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Comparison of physico-chemical, functional and cooking properties of selected horse gram varieties

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Abstract

The study was conducted with view to explore the physico-chemical, functional and nutritional properties of horse gram to maximize its usage in developing various products. Two varieties of horse gram viz., Paiyur 2 (TNAU variety) and commercial variety were studied for various physico-chemical, functional and cooking properties. In the physical parameters seed weight, hydration capacity, hydration index, swelling capacity, swelling index, germination was high in Paiyur 2 horse gram variety and bulk density was high in commercially available variety. The Paiyur 2 variety has high functional properties than commercial variety. The cooking qualities like cooking time is low and volume expansion ratio was found to be high in Paiyur 2 horse gram variety which is an important parameter for extruded product when compared to commercially available variety. The nutritional composition of two horse gram varieties does not differ much in all parameters. The results showed that the observed properties are found to be superior in Paiyur 2 (TNAU) variety of horse gram and can be used to develop products.

Keywords: Horse gram, Paiyur 2 variety, physico-chemical, functional, cooking properties

Introduction

In developing countries legumes are considered as one of the world's most important source of food supplies. At present considerable interest has been focused on the utilization of neglected legumes for human (Niharika *et al.*, 2016) [18]. Horse gram (*Macrotyloma uniflorum*) is one such underutilized crop belonging to Fabaceae and well known for its hardiness, adaptability to poor soil and adverse climatic condition. It is a cheapest source of protein and also rich in minerals such as calcium (Sawant *et al.*, 2015) [28].

The production of horse gram was 1.24 lakh tonnes and 1.36 lakh tonnes and in Tamil Nadu during kharif and rabi season, the production was 0.10 lakh tonnes and 0.57 lakh tonnes during 2014-15 respectively (Tiwari and Shivhare, 2016) [33]. The horse gram was used to make various foods and traditional medicines due to its nutritional composition and also has a place in ayurvedic medicine (Bhuvaneswari *et al.*, 2014) [7]. Horse gram has excellent therapeutic properties and traditionally used to cure kidney stones, asthma, bronchitis, leucoderma, urinary discharges, heart diseases, piles etc. Besides, it also possess anti-diabetic, anti-ulcer activity and also helps in dietary management of obesity due to the presence of beneficial bioactive compounds. (Bhartiya *et al.*, 2015) [6]. The fibre content of horse gram was high and it helps in reducing the body fat (Kamala, 2009) [15].

Though horse gram has many health benefits the utilization of horse gram as human food is restricted due to presence of high level of enzyme inhibitors, haemagglutinin activities, oligosaccharides, tannins, polyphenols and phytic acid compared to the other legumes which can be reduced below their harmful potential through processing (Dhumal and Bolbhat, 2012) [8]. Germination plays an important role in improving nutritive value of horse gram (Jain *et al.*, 2012) [29]. Dehusking, germination, cooking, and roasting are some conventional methods that have been shown to produce beneficial effects by decreasing the content of undesirable components and enhanced the acceptability and nutritional quality along with optimal utilization of horse gram as human food (Kadam and Salunkhe, 1985) [14].

The understanding of physico-chemical parameters, functional properties, cooking qualities of horse gram can increase horse gram utilization through various processing methods in developing new food products.

Thus this present work was carried out with the view to improve the utilization of horse gram flour in developing value added products by exploring its characteristics.

Materials and Methods

Materials

The TNAU Paiyur-2 horse gram was purchased from KathirvelDhaniyaMandi, Kariyamangalam, Dharmapuri and commercially available horse gram was purchased from Simmakal, Madurai. Chemicals and reagents used in the experiments were of Laboratory Reagent (LR), Analytical Reagent (AR). All the reagents and standard stock solutions were prepared using purified deionized water.

Methods

Preparation of Sample

The two varieties of horse gram (Paiyur 2 and commercial) given in Figure 1 was cleaned manually to remove extraneous material and stored in cool and dry place. For chemical analysis the cleaned horse gram was milled and stored in air tight container. These whole and milled horse gram were used for further analysis.

Physical parameters of horse gram

The physical parameters such as seed weight (Thilagavathi *et al.*, 2015), bulk density (Onwuka, 2005) [19], hydration capacity and hydration index, swelling capacity and swelling index (Adebowale *et al.*, 2005) [1] and germination percentage (Khatun, 2009) were analysed.

