Functional and physicochemical properties of flours of six *Mucuna* species

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Legume flours were prepared from six species of mucuna bean, *M. Veracruz* mottle, *M. rajada*, *M. cochinchinensis*, *M. deerigeana*, *M. pruriens* and *M. veracruz* white. Physicochemical and functional characteristics were carried out on full fat and defatted flours. Bulk density of the flours increased following defatting. Isoelectric point of the proteins lies between 4 and 5. Generally, solubility reduced as the pH increases until it reached isoelectric point, followed by progressive increase in solubility with further increase in pH. Defatted flours have higher water and oil absorption capacities compared with full fat samples and *M. veracruz* white recorded the lowest value (1.40 g/g) while *M. veracruz* mottle had the highest value (2.20 g/g). Gelation studies revealed that *M. veracruz* mottle and *M. rajada* recorded the highest values (20%) while *M. veracruz* white and *M. deerigeana* had the lowest value (14%). The foaming capacity in full fat flours ranged between 9.6% in *M. veracruz* white and 19.23% in *M. pruriens* while the foaming capacity in defatted flours ranged from 50.0% in both *M. pruriens* and *M. veracruz* white and 84.30% in *M. veracruz* mottle. In addition, foaming capacities in full fat flours are lower than those of defatted flours. Emulsion capacity ranged between 78-90% in full fat flours and 56-68% in defatted flours.

**Key words:** Mucuna, flours, functional properties.

**INTRODUCTION**

The wide prevalence of protein-calories malnutrition in developing countries is of great importance not only to food scientists, nutritionists or agricultural scientists but also for concerned governments as well (Olsen, 1975). The continuous increase in population and inadequate supply of protein has inadvertently increased the occurrence of malnutrition in developing countries (Sidduraju, 1996). Recent studies have shown that malnutrition among children in developing countries is mainly due to the consumption of cereal based porridge which is bulky, low in energy and density and high in anti-nutrients (Michaelsen and Henrik, 1998). Plant protein products are gaining increased interest as ingredients in food systems throughout many parts of the world; the success of utilizing plant proteins as additives depends greatly upon the favourable characteristics that they impart to foods. In the developed countries, plant proteins are now either regarded as versatile functional ingredients or as biologically active components more than as essential nutrients (Marcello and Gius, 1997). The partial replacement of animal foods with legumes has been shown to improve nutritional status (Guillion and Champ, 1966) due to lower cholesterol level in plant foods. Also, plant food diets increase the level of fibre intake which reduces the risk of bowel diseases, including cancer and also reduction in osteoporosis incidence (Strtori and Lovati, 2001). This evolution towards health and functionality is mainly driven by the demands of consumers and health professionals. The partial replacement of animal foods with legumes is claimed to improve overall nutritional status (Guillion and Champ, 1996).

*Mucuna* bean is one of the underutilized legumes in Africa. The seed is not only rich in proteins but also in carbohydrates, fats, mineral and other nutrients. The

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seeds of mucuna beans (*Mucuna pruriens*) are less exploited as protein source in Africa. They are traditionally used as soup thickener by Ibos in south-eastern Nigeria. Outside Africa, the seeds are also eaten by Indian tribal sects, Mundari and Dravidian groups. In an earlier work, we have presented the variability in the chemical composition, amino acids and antinutrients of six varieties of *Mucuna* (Adebowale et al., 2005). Therefore in continuation of our studies on these under-utilised tropical legumes, this article considers the functional properties of full fat and defatted flours of six *Mucuna* species. The output of the research involves the collation of the data on the functional and physico-chemical properties of the mucuna bean flours. This would provide useful information to industrialists and others alike on the subsequent incorporation of the *Mucuna* species into food products to produce natural, cheap and adaptable functional foods.

