Determination of physico-chemical and functional properties of different genotypes of horse gram

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ABSTRACT
A study was carried out to determine the physicochemical and functional properties of seeds of five different genotypes of horsegram obtained from AICRP on Arid Legumes at Parbhani centre to assess their potential use in the food products. The five different genotypes viz. VLG-34, SHG-0628-4, AK-53, AK-21 and AK-52 were analysed. The AK-21 have highest 100 seed weight (3.75%) followed by AK-52 (3.61g) while maximum density (1.42g/ml) and bulk density (0.833 g/ml) was found in AK-52. The data on proximate composition showed that among all genotypes the AK-21 had highest protein (30.08%), crude fiber(5.5%) which could be exploited for nutritional purpose and genotype VLG-34 scored highest in crude fat (2.56%), carbohydrate (64.53%) and ash content(3.10%) will be used in different food formulation. The functional properties study revealed that the genotype AK-21 was superior in most of the functional properties viz. swelling capacity(0.041ml/seed), water absorption capacity (1.53g/g), oil absorption capacity(1.21 g/g), foaming capacity (48.18%), foaming stability (40.13%), emulsifying activity(59.53%), emulsifying stability(55.16%), invitro protein digestibility(81.80%) and required less cooking time(55 min.). These properties makes AK-21 suitable for processor and consumer also. These results suggest the potential utility of horse gram flour as substitutes for other legume flour for food products formulations.

Key words: Functional properties, Horsegram, Hydration capacity, Physicochemical properties, Swelling capacity.

INTRODUCTION
Legumes as good sources of proteins, carbohydrates, and several water soluble vitamins, and minerals, legumes in general make a major contribution to human nutrition. However, underutilised legumes, such as cowpea (Vigna unguiculata L. Walp.) and horse gram (Macrotyloma uniflorum L.) have been recognised as potential sources of protein and other nutrients (Prinyawiwatkul a et al., 1996 and NAS,1979 ). Horse gram is however, consumed as sprouts in many parts of India (Ghorpade et al., 1986). Horse gram is largely cultivated, especially in dry areas of Australia, Burma, India and Sri Lanka, mainly for animal feed. It is also used as a vegetable in India and is known as the poor man’s pulse crop in southern India (Kadam and Salunkhe, 1985). Both cowpea and horse gram are low in fat and are excellent sources of protein, dietary fibre, a variety of micronutrients and phytochemicals (Kadam and Salunkhe, 1985; Siddhuraju and Becker, 2007). The use of horse gram flour, as ingredients in composite flours and functional foods, is limited, due to the presence of certain phytochemicals with antinutrient effects that limit the nutritive value of these legumes. Conventional processing methods, such as soaking, boiling, germination, and fermentation, are widely used to decrease the content of these undesirable components, which results in enhanced acceptability and nutritional quality in addition to optimal utilisation of these legumes as human food (Kadam and Salunkhe, 1985). However, recently, health-promoting and disease-preventing properties have been attributed to these phytochemicals with antinutrient effects, thus attracting more and more interest from both researchers and food manufacturers (Jacobs and Steffen, 2003). Horsegram has been reported to have a lot of medicinal value. The rich fibre content of horsegram helps in reducing the body fat in fast mode. It is believed that eating horsegram makes our body strong and is also good in treating stones, menstrual problems, obesity, curing cough and cold (Kamala, 2009). Improved utilisation of such underutilised legume flour can be maximised through an understanding of their physical and chemical components and through the implementation of diverse processing strategies to facilitate the development of economically viable alternative products. In this respect, some recent studies have indicated that the consumption of cowpea and horse gram could be improved by processing them into ingredients that can be used in food product applications (Prinyawiwatkul b et al., 1996; Sreerama et al., 2008). However, the use of legume flours in various food formulations is dependent on their nutritional and functional properties. Therefore, an investigation was carried out first, to elucidate the nutritional and functional properties of horse

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gram. This is expected to give insight into the possible utilisation of horse gram as partial substitutes of other legume in snack, confectionary and other traditional food products.