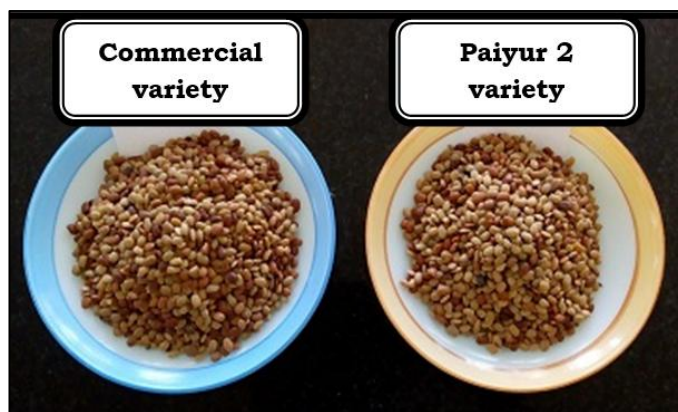


Fig 1: Selected varieties of horse gram

Results and Discussion

The physical parameters of two varieties of horse gram are given in the Table 1. The seed weight of Paiyur 2 variety (20.06 ± 0.75 g) was high than commercial variety (18.93 ± 0.69 g). The commercial variety (0.88 ± 0.01 g/ml) has more bulk density than Paiyur 2 variety (0.86 ± 0.01 g/ml). The bulk density of kidney bean cultivars were in the range of 0.72 to 0.87 kg/L (Ozturk *et al.* 2010, 2009) [20, 21]. The hydration capacity and index was high in Paiyur 2 variety (0.031 ± 0.00 g/seed, 0.92 ± 0.03 %) than commercial variety (0.042 ± 0.00 g/seed, 0.87 ± 0.01 %). Vashishth *et al.* 2017 [35] reported that the hydration capacity and hydration index were in the range of 0.034 and 0.967 respectively. Similarly the swelling capacity and index was also high in Paiyur 2 variety (0.057 ± 0.00 ml/seed, 1.61 ± 0.02 %) than commercial variety (0.049 ± 0.00 ml/seed, 1.27 ± 0.04 %). Swelling capacity and swelling index of kidney bean cultivars in the range of 0.30–0.56 mL/seed and 0.91–1.39, respectively have been reported (Saha *et al.*, 2009) [26]. The Paiyur 2 variety (97 ± 2.27 %)

Cooking qualities of horse gram

The cooking qualities such as cooking time and cooked length-breadth ratio (Wani *et al.*, 2017) [12], elongation ratio and swelling ratio (Azeez and Safi, 1966) [5], volume expansion ratio (Sidhu *et al.*, 1975) [30], water uptake ratio (Hamid *et al.*, 2016) [27] were analysed.

Chemical composition of horse gram

The chemical composition of two varieties of horse gram flour were determined by standard methods. The moisture content by hot air oven method (AOAC, 1997) [3], the protein content by Ma and Zuazaga, 1942 [16], the fat content was estimated by extracting the sample with petroleum ether (60–80°C) as described by Cohen, 1917 [9] using Soxhlet apparatus. The crude fibre content was determined by the method of AOAC, 1997 [3]. The carbohydrate content by Anthrone method (Colorimetry) as mentioned by Sadasivam and Manickam, 2008 [25]. The ash content was determined by Hart and Fisher, 1971 [11]. The phytate content was estimated by the procedure given by Sadasivam and Manickam, 2008 [25]. The tannin was analysed through vanillin hydrochloride method as suggested by Ranganna, 1986 [23]. The iron and calcium were estimated by the procedure given in Ranganna, 1986 [23].