**MATERIALS AND METHODS**

**Materials**

Six species of mucuna beans seeds namely: M. *Veracruz* mottle, M. *raja da*, M. *cochinchenensis*, M. *deerigeana*, M. *pruriens* and M. *veracruz* white were obtained from the International Institute for Tropical Agriculture, Ibadan. All chemicals used were of analytical grade.

**Preparation of flours**

Cleaned seeds of mucuna seeds were dehulled with a hammer mill followed by winnowing of the seed coats. The dehulled seeds from each legume species were then milled into flour in a hammer mill. They were ground to pass through a BS 60 mesh screen. The samples were then kept in the refrigerator at 4°C prior use. A portion of the flour was defatted by extracting with n-hexane in a soxhlet for the analysis.

**Determination of bulk density**

This was carried out using the procedure of Narayana and Narasinga (1984). A specified quantity of the flour sample was transferred into an already weighed measuring cylinder (w1). For the packed bulk density determination, the flour sample was gently tapped to eliminate spaces between the flour and the level was noted to be the volume of the sample and then weighed (W2). No tapping was made in the case of loosed bulk density and the level was also noted to be the volume of the sample and then weighed. The study was conducted in triplicate.

\[
\text{Bulk density (g/cm}^3\text{) = } \frac{W_2 - W_1}{\text{Vol. of Sample}}
\]

**Protein solubility**

Protein solubility was determined by the method of Sathe et al. (1982) with some modifications. The suspensions (0.2%) of the flour in distilled water were adjusted to pH 2-11 using 1 M HCl and 1 M NaOH. The amount of nitrogen in each supernatant was determined by micro Kjedahl method according to the method already described in the AOAC (1990). Percent soluble protein was calculated as percent nitrogen multiplied by 6.25 on wet basis.

**Determination of water and oil absorption capacity**

Water absorption capacity was determined using the method of Sathe and Salunkhe (1981) with slight modifications. 10 mL of distilled water was added to 1.0 g of the sample in a beaker. The suspension was stirred using a magnetic stirrer for 5 min. The suspension obtained was thereafter centrifuged at 3555 rpm for 30 min and the supernatant measured in a 10 mL graduated cylinder. The density of water was taken as 1.0 g/cm³. Water absorbed was calculated as the difference between the initial volume of water added to the sample and the volume of the supernatant. The same procedure was repeated for oil absorption except that oil was used instead of water.

**Determination of the gelation concentration**

The least gelation concentration was determined by the method of Sathe et al. (1981). Test tubes containing suspensions of 2, 4, 6, 8 up to 20% (w/v) flour in 5 ml distilled were heated for 1 h in boiling water, followed by cooling in ice and further cooling for 2 h at 4°C. The least gelation concentration was the one at which the sample did not fall down or slip when the test tube was inverted.

**Determination of foaming properties**

The foam capacity and stability were studied by the method of Coffman and Garcia (1977). A known weight of the mucuna sample was dispersed in 100 mL distilled water. The resulting solution was homogenized for 5 min at high speed. The volume of foam separated was noted. The total volume remaining at interval of 0.00, 0.30, 1, 2, 3, 4 up to 24 h was noted for the study of foaming stability.

\[
\% \text{ Foaming capacity} = \frac{\text{vol. after homogenization} - \text{vol. before homogenization}}{\text{vol. before homogenisation}} \times 100
\]

\[
\% \text{ Foam stability} = \frac{\text{foam volume after time (t)}}{\text{Initial foam volume}} \times 100
\]

The effect of pH on foaming properties was carried out by adjusting 2% (w/v) dispersion to the desired pH range from 2 to 11 using either 1 M HCl or NaOH followed by vigorous whipping as described above.