MATERIALS AND METHODS

The legume seeds of different genotypes of horse gram viz. VLG-34, SHG-0628-4, AK-53, AK-21 and AK-52 were obtained from All India Coordinated Project on Arid Legume Parbhani. Extraneous matter such as unhealthy seed, infected seed, sand and chaff were removed from the samples. The samples were separately ground with an attrition mill and sieved to a particle size of 1mm. Flour samples were packed and stored in an air tight labelled plastic bottles prior to analysis.

Determination of physical properties: Using vernier caliper the length, width and breadth of seeds were determined. 100-seed weight was determined by weighing 100 randomly selected raw seeds of each variety as recommended by AOAC (2000).

Bulk density: The method of Onwuka (2005) was followed. The bulk density was calculated as: Bulk Density (g/ml) = Weight of sample (g)/Volume of sample (ml) and expressed as g/ml.

Seed porosity: Seed porosity is a property of grain which depends on its bulk- and kernel densities. Seed porosity (P) was determined using the equation stated by Mpotokwane et al. (2008)

\[ P = (1-Pb/Pt)*100 \]

Where \( pb \) = bulk density (kg/m\(^3\)) and \( pt \) = seed density (kg/m\(^3\)).

The colour of horsegram seeds was determined by using of Munshell colour chart.

Determination of chemical properties: The horse gram genotypes were analyzed for moisture, protein, fat, carbohydrate, ash, crude fibre, tannin. Carbohydrate was determined by difference. All determinations were carried out using standard procedures (AOAC, 2000). The analytical values were evaluated from the mean of three determinations for each sample.

Determination of functional properties: Hydration and swelling capacities, were determined by the techniques used by Bishnoi and Khetarpaul (1993).

Hydration capacity: A hundred seeds were counted and transferred to a measuring cylinder and 100ml water was added. The cylinders were covered with aluminum foil and left overnight at room temperature. Next day seeds were drained, superfluous water removed with filter paper and swollen seeds reweighed. Hydration capacity per seed was determined by using the following formula and expressed as g/seed.

\[ \text{Hydration capacity} = \frac{\text{Weight of soaked seed}}{\text{Weight of seed before soaking}} \]

Swelling capacity – A hundred seeds were counted, their volume noted and soaked overnight. The volume of the soaked seeds was noted in a graduated cylinder. Swelling capacity per seed was calculated by following formula and expressed as ml/seed.

\[ \text{Swelling capacity} = \frac{\text{Volume after soaking}}{\text{Volume before soaking}} \times 100 \]

Emulsifying activity: The procedure of Beuchat et al., (1975) was adapted as described by Eke (1993).

Emulsion Stability: Emulsion Stability was determined using the procedure described by Kinsella (1979).

Foaming capacity: The foaming capacities of flour samples were determined according to Onwuka (2005). The foam capacity was expressed as percent increase in volume using the formula of Abbey and Ibeh (1988) as reported by Onwuka (2005).

\[ \text{Foaming capacity} = \frac{\text{Volume after whipping}}{\text{Volume before whipping}} \times 100 \]

Foam stability: Foam stability of samples (flours) was determined using the methods described by Chinma et al. (2008).

Water and oil absorption capacity: The method of Carcea Benecini (1986) was used. The oil/water absorption capacities were expressed as grams of oil/water absorbed per gram of flour sample.

Cooking time: Cooking time of each horsegram genotypes was determined according to the method of Akinyle et al. (1986) with slight modifications in terms of quantity of water and seeds used. Cooking time was determined by noting the time in minutes required for soft cooking as assessed by pressing the cooked seeds between two fingers until no hard material was found.

In vitro Protein digestibility: To determine in vitro protein digestibility (IVPD) the procedure of Hsu et al. (1977) as modified by Satterlee et al. (1979) was used.

