates can be incorporated into aqueous food formulations especially those involving dough handling where an increase in unit yield is desirable [27]. Water, oil absorption capacity and water soluble index of horse gram were found to be 142.14 ± 0.20g $100g^{-1}$, 7.56 ± 0.15% respectively. It also indicates the gelling capacity of the starch and also very important in the texture of food systems. Horse gram starch can contribute greatly to the textural properties of many foods and in industries as a thickener, gelling agent and bulking agent.

Foaming properties are much important in the maintenance of the texture and structure of different food products (ice creams and bakery products) during and after processing. The foam stability of the flour depends on the presence of the flexible protein molecules which may decrease the surface tension of water [28]. The results revealed that foaming capacity and foaming stability of horse gram seed flour were found to be 38.16 ± 1.00% and 35.12 ± 0.11% respectively. The low foam ability of lotus rhizome flour indicates the presence of highly ordered globular protein molecules which increase the surface tension. In food foams, foaming performance depends on the ability of the continuous phase to include air (foam capacity) and also retain it for specific period of time (foam stability) [29]. [30]Also reported that ability of protein to reduce surface tension upon adsorption affects foam formation. According to [31], ability to form stable foam depends on sufficient intermolecular (protein-protein) interaction and thus degree of cohesion.

Emulsion capacity determines the maximum amount of oil that can be emulsified by protein dispersion. On the other hand, emulsion stability determines the ability of an emulsion with a specific composition to remain unchanged. Horse gram seed powder exhibited good emulsion properties (emulsion capacity of 52.15 ± 0.25% and emulsion stability of 50.32 ± 0.41%). Emulsion stability is important in food emulsions as it indicates the capacity of emulsion droplets to remain dispersed without separation by creaming, coalescing and flocculation [30]. Unfolding of proteins at oil and water interfaces plays a significant role in formation and stability of emulsions. Other factors such as adsorption kinetics, interfacial load, decrease of interfacial tension, rheology of the interfacial film and its surface hydrophobicity also affect emulsion properties [32]. The result showing horse gram could be attributed to protein denaturation during isolation.

Table 1: Nutrients and proximate composition of Horse gram

Proximate Composition*	
Moisture content (%)	6.72 ± 0.03
Ash content (g $100g^{-1}$)	2.24 ± 0.20
Total dietary fibre (g $100g^{-1}$)	12.14 ± 0.12
Crude carbohydrate (g $100g^{-1}$)$^{\$}$	58.32 ± 0.01
Crude fat (g $100g^{-1}$)	1.25 ± 0.10
Crude protein (g $100g^{-1}$)	22.12 ± 0.11
Resistant starch	2.15 ± 0.20

** Results are means ± standard deviation of triplicate determinations.*
$^{\$}$ By difference as 100- (moisture + protein + ash + fat).

Table 2: Functional properties of Horse gram

Parameter*	Horse gram
Swelling Capacity(ml)	1.43 ± 0.01
Swelling index	0.46 ± 0.15
Oil Absorption Capacity (%)	80.76 ± 0.03
Water Absorption Capacity (g $100g^{-1}$)	142.14 ± 0.10
Water solubility index (%)	7.56 ± 0.10
Foam capacity (%)	38.16 ± 1.00
Foam stability (%)	35.12 ± 0.01
Emulsion capacity (%)	52.15± 0.05
Emulsion stability (%)	50.32± 0.11

** Results are means ± standard deviation of triplicate determinations.*

CONCLUSION

In conclusion, the physico-chemical, and functional properties obtained indicate that horse gram can be used as alternative binders owing to its appreciably values of swelling power and solubility. However, the starch isolate exhibited good oil and water absorption, foam and emulsion properties. From the findings, horse gram starch could be used in food systems as a functional ingredient after modification through physical, chemical, or enzymatic methods to improve functional properties. Overall, horse gram starch isolate has good nutritional quality and used as functional foods.

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