**Emulsion capacity and stability**

Emulsions were formed inside a 600 ml beaker using a continuous stirring apparatus. The apparatus consisted of a regulated/stabilised 6 V power supply, a burette, a stirrer, a beaker with emulsion and a digital milliameter. The stirrer was made up of stainless steel rod holding a Perspex bridge was fixed to a 6 V D.C motor spindle by means of a plastic adaptor. The motor itself was driven by a regulated and stabilized 6 V D.C power supply. The milliameter monitored the current drop by the stirrer motor to maintain a constant speed. The greater the viscosity of the emulsion, the greater will be the current drawn. The protein sample (0.25, 0.5, 0.75, 1.00 and 1.25 g) was dissolved in 25 ml of distilled water making 1, 2, 3, 4 and 5% slurries (w/v), respectively.
Table 1. Bulk density of full fat and defatted mucuna flours*

<table>
<thead>
<tr>
<th>Sample</th>
<th>Full fat (g/cm³)</th>
<th>Defatted (g/cm³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mucuna vera cruz mottle</td>
<td>0.51±0.02</td>
<td>0.80±0.04</td>
</tr>
<tr>
<td>Mucuna rajada</td>
<td>0.61±0.04</td>
<td>0.88±0.05</td>
</tr>
<tr>
<td>Mucuna cochinchenensis</td>
<td>0.50±0.03</td>
<td>0.80±0.04</td>
</tr>
<tr>
<td>Mucuna deerigeana</td>
<td>0.42±0.03</td>
<td>0.74±0.05</td>
</tr>
<tr>
<td>Mucuna pruriens</td>
<td>0.54±0.04</td>
<td>0.72±0.04</td>
</tr>
<tr>
<td>Mucuna vera cruz white</td>
<td>0.60±0.02</td>
<td>0.84±0.05</td>
</tr>
</tbody>
</table>

* Mean ±SD of three replicate determinations

Figure 1. Protein solubility of mucuna flours. B. M. veracruz mottle, C. M. rajada, D. M. cochinchenensis, E. M. deerigeana, F. M. pruriens and G. M. veracruz white.

Necessary pH adjustment was made to ensure maximum solubilisation of the protein. The mixture was stirred for 30 min in order to disperse the sample. Oil was then added at a rate of 1.00 ml/s from a burette until emulsion collapsed indicated by a sharp fall in motor current. The volume of oil added up to inversion point was noted and the emulsion capacity expressed as ml oil per g of sample. The emulsion stability was determined by allowing the emulsion prepared to stand in a graduated cylinder and the volume of oil separated at time of 0.00, 0.5, 1, 2, 3 up to 24 h was noted in each case. The emulsion stability was determined by following the procedure used for emulsion capacity except that 100 ml of oil was added rather than adding oil until the emulsion breakdown.

% emulsion stability = \( \frac{\text{Height of the emulsified layer}}{\text{Height of the total content}} \times 100 \)

Statistical analysis

All experiments in this study are reported as mean of three replicate analyses. One way analysis of variance (ANOVA) was carried out to compare between the mean values of different species of the seeds. Differences in the mean values were determined at P < 0.05 (SAS, 1990).

RESULTS AND DISCUSSION

Bulk density

The results of bulk densities of full fat and defatted flours are presented in Table 1. The results obtained indicate that bulk density increased following defatting of flours. The values obtained ranged from 0.42 to 0.61 g/cm³ in full fat flours and 0.72 to 0.88 g/cm³ in defatted flours. Similar results were reported by Chau and Cheung (1997) in their studies of another legume, Dolichos lablab. High bulk density of the Mucuna species indicates that they would serve as good thickeners in food products.

Protein solubility

pH dependent protein solubility profile of flours are presented in Figure 1. Isoelectric point of the proteins was between pH value 4 and 5. Generally, solubility reduced as the pH increased until it reached isoelectric point, followed by progressive increase in solubility with further increase in pH. Similar observations have been presented earlier by Sathe et al. (1982) for winged bean. Prevalent charge on the constituent amino acids of proteins at various pH values determine protein solubility as follows:

\[
\begin{align*}
\text{II} & \quad \text{I} \\
\text{II} & \quad \text{III}
\end{align*}
\]