Statistical analysis: The data obtained was analyzed statistically by completely randomized design (CRD) as per the procedure given by Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

Physical properties: The Physical properties of horse gram seeds of four different genotypes are shown in Table -1. The length, width and breadth of the horse gram genotypes were ranged between 5.3 and 6.1 mm, 3.5 and 4.0 mm and 1.7 and 2.0 mm respectively. The differences between the length, width and breadth of the cowpea genotypes were significant (P>0.05). The genotype AK-53 was marginally longer (6.1mm) and having maximum width (4.0mm) than rest of genotypes. The genotype SHG-0628-4 and AK-52 have maximum breadth (2.0mm). Length and thickness of horse gram seeds were in comparison with the values
reported by Shashi Jain et al. (2012) i.e. 5.66 to 5.59mm and 2.16 to 2.09 respectively. There were also significant differences found among the 100-seed weight of the horsegram genotypes which ranged between 3.13 to 3.75g. The genotype AK-21 was significantly highest than rest of genotypes (3.75g) followed by AK-52 (3.61g). The 100 seed weight values were in comparison with the result reported by Shashi Jain et al. (2012) i.e. 3.33 to 3.39g. The small size and thickness of the seeds might be attributed to drought resistant grain crops being hardy in nature, have a thick endosperm as observed in other millets and legumes like pearl millet, foxtail millet, barnyard millet etc. The density, bulk density and porosity were also differing genotype to genotype. The seed density of the five genotypes were found to be higher as compared to the result reported by Shashi Jain et al. (2012) i.e. 0.47-0.51g/ml. The higher density may be attributed to its higher weight of seeds and hence more seed volume. The AK-52 having highest bulk density (0.833%) and SHG-0628-4 had highest porosity (46.31%). The high bulk densities observed in the horsegram genotypes used in this study indicate that their flours are heavy. The high bulk densities of the flours suggest their suitability for use in various food preparations. According to Padmasshree et al. (1987), higher bulk density is desirable for greater ease of dispersibility of flours. In contrast, however, low bulk density would be an advantage in the formulation of complementary foods (Akpata and Akubor, 1999). Since SHG-0628-4 and AK-53 genotype had the least bulk density (0.714g/ml). It could be the most suitable for production of complementary foods. The color of genotype VLG-34 was reddish yellow and SHG-0628 was Red. The genotype AK-53, AK-21 and AK-53 seed were reddish brown in colour.

**Proximate composition:** The proximate composition of the horse gram genotypes are presented in Table 2. The moisture content of the horse gram genotypes varied significantly between 11.10 to 13.0% with VLG-34 having maximum moisture content (13.0%) and AK-21 having lowest moisture of 11.10%. The fat content of horse gram genotypes was ranged between 1.61 to 2.56 percent and these values were comparable to reported values by Sudha et al. (1995) and Gopalan et al. (1989) and Shashi Jain et al. (2012). Higher fat parentage in VLG-34 (2.56%) flour also enhances the ability of flour to absorb and retain oil, improves binding of the structure, enhances flavour retention, improves mouth feel and reduces moisture and fat losses of food products (Sreerama et al. 2008). The lower lipid content of horse gram flour in AK-52 (1.61%) may be utilised as ingredients in weight restriction diets. These values are similar to the values reported for horse gram (Sreerama et al. 2008).

The protein content of the five genotypes were in the range of 24.30-30.08 percent which was found to be higher than result reported by Shashi Jain et al. (2012) i.e.

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**TABLE 1:** Physical properties of horsegram genotypes.

