CHAPTER-I
INTRODUCTION

Pulses occupy an indispensable place in our daily diet as a source of protein. India is largest pulse producer of the world accounting for 25 % of world’s pulses production. The annual production of pulses in 2015-16 was 17.2 million tonnes, from a cultivated area of 23.1 million hectares (Anon., 2016). Pulses are a valuable source of proteins, minerals and vitamins in the daily diets of the people.

The pigeon pea (*Cajanus Cajan* L.) is a perennial legume from the family Fabaceae. Since its domestication in South Asia at least 3,500 years ago, its seeds have become a common food grain in Asia, Africa, and Latin America. Pigeon pea is grown in the semi-tropical and tropical regions. Pigeon pea is among grain legume highly cultivated in Africa. Generally pigeon pea contains 20-25 % protein and is consumed after suitable processing.

The major pigeon pea producing countries include India (63.74 % of global production), Myanmar (18.98 %), Malawi (6.07 %), Tanzania (4.42 %) and Uganda (1.98 %). In India pigeon pea was cultivated on 3.7 million hectares with a total production of 2.8 million tonnes and yield of 750 kg/ha during 2015-16 (Anon., 2016). The most important pigeon pea growing states are Maharashtra, Karnataka, Andhra Pradesh, Madhya Pradesh, Uttar Pradesh, Gujarat, Jharkhand, Rajasthan, Odisha, Punjab and Haryana.

The total area and production of pigeon pea in Gujarat state during 2015-16 were 0.21 million hectares and 0.23 million tonnes, respectively. The average yield was 1120 kg/ha. (Anon., 2016)

Our country is exporting pigeon peas (Tur) to USA (40.79 %), Canada (11.28 %), UK (10.75 %), Singapore (5.11 %), and importing to Myanmar (46.35 %), Tanzania (18.71 %), Mozambique (15.36 %), Malawi (12.56 %), and Sudan (3.36 %) in 2015-16. (Anon., 2016)

Pigeon pea (*BSMR-736*) is grown in Marathwada Agriculture University, Parbhani (Maharashtra). This variety released in 1994. The average yield of this
variety is 18 to 20 Q/ha. This variety matures in 180-185 days. It is high resistant to wilt and Sterility mosaic disease (SMD). It is high yielding variety and get in the form of red colour seeded.

**Table 1.1 Annual production of pigeon pea in India**

<table>
<thead>
<tr>
<th>Year</th>
<th>Production (in million tonnes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009-10</td>
<td>2.46</td>
</tr>
<tr>
<td>2010-11</td>
<td>2.86</td>
</tr>
<tr>
<td>2011-12</td>
<td>2.65</td>
</tr>
<tr>
<td>2012-13</td>
<td>3.02</td>
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<tr>
<td>2013-14</td>
<td>3.29</td>
</tr>
<tr>
<td>2014-15</td>
<td>2.81</td>
</tr>
<tr>
<td>2015-16</td>
<td>2.80</td>
</tr>
</tbody>
</table>

(Source: Anon., 2016)

Pigeon pea is mostly consumed as dry split dhal besides several other uses of various parts of pigeon pea plant. It is an excellent source of protein (20-22 %), supplementing energy rich cereal diets in a mainly vegetarian population. Pigeon pea is significantly contributing to meet the dietary requirement of crude fibre, ash, fat, magnesium, manganese and copper. Pigeon pea contains high amount of vitamin B, Carotene and ascorbic acid (Singh and Diwakar, 1993). Pigeon pea is consumed as dehulled splits, whole, canned, boiled, roasted or ground in to flour to make a variety of desserts, snacks and main dishes. The cotyledons of dry grains excluding seed coat are called dhal. Pigeon pea is mainly consumed as dhal because it takes less time to cook and has acceptable appearance, texture, palatability, digestibility, and overall nutritional quality.