It is a zwitterion or dipolar ion which predominates at the region of isoelectric point in protein. At this pH, minimum solubility takes place because of minimum repulsion among the constituent amino acids. The balance in positive and negative charges minimised the
Table 2. Water and Oil absorption capacity of full fat and defatted mucuna flours.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Full fat</th>
<th>Defatted</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>WAC</td>
<td>OAC</td>
</tr>
<tr>
<td><em>M. vera cruz mottle</em></td>
<td>2.00±0.06</td>
<td>2.00±0.06</td>
</tr>
<tr>
<td><em>M. rajada</em></td>
<td>1.20±0.04</td>
<td>2.20±0.06</td>
</tr>
<tr>
<td><em>M. cochinchnensis</em></td>
<td>1.20±0.04</td>
<td>2.00±0.06</td>
</tr>
<tr>
<td><em>M. deerigeana</em></td>
<td>1.60±0.05</td>
<td>2.30±0.07</td>
</tr>
<tr>
<td><em>M. prurien</em></td>
<td>1.50±0.04</td>
<td>2.25±0.07</td>
</tr>
<tr>
<td><em>M. vera cruz white</em></td>
<td>1.20±0.04</td>
<td>2.40±0.07</td>
</tr>
</tbody>
</table>

* Mean ±SD of three replicate determinations
WAC = Water absorption capacity
OAC = Oil absorption capacity

Figure 2. Least gelation concentration of mucuna flours. A. *M. vera cruz mottle*, B. *M. rajada*, C. *M. cochinchnensis*, D. *M. deerigeana*, E. *M. prurien* and F. *M. vera cruz white*.

Water/oil absorption capacities

The results of water and oil absorption capacities are presented in Table 2. The water absorption capacities ranged between 1.2 to 2.00 g/g for full fat and 1.40 to 2.20 g/g for defatted flours, respectively. Defatted flours have higher water and oil absorption capacities compared with full fat samples. The results indicate that *M. vera cruz white* recorded the lowest value (1.40 g/g) while *M. vera cruz mottle* had the highest value (2.20 g/g). The removal of fat from the samples exposes the water binding sites on the side chain groups of protein units previously blocked in a lipophilic environment thereby leading to an increase in WAC values in defatted flours. Similar observation has been reported by Lin et al. (1974) on sunflower meal products. Water absorption capacity is a critical function of protein various food products like soups, gravies, doughs and baked products (Sosulski et al., 1976). Mucuna bean could be useful in these formulations. Oil absorption capacities ranged from 2.00 to 2.40 g/g for full fat and 2.10 to 2.60 g/g in defatted samples. *M. vera cruz white* recorded the highest oil absorption capacity (2.60 g/g) while *M. vera cruz mottle* had the lowest value (2.1 g/g). It was observed that the oil absorption capacity of defatted samples was better than full fat samples. These values compared favourably with oil absorption capacity reported for African yam bean by Oshodi et al. (1997). Lower values were recorded by Oshodi and Fagbemi (1992) in their work on pumpkin seeds. Also the oil absorption capacity values obtained in this work is higher than the values obtained for pigeon pea (Oshodi and Ekperigin, 1989). Liquid retention is an index of the ability of proteins to absorb and retain oil/water which in turn influences the texture and mouth feel characteristics of foods and food products like comminuted meats, extenders or analogues and baked dough (Cheftel et al., 1985; Okezie and Bello, 1988). Mucuna bean would therefore be useful as a flavour retainer in certain food products.

Least gelation concentration

The least gelation concentration for full fat mucuna flours is presented in Figure 2. It ranged from 14 to 20%. *M. vera cruz mottle* and *M. rajada* recorded the highest values (20%) while *M. vera cruz white* and *M. deerigeana* had the lowest value (14%). These values compared
solubility is always necessary for gelation as observed by Wilton et al. (1997). The high least gelation concentration observed in the Foaming properties shown in Tables 3 and 4. The foaming capacity in full fat and Wilcke, 1985). Higher protein concentration because of greater capacities hence the low water absorption capacity of different constituents such as protein, lipids and carbohydrates in different legumes. Moreover, Flemming et al. (1975) suggested a direct correlation between least gelation concentration and the level of globulin in legume seeds.