<table>
<thead>
<tr>
<th>Genotype</th>
<th>Length (mm)</th>
<th>Width (mm)</th>
<th>Breadth (mm)</th>
<th>Hundred seed wt (g)</th>
<th>Density g/m</th>
<th>Bulk Density g/ml</th>
<th>Porosity (%)</th>
<th>Colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>VLG-34</td>
<td>5.8</td>
<td>4.0</td>
<td>1.7</td>
<td>3.50</td>
<td>1.33</td>
<td>0.740</td>
<td>44.56</td>
<td>5YR 6/8 Reddish yellow</td>
</tr>
<tr>
<td>SHG-0628-4</td>
<td>5.3</td>
<td>3.7</td>
<td>2.0</td>
<td>3.22</td>
<td>1.33</td>
<td>0.714</td>
<td>46.31</td>
<td>5YR 5/8 Red</td>
</tr>
<tr>
<td>AK-53</td>
<td>6.1</td>
<td>4.0</td>
<td>1.9</td>
<td>3.13</td>
<td>1.25</td>
<td>0.714</td>
<td>42.88</td>
<td>5YR 2.5/4 Reddish brown</td>
</tr>
<tr>
<td>AK-21</td>
<td>5.4</td>
<td>3.5</td>
<td>2.0</td>
<td>3.75</td>
<td>1.33</td>
<td>0.769</td>
<td>42.18</td>
<td>5YR 5/4 Reddish brown</td>
</tr>
<tr>
<td>AK-52</td>
<td>5.3</td>
<td>3.9</td>
<td>2.0</td>
<td>3.61</td>
<td>1.42</td>
<td>0.833</td>
<td>41.33</td>
<td>5YR 6/4 Light Reddish brown</td>
</tr>
</tbody>
</table>

**TABLE 2.** Proximate composition (%) of Horse gram genotypes

<table>
<thead>
<tr>
<th>Genotypes</th>
<th>Moisture</th>
<th>Fat</th>
<th>Protein</th>
<th>Carbohydrate</th>
<th>Crude Fibre</th>
<th>Ash</th>
<th>Tannin (mg/g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VLG-34</td>
<td>13.0</td>
<td>2.56</td>
<td>24.30</td>
<td>64.53</td>
<td>4.4</td>
<td>3.10</td>
<td>1.68</td>
</tr>
<tr>
<td>SHG-0628-4</td>
<td>11.70</td>
<td>1.76</td>
<td>25.70</td>
<td>61.18</td>
<td>5.1</td>
<td>2.10</td>
<td>1.22</td>
</tr>
<tr>
<td>AK-53</td>
<td>11.40</td>
<td>1.68</td>
<td>25.48</td>
<td>60.93</td>
<td>4.8</td>
<td>2.91</td>
<td>1.09</td>
</tr>
<tr>
<td>AK-21</td>
<td>11.10</td>
<td>1.73</td>
<td>30.08</td>
<td>60.19</td>
<td>5.5</td>
<td>2.68</td>
<td>1.27</td>
</tr>
<tr>
<td>AK-52</td>
<td>12.22</td>
<td>1.61</td>
<td>26.66</td>
<td>61.38</td>
<td>4.3</td>
<td>2.58</td>
<td>1.55</td>
</tr>
<tr>
<td>SE±</td>
<td>0.20</td>
<td>0.22</td>
<td>0.11</td>
<td>0.10</td>
<td>0.04</td>
<td>0.02</td>
<td>0.035</td>
</tr>
<tr>
<td>CD at 5%</td>
<td>0.61</td>
<td>0.68</td>
<td>0.33</td>
<td>0.31</td>
<td>0.13</td>
<td>0.07</td>
<td>0.106</td>
</tr>
</tbody>
</table>
15.10 to 15.32% and in comparison with the reported values of 17.9 – 25.3 % (Sudha et al. 1995) and 22.0 g% (Gopalan et al. 1989) for horse gram cultivars. The protein content is comparable to those of other edible leguminous seed flours, such as pigeon peas, some genotypes of cowpea and soyabean (Olaofe. et al. 1994). The lower amount of protein estimated might be attributed to the higher amount of anti nutritional factors like TIA, saponins, hemagglutinins in those genotypes of horse gram. Generally, higher protein content is desirable for improved nutrition. The protein content was found maximum in AK-21 (30.08%) followed by AK-52 (26.66%) among all genotypes. The high protein content of the genotypes is indicative that its use could help to reduce protein-deficiency conditions such as Kwashiorkor. There was significant difference between the carbohydrate content of horse gram flours. The VLG-34 recorded significantly highest carbohydrate (64.53 %) followed by AK-53(61.93 %). However, VLG-34 has more of raw seeds than the reported values of 74.88-76.06 g% by Shashi Jain et al (2012), and higher than the reported values of 51.9-60.9 g% by Sudha et al. (1995) and 57.2g % by Gopalan et al. (1989). The carbohydrates of horse gram can easily provide the energy required for oxidative metabolism. In addition, carbohydrate-rich food maintains glycemic homeostatic, gastro intestinal integrity and also serves as the vehicle for important micronutrients and phytochemicals. Unlike fats and proteins, high level of carbohydrate intake is not associated with adverse health effects.