Functional properties of horse gram flour

The functional properties such as water and oil absorption capacities (Rosario and Flores, 1981) [10], Solubility and swelling power (Iyer & Singh, 1997) [13] were analysed.

showed more germination percentage than commercial variety (92 ± 1.49 %). Martin *et al.*, 1975 [17] studied the germination responses of 20 legume seeds subjected to moist and dry heat. The cooking quality of both Paiyur 2 and commercial variety of horse gram are given in Table 2. It shows that the Paiyur 2 variety (63 ± 2.53 mins) takes less time to cook than commercial variety (70 ± 2.87 mins) when cooked in distilled water without soaking. Appiah *et al.*, 2011 [4] reported that difference in cooking time may be attributed to varietal difference or condition of crop cultivation. Uzogara *et al.*, 2007 [34] reported that hardness of water can increase the cooking time of seeds. The cooking time of unsoaked cowpea cooked in distilled water was less (45 mins) when compared to unsoaked cowpea cooked in tap water. The volume expansion ratio was also high in Paiyur 2 variety (8.01 ± 0.35) of horse gram. The elongation and swelling ratio was high in Paiyur 2 variety (1.26 ± 0.02 , 1.35 ± 0.00). Paiyur 2 horse gram variety (1.54 ± 0.02) attains high length-breadth ratio during cooking than commercial variety (1.37 ± 0.00). Wani *et al.*,

2017^[12] reported that elongation ratio and cooked length breadth ratio four kidney bean cultivars ranged from 1.19 to 1.35 and 1.89 to 2.15 respectively. The water uptake ratio was high in commercial horse gram variety (18.7 ± 0.01) than Paiyur 2 variety due to high cooking time. Hamid *et al.*, 2016^[27] reported that water uptake ratio of red cowpea and black cowpea were in the range of 6.07 and 4.86.

The proximate composition of both horse gram variety was given in the Table 3. This shows that the moisture content of Paiyur 2 horse gram (10.1 ± 0.17 %) was lower than other variety. Thilagavathi *et al.*, 2015^[32] reported that moisture content of horse gram as 10.82g/100g. Vashishth *et al.*, 2017^[35] reported that the moisture content of grain should be below 12% to have good shelf life. Thus the Paiyur 2 variety of horse gram will have good shelf life when compared to commercial variety. The ash content of commercial variety of horse gram (3.2 ± 0.01 %) was less than Paiyur 2 variety (3.6 ± 0.05 %). The Paiyur 2 horse gram variety contains high protein (17.58 ± 0.68 g) and fat content (2.0 ± 0.04 g) than commercial variety. Similarly the crude fibre content of Paiyur 2 horse gram (7.10 ± 0.30 g) was more than commercially available horse gram but the commercial horse gram (57.12 ± 0.72 g) has high carbohydrate than Paiyur 2 variety. The minerals like iron and calcium content was high in Paiyur 2 horse gram variety (20.27 ± 0.89 mg, 258.3 ± 5.58 mg) while it has low phytate content (146.8 ± 2.11 mg) when compared to commercial horse gram variety (151.4 ± 2.86 mg). The tannin was high in Paiyur 2 horse gram (19.21 ± 0.01 mg) when compared to commercial horse gram variety (18.45 ± 0.16 mg). Similar proximate composition for different horse gram varieties were reported in Vashishth *et al.*, 2017^[35], Ravindran and Sundar, 2009^[24]. It shows that proximate composition differs significantly according to the varieties of horse gram.

The functional properties of Paiyur 2 and commercial variety of horse gram flour are shown in Figure 2. The water absorption capacity of flour was found to be high in Paiyur 2 variety (2.18 ± 0.07 ml/g) than commercial variety (1.95 ± 0.01 ml/g). Similar results are reported for water absorption capacity of horse gram flour by Kadam and Salunkhe, 1985^[14]. The oil absorption capacity of flour was high in Paiyur 2 variety (0.86 ± 0.01 ml/g) than commercial variety (0.79 ± 0.03 ml/g). Pavithra *et al.*, 2006^[22] reported that the oil absorption capacity of raw horse gram flour was found to be 1.9 g/g. Fat absorption capacity has been attributed to the physical entrapment of oil and it is important, since fat acts as

flavor retainer and increase the mouth feel of foods. Sreerama *et al.*, 2008^[31] revealed that the enhanced ability of flour to absorb and retain water and oil may help to improve binding of the structure, enhance flavour retention, improve mouth feel and reduce moisture and fat losses of food products. The solubility and swelling power are also found to be high in Paiyur 2 horse gram (2.45 ± 0.05 %, 2.84 ± 0.02 g/g) when compared to commercial variety horse gram (3.67 ± 0.13 %, 3.73 ± 0.09 g/g). Similar results of swelling power and solubility was reported by Khatun (2009)^[2]. It also states that swelling capacity is high due to high protein content because protein holds water.