Gelation properties are interrelated to water absorption capacities hence the low water absorption capacity recorded by the flours could explain the deficient gel formation capacity. Gelation takes place more readily at higher protein concentration because of greater intermolecular contact during heating. High protein solubility is always necessary for gelation as observed by Wilton et al. (1997). The high least gelation concentration observed in the Mucuna species may be a disadvantage for its use in the production of curd and cheese (Altschul and Wicke, 1985).

**Foaming properties**

The results of foaming capacity and foam stability are shown in Tables 3 and 4. The foaming capacity in full fat flours ranged between 9.6% in *M. veracruz* white and 19.23% in *M. pruriens* while the foaming capacity in defatted flours ranged from 50.0% in both *M. pruriens* and *M. veracruz* white and 84.30% in *M. veracruz* mottle.

The foaming capacities in full fat flours are lower than those of defatted flours. Defatting markedly increase the foaming capacity in the flours. The foaming capacity recorded in defatted flours is higher than those recorded for pumpkin flours (13.2%) by Oshodi and Fagbemi (1992), and defatted cowpea flour (40%) reported by Abbey and Ibeh (1988). It was reported that foamability is related to the rate of decrease of the surface tension of the air/water interface caused by absorption of protein molecules (Sathe et al., 1982). Graham and Phillips (1976) linked good foamability with flexible protein molecules, which reduces surface tension. Low foamability on the other hand can be related to highly ordered globular proteins, which resists surface denaturation. The basic requirements of proteins as good foaming agents are the ability to (i) adsorb rapidly at air-water interface during bubbling, (ii) undergo rapid conformational change and rearrangement at the interface, and (iii) form a cohesive viscoelastic film via intermolecular interactions. The first two factors are essential for better foamability whereas the third is important for the stability of the foam. The foam stability ranged from 7.5 – 17.31 at 4 h for full fat flours and 26.92 to 73.10 at 4 h for defatted flours as indicted in Figures 3 and 4. The success of whipping agents largely depends on how long the whip can be maintained. Oil seed

<table>
<thead>
<tr>
<th>Mucuna sp</th>
<th>Foaming Capacity (%)</th>
<th>0.5 hour</th>
<th>1 hour</th>
<th>2 hours</th>
<th>4 hours</th>
<th>6 hours</th>
<th>10 hours</th>
<th>24 hours</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>M. vera cruz</em> mottle</td>
<td>15.4 ±0.4b</td>
<td>60.0±1.7</td>
<td>60.0±1.7</td>
<td>60.0±1.7</td>
<td>56.0±1.6a</td>
<td>56.0±1.6a</td>
<td>56.0±1.6a</td>
<td>52.0±1.5a</td>
</tr>
<tr>
<td><em>M. rajada</em></td>
<td>9.80±0.3a</td>
<td>56.0±1.6</td>
<td>56.0±1.6</td>
<td>56.0±1.6</td>
<td>56.0±1.6</td>
<td>56.0±1.6</td>
<td>54.0±1.6a</td>
<td>54.0±1.6a</td>
</tr>
<tr>
<td><em>M. cochinchinensis</em></td>
<td>15.7±0.5b</td>
<td>59.0±1.7</td>
<td>59.0±1.7a</td>
<td>59.0±1.7b</td>
<td>57.0±1.6b</td>
<td>56.0±1.6b</td>
<td>56.0±1.6b</td>
<td>52.0±1.5a</td>
</tr>
<tr>
<td><em>M. deeringaena</em></td>
<td>17.7±0.5c</td>
<td>57.0±1.6</td>
<td>56.0±1.6a</td>
<td>54.0±1.6b</td>
<td>61.0±1.8c</td>
<td>61.0±1.8b</td>
<td>61.0±1.8b</td>
<td>51.0±1.5a</td>
</tr>
<tr>
<td><em>M. pruriens</em></td>
<td>19.2±0.6d</td>
<td>61.0±1.8</td>
<td>61.0±1.8b</td>
<td>53.0±1.5a</td>
<td>52.0±1.5a</td>
<td>52.0±1.5a</td>
<td>52.0±1.5a</td>
<td>52.0±0.9a</td>
</tr>
<tr>
<td><em>M. veracruz</em> white</td>
<td>9.60±0.3a</td>
<td>57.0±1.6</td>
<td>54.0±1.6a</td>
<td>53.0±1.5a</td>
<td>52.0±1.5a</td>
<td>52.0±1.5a</td>
<td>52.0±1.5a</td>
<td>52.0±1.5a</td>
</tr>
</tbody>
</table>