The crude fibre content of raw seeds of horse gram was ranged between 4.3 to 5.5 percent, which was similar to the reported values of Shashi Jain et al (2012), Sudha et al. (1995) and Gopalan et al. (1989). Fibre regulates digestion, detoxifies and normalizes bowel function, reduces blood cholesterol and prevents colon cancer. With respect to the ash content of the genotypes is ranged from 2.10 to 3.10% which were similar with the reported values of Bhokre et al (1995) and Gopalan (1994). The lower amount of water or oil retained by a known weight of flour might be responsible for high hydrogen bonding and high electrostatic repulsion Altschul and Wilcke (1985). Water absorption capacity was comparable with that of the result reported by Shashi Jain et al (2012) and AK-21(0.034ml/seed) at par each other and significantly maximum compared to other genotypes. The hydration capacity was comparable with that of the result reported by Jayashri et al. 2012 i.e. 0.03 to 0.04 g/seed and velvet bean germplasms (0.29-1.14ml/ seed) as reported by Gurumoorthri and Janardhanan (2008). Lower values for swelling capacity reflected that the seeds possessed very hard and impermeable seed coat and they were not hydrated easily. The lower hydration and swelling capacity of horse gram seeds as compared to other beans and peas clearly indicated their hard to cook defect and hence not preferred by food processors. The hydration capacity of AK-21(0.034ml/seed) and AK-21(0.034ml/seed) at par each other and significantly maximum compared to other genotypes. The hydration capacity was comparable with that of the result reported by Shashi Jain et al (2012) i.e. 0.03 to 0.04 g/seed and velvet bean as reported by (Gurumoorthri and Janardhanan, 2008) and other conventional pulses (Singh et al. 2004).

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 higher protein content in the flour might be responsible for high hydrogen bonding and high electrostatic repulsion Atschul and Wilcke (1985). Water absorption capacity of horse gram were found to be in the range 1.33 to 1.53g/g. The values are found to be in comparison with the values of 142.14g/100g (ie 1.42g/g) obtained were less as compared to reported values of Jayashri et al. (2001). The differences observed for tannin content among them however, not significant.

**Functional properties:** The functional properties of the horse gram flours are shown in Table 3. The data depicted revealed that AK-21 had significantly highest value for all functional properties expect cooking time which show minimum value. The lower cooking time is preferred by consumers and processors. The swelling capacity of the horse gram seeds significantly differed from each other and ranged between 0.029 to 0.041ml/seed with AK-21and AK-52 had significantly maximum swelling capacity 0.041ml/seed and 0.039 ml/seed respectively. The genotype AK-53 having the least swelling capacity (0.029ml/seed). Swelling capacity of horse gram was comparable with the result reported by Shashi Jain et al (2012) and AK-21(0.034ml/seed) at par each other and significantly maximum compared to other genotypes. The hydration capacity was comparable with that of the result reported by Shashi Jain et al (2012) and AK-21(0.034ml/seed).