Table 1: Physical parameters of two varieties of horse gram

Parameters/Variety	Commercial Variety	Paiyur 2
Seed weight (g)	18.93 ± 0.69	20.06 ± 0.75
Bulk density (g/ml)	0.88 ± 0.01	0.86 ± 0.01
Hydration capacity (g/seed)	0.031 ± 0.00	0.042 ± 0.00
Hydration index (%)	0.87 ± 0.01	0.92 ± 0.03
Swelling capacity (ml/seed)	0.049 ± 0.00	0.057 ± 0.00
Swelling index (%)	1.27 ± 0.04	1.61 ± 0.02
Germination (%)	92 ± 1.49	97 ± 2.27

*Values reported are mean \pm SD of three replicates.

Table 2: Cooking quality of two varieties of horse gram

Parameters/Variety	Commercial Variety	Paiyur 2
Cooking time (mins)	70 ± 2.87	63 ± 2.53
Elongation ratio	1.15 ± 0.00	1.26 ± 0.02
Swelling ratio	1.28 ± 0.01	1.35 ± 0.00
Volume expansion ratio	6.85 ± 0.02	8.01 ± 0.35
Cooked length-breadth ratio	1.37 ± 0.00	1.54 ± 0.02
Water uptake ratio	18.7 ± 0.01	14.4 ± 0.04

*Values reported are mean \pm SD of three replicates.

Table 3: Nutritional quality of two varieties of horse gram

Parameters/Variety	Commercial Variety	Paiyur 2
Moisture (%)	11.2 ± 0.41	10.1 ± 0.17
Ash (%)	3.2 ± 0.01	3.6 ± 0.05
Protein (g)	16.10 ± 0.15	17.58 ± 0.68
Fat (g)	1.4 ± 0.05	2.0 ± 0.04
Crude fibre (g)	6.62 ± 0.22	7.10 ± 0.30
Carbohydrate (g)	57.12 ± 0.72	54.24 ± 1.32
Iron (mg/100g)	18.24 ± 0.75	20.27 ± 0.89
Calcium (mg/100g)	242.2 ± 7.85	258.3 ± 5.58
Phytate (mg/100g)	151.4 ± 2.86	146.8 ± 2.11
Tannin (mg/100g)	18.45 ± 0.16	19.21 ± 0.01

*Values reported are mean \pm SD of three replicates.

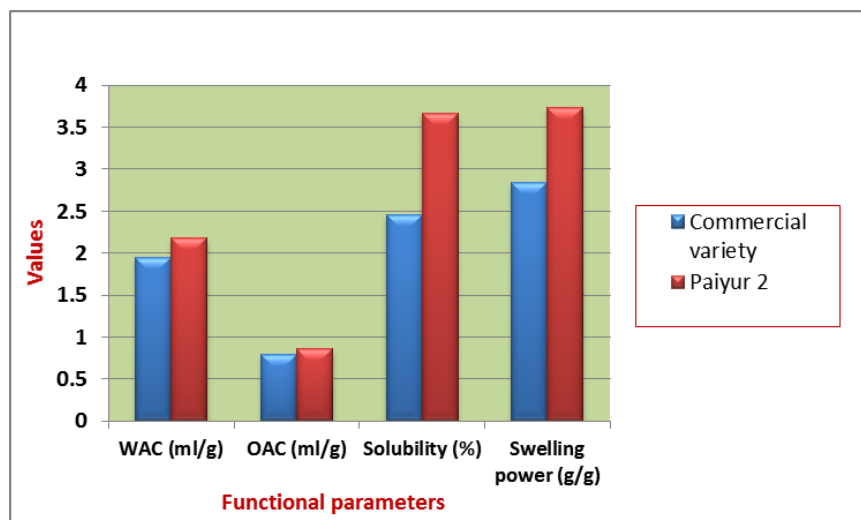


Fig 2: Functional properties of two varieties of horse gram

Conclusion

In conclusion the Paiyur 2 variety has superior physical, functional and cooking qualities which increases their opportunities to act as a substitute for other legumes in developing various food products. The nutritional quality of both horse gram variety does not have significant difference in all parameters. Among the functional properties due to high swelling power of Paiyur 2 horse gram it can be used to make expanded extruded products which can gain more market demand.

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