* Mean ±SD of three replicate determinations.

Means within columns with different letters are significantly different (P ≤ 0.05).

<table>
<thead>
<tr>
<th>Mucuna sp</th>
<th>Foaming Capacity (%)</th>
<th>0.5 hour</th>
<th>1 hour</th>
<th>2 hours</th>
<th>4 hours</th>
<th>6 hours</th>
<th>10 hours</th>
<th>24 hours</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>M. vera cruz</em> mottle</td>
<td>84.3±2.4a</td>
<td>94.0±2.7a</td>
<td>94.0±2.7a</td>
<td>92.0±2.7a</td>
<td>90.0±2.6a</td>
<td>90.0±2.6a</td>
<td>76.0±2.2a</td>
<td>70.0±2.0a</td>
</tr>
<tr>
<td><em>M. rajada</em></td>
<td>66.7±1.9b</td>
<td>85.0±2.5b</td>
<td>85.0±2.5b</td>
<td>82.0±2.4b</td>
<td>80.0±2.3b</td>
<td>80.0±2.3b</td>
<td>70.0±2.0b</td>
<td>66.0±1.9b</td>
</tr>
<tr>
<td><em>M. cochinchinensis</em></td>
<td>73.1±2.1c</td>
<td>76.0±2.2a</td>
<td>74.0±2.1a</td>
<td>72.0±2.1a</td>
<td>70.0±2.0a</td>
<td>70.0±2.0a</td>
<td>66.0±1.9b</td>
<td>62.0±1.8b</td>
</tr>
<tr>
<td><em>M. deeringaena</em></td>
<td>73.1±2.1c</td>
<td>90.0±2.6a</td>
<td>74.0±2.1a</td>
<td>70.0±2.0a</td>
<td>68.0±2.0a</td>
<td>62.0±1.8b</td>
<td>62.0±1.8a</td>
<td>54.0±1.6a</td>
</tr>
<tr>
<td><em>M. pruriens</em></td>
<td>50.0±1.4a</td>
<td>74.0±2.1a</td>
<td>72.0±2.1a</td>
<td>68.0±2.0a</td>
<td>62.0±1.7a</td>
<td>56.0±1.6a</td>
<td>54.0±1.6a</td>
<td>52.0±1.5a</td>
</tr>
<tr>
<td><em>M. veracruz</em> white</td>
<td>50.0±1.4a</td>
<td>74.0±2.1a</td>
<td>72.0±2.1a</td>
<td>68.0±2.0a</td>
<td>62.0±1.7a</td>
<td>56.0±1.6a</td>
<td>52.0±1.5a</td>
<td>52.0±1.5a</td>
</tr>
</tbody>
</table>

* Mean ±SD of three replicate determinations.

Means within columns with different letters are significantly different (P ≤ 0.05).
proteins have recently found increasing use as aerating agents in whipped toppings, frozen desserts and angel food and sponge cakes. Defatted mucuna flours could be utilized for these food products in view of their good foaming properties.