### TABLE 3 Functional properties of the horse gram genotypes

<table>
<thead>
<tr>
<th>Genotypes</th>
<th>SC ml/seed</th>
<th>HC g/seed</th>
<th>WAC g/g</th>
<th>OAC g/g</th>
<th>FC %</th>
<th>FS %</th>
<th>EA %</th>
<th>ES %</th>
<th>Cooking Time (Min)</th>
<th>IVPD (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VLG-34</td>
<td>0.035</td>
<td>0.031</td>
<td>1.40</td>
<td>0.80</td>
<td>40.30</td>
<td>36.43</td>
<td>52.10</td>
<td>51.63</td>
<td>61</td>
<td>79.0</td>
</tr>
<tr>
<td>SHG-0628-4</td>
<td>0.034</td>
<td>0.030</td>
<td>1.46</td>
<td>0.91</td>
<td>43.10</td>
<td>38.61</td>
<td>57.53</td>
<td>54.31</td>
<td>57</td>
<td>74.60</td>
</tr>
<tr>
<td>AK-53</td>
<td>0.029</td>
<td>0.028</td>
<td>1.33</td>
<td>0.82</td>
<td>42.91</td>
<td>38.01</td>
<td>56.03</td>
<td>53.12</td>
<td>62</td>
<td>80.20</td>
</tr>
<tr>
<td>AK-21</td>
<td>0.041</td>
<td>0.034</td>
<td>1.53</td>
<td>1.21</td>
<td>48.18</td>
<td>40.13</td>
<td>59.53</td>
<td>55.16</td>
<td>55</td>
<td>81.80</td>
</tr>
<tr>
<td>AK-52</td>
<td>0.039</td>
<td>0.035</td>
<td>1.48</td>
<td>1.15</td>
<td>43.28</td>
<td>39.16</td>
<td>58.31</td>
<td>55.01</td>
<td>56</td>
<td>81.40</td>
</tr>
<tr>
<td>SE±</td>
<td>0.0018</td>
<td>0.0006</td>
<td>0.016</td>
<td>0.015</td>
<td>0.015</td>
<td>0.045</td>
<td>0.051</td>
<td>0.0501</td>
<td>0.70</td>
<td>0.072</td>
</tr>
<tr>
<td>CD at 5%</td>
<td>0.0057</td>
<td>0.0021</td>
<td>0.054</td>
<td>0.049</td>
<td>0.049</td>
<td>0.149</td>
<td>0.169</td>
<td>0.1637</td>
<td>2.31</td>
<td>0.236</td>
</tr>
</tbody>
</table>

SC-swelling capacity, HC-hydration capacity, WAC-water absorption activity, OAC-oil absorption capacity, FC-foaming capacity, FS-foaming stability, EA-emulsion activity, ES-emulsion stability and IVPD – Invitro protein digestibility.
The water absorption capacities of genotype AK-21 was recorded significantly highest (1.53 g/g) followed by AK-52 (1.48 g/g) while AK-53 recorded lowest (1.33 g/g) among all genotypes. Water absorption capacity of flours plays an important role in the food preparation process because it influences other functional and sensory properties. Furthermore, the range of application of flours as food ingredients is dependent, to a large extent, on their interaction with water. The oil absorption capacity is also due to enhanced hydrophobic character of proteins in the flours. The oil absorption capacity of horse gram flour was found to be in the range 0.80 to 1.21 g/g. The values are found to be in comparison with the values of 80.76% (i.e. 0.80 g/g) reported by Marimuthu and Krishnamoorthi (2013). Significant differences in the oil absorption capacities were noted among the horse gram genotype studied. The genotype AK-21 had the highest OAC value (1.21 g/g) while VLG-34 had lowest OAC (0.80 g/g). The oil-adsorption capacity of any food compound is important for food applications because it relies mainly on its capacity to physically entrap oil by a complex capillary attraction process. In many food applications, such as emulsion-type meat products, the ability of a food component to entrap oil is an important characteristic because fat acts as a flavour retainer, a consistency trait and an enhancer of mouth feel (Khattab and Arntfield, 2009). 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.