**Effect of pH on foaming capacity and solubility**

The result of the effect of pH on foaming stability is presented in Figures 3 to 8. The pattern of foamability response to pH was similar to the pattern of solubility profile. All the flour samples showed minimum foamability at pH 4. Maximum capacity was recorded at pH 11 while increase in foaming capacity was observed at pH 2. The foaming capacity at alkaline region was however higher than the value obtained at pH 2. Foams of all the flours were more stable at the acidic pH range than in the

**Figure 3.** Effect of pH on the foaming stability of *M. veracruz* mottle. B. 0.5 h, C. 1 h, D. 2 h, E. 4 h, F. 5 h, G. 10 h, H. 24 h.

**Figure 4.** Effect of pH on the foaming stability of *M. rajada*. B. 0.5 h, C. 1 h, D. 2 h, E. 4 h, F. 5 h, G. 10 h, H. 24 h.

**Figure 5.** Effect of pH on the foaming stability of *M. veracruz* white. B. 0.5 h, C. 1 h, D. 2 h, E. 4 h, F. 5 h, G. 10 h, H. 24 h.

**Figure 6.** Effect of pH on the foaming stability of *M. pruriens*. B. 0.5 h, C. 1 h, D. 2 h, E. 4 h, F. 5 h, G. 10 h, H. 24 h.

**Figure 7.** Effect of pH on the foaming stability of *M. cochichinensis*. B. 0.5 h, C. 1 h, D. 2 h, E. 4 h, F. 5 h, G. 10 h, H. 24 h.
alkaline pH region. After 24 h the highest foam stability was observed at pH 4 while the least value was recorded at pH 11. Earlier workers (Sathe et al., 1982; Linn et al., 1974; Aluko and Yada, 1995) reported a pH dependency of foaming capacity and stability in lupin, winged bean, sunflower and cowpea seed proteins. The better stability of the foams in the acidic pH range might be attributed to the formation of stable molecular layers in the acidic pH range, which contributes to the foam stability and elasticity. Since the foam stability is governed by the ability of the film around the entrapped air bubbles to remain intact, the poor foam stability at alkaline pH region indicates a positive correlation between alkalinity and surface activity.

Table 5. Emulsion capacity of full fat and defatted mucuna flours*.  

<table>
<thead>
<tr>
<th>Sample</th>
<th>Emulsion capacity (%)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Full fat</td>
<td>Defatted</td>
<td></td>
</tr>
<tr>
<td>Mucuna vera cruz mottle</td>
<td>80 ± 5.1</td>
<td>68 ± 3.4</td>
<td></td>
</tr>
<tr>
<td>Mucuna rajada</td>
<td>84 ± 4.0</td>
<td>56 ± 4.0</td>
<td></td>
</tr>
<tr>
<td>Mucuna cochinchinensis</td>
<td>78 ± 3.3</td>
<td>62 ± 3.5</td>
<td></td>
</tr>
<tr>
<td>Mucuna deerigeana</td>
<td>90 ± 4.0</td>
<td>66 ± 3.2</td>
<td></td>
</tr>
<tr>
<td>Mucuna pruriens</td>
<td>80 ± 4.5</td>
<td>60 ± 2.9</td>
<td></td>
</tr>
<tr>
<td>Mucuna vera cruz white</td>
<td>86 ± 5.0</td>
<td>60 ± 2.9</td>
<td></td>
</tr>
</tbody>
</table>

Mean ± SD of three replicate determinations.

**Emulsion capacity**

The result of emulsion capacity for full fat and defatted samples are presented in Table 5. It ranged between 78 to 90% in full fat flours and 56 to 68% in defatted flours. These flours compared favourably with the values reported for *Citrus vulgaris* varieties (Ige et al., 1984) but higher than the values reported by Oshodi and Fagb-

**REFERENCES**


Association of Official Analytical Chemists.