The foaming capacity and foam stability values of flours varied significantly. 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 (Sathe, et al 1982). The results revealed that foaming capacity and foaming stability of horse gram seed flour were found to be 40.30 to 48.18 percent and 36.43 to 40.13 percent respectively. The values are found to be in comparison with the values of 38.16 ± 1.00% and 35.12 ± 0.11% reported by Marimuthu and Krishnamoorthi (2013). The FC of AK-21 (48.18 %) was found to be greater than that of other genotypes of horse gram (Table 3). Better foaming capacity of AK-21 flour implies greater incorporation of air bubbles into the product. In general, all horse gram flours depicted high foam stability and may find application in baked and confectionery products.

The emulsifying activities and emulsion stabilities of horse gram flours are shown in Table 3. The emulsifying activity of each of the 5 genotypes varied from 52.10 to 59.53 percent and emulsifying stability varied between 51.63 to 55.16 percent. The results of emulsifying activity were found to be less as compared to the reported values of Yadahally et al.,(2012) i.e. 58.1 percent and comparable for emulsifying stability i.e. 52.0 percent. Also the values are found to be in comparison with the values reported by Marimuthu and Krishnamoorthi (2013). The emulsion activity reflects the ability and capacity of a protein to aid in the formation of an emulsion and is related to the protein’s ability to absorb to the interfacial area of oil and water in an emulsion. The emulsion stability normally reflects the ability of the proteins to impart strength to an emulsion for resistance to stress and changes and is therefore related to the consistency of the interfacial area over a defined time period (Pearce and Kinsella, 1978). However, emulsion stability values of all the horse gram genotype flours differed significantly. The flour of genotype AK-21 was superior to the other genotype in emulsifying capacity (59.53%) and emulsifying stability(55.16 %). The increased emulsion activity of horse gram flour might be due to the dissociation and partial unfolding of globular proteins, leading to exposure of hydrophobic amino acid residues, which consequently increased the surface activity and adsorption at the oil and water interface. (Yadahally et al, 2012).

The cooking time study revealed that minimum cooking time of 55 minute was required for genotype AK-21 followed by AK-52 (56 min.). Short cooking time is desirable as it reduces duration, energy used in cooking as well as save labour cost. The results were comparable with the result reported by Shashi Jain et al (2012) i.e. 50 to 60 min. The cooking time of genotypes AK-21, AK-52 and SHG-0628-4 were not significantly differed. Whereas AK-53(62 min) and VLG :34(61 min) required significantly highest cooking time than rest of genotypes. Modern trend towards convenience foods with reduced cooking time makes genotype AK-21 superior to the other genotypes of horse gram, therefore, could be more acceptable to consumers and processors with limited time and resources. Invitro protein digestibility of horse gram genotypes varied in between 74.60 to 81.80 %. The genotypes AK-21 having highest IVPD(81.80 %) while lowest recorded for genotype SHG-0628-4(74.60%). The results were in accordance with the values of invitro protein digestibility of horse gram as 76.3 per cent by Ismail et al(2003).

CONCLUSION
The findings of this study showed that the variety AK-21 is rich in protein (30.08%) which could be exploited for nutrition and flour of this could be used to fortify conventional flours which are low in protein. While VLG-34 scored higher value for chemical parameter such as carbohydrate, fat, ash and moisture. The consumption of foods based on these horsegram genotypes would be an important step towards alleviating protein malnutrition. The genotype AK-21 have good functional properties also i.e.
highest WAC (1.53g/g), OAC (1.21g/g), FC (48.18%), FS (40.13%), EA (59.53%) and highest ES (55.16%) and less cooking time (55 min) make it useful in different foods formulation. It can be concluded that genotypes AK-21 and VLG -34 was physically, chemically and functionally superior than the rest of genotypes. These genotypes can be used easily in formulating different type of products and looking to its beneficial nutrient properties it is suggested that it be included in daily diet as a source of various nutrients.

REFERENCES


National Academy of Sciences (1979). In Tropical legumes: Resources for the future, Report of an Ad hoc panel of the advisory committee on technology innovation board on science and technology for international development, Washington, D.C.