Pigeon pea contains considerable amount of several anti-nutritional factors, namely, protein inhibitors, amylase inhibitors causing sugar and phytic acid. Pigeon pea contains some amount of polyphenolic compounds (tannins) that inhibit the digestive enzyme-trypsin, chymotripsin and amylase. These are especially present in dark seed coated pigeon pea. These compounds create problems when pigeon pea is consumed in large quantities. Deshpande et al. (1982) reported that the dehulling legume grains may lower the tannin content and improve their digestibility. Dehulling pigeon pea helps to remove anti-nutritional compounds such as polyphenols located in the seed coat.
Introduction

Pigeon pea is capable to prevent and number of human ailments such as bronchitis, coughs, pneumonia, respiratory infections, dysentery, menstrual disorders, wounds, abdominal tumours and diabetes. (Saxena et al., 2010)

Pigeon pea seeds are mainly eaten as dry decorticated split cotyledon by a milling process called dehulling. Dehulling is defined as the removal of the outer hull (fibrous seed coat or testa) which is tightly attached to the cotyledons.

The pigeon pea grain is considered as most difficult for dehulling as compared to other pulses. Seed coat is more firmly attached with the cotyledons through a layer of gum and mucilage (Rout et al., 2007). Due to the presence of gummy layer and hard seed coat, it is difficult to mill. The primary objective of dehulling is to remove seed coat from the cotyledons, during which four different fractions, i.e., dhal, broken, powder and husk are obtained.

During dehulling, noticeable amounts of cotyledon material and germ are removed resulting into considerable loss. In large scale processing of pigeon pea, the per cent loss of cotyledon in terms of powder and broken grain is as high as 12.8 % and 4.4 %, respectively (Singh, 1995). In view of this, when considering 10 % on an average milling loss of pigeon pea, it amounts to 2.7 lakh tonnes for all India with a value of Rs. 675 crores on dhal basis (Patel et al., 2001). Pre- milling treatments are generally employed to loosen the seed coat to remove husk without losing any edible portion.

Pre-treatment is required prior to removal of the hull to: (a) loosen the hull, (b) ease milling, (c) reduce breakage and (d) improve the quality of splits. Legumes are generally dehulled to improve their cooking and nutritional quality and dehulling efficiency and also help to remove anti-nutritional compounds (Bhowmik et al., 2014).

In milling method various approaches to remove hulls, namely wet and dry milling, CFTRI method, Pantnagar process, CIAE method and IIPR method for pigeon pea milling. Generally, the dry method of milling is used throughout the Indian subcontinent for milling of pigeon pea because the quality of splits obtained from wet milling is poor (Kurien and Parpia, 1968; Kulkarni, 1991). The maximum
theoretical recovery of dehulled pigeon pea is around 87-89 %, whereas traditional dehulling recovery is only about 65-75 % (Singh, 1995).

In wet milling method, grains are soaked in water for 4 to 12 hr., then mixed with red earth and heaped for 16 hr. The grains are then dried for 2 to 4 days under sun in thin layer. Milling of pigeon pea on a commercial scale is generally based on dry milling technique. In dry milling, grains are passed through an emery coated roller for pitting. The pitted grains are mixed with linseed oil @ 1.5 to 2.5 kg/t followed by sun drying for 2-5 days. After that the grains are sprayed with 3 to 5 % water and heaped over night for tempering. In CFTRI method, the grains are conditioned by dry heat treatment in two passes in LSU dryer with 120 °C hot air. After each pass the hot grains are tempered in bins for 6 hr. In pantnagar process, pitted grains are mixed with 10 % sodium bicarbonate solution. The treated grains are tempered for 4 hours in shade and then dried under sun to 9.5 % moisture content. In CIAE method, scratched grains are soaked in tap water at ambient temperature for one hour, after draining the water, soaked grains are dried to 9 to 10 % moisture content. In IIPR method, grains are soaked in water for 5 to 6 hr. The soaked grains are spread under the sun for drying for 1 to 2 days till grains start breaking under the teeth with sound, i.e., 9 to 10 % moisture content.

All these treatments are time consuming and overall the complete milling of pigeon pea requires 4 to 7 days. Also the survey work of few pulse mills in Gujarat revealed that the presently followed dry milling treatment carried out in the pulse milling industries take longer processing time, about 7 to 8 days depending upon weather as sun drying is required to get satisfactory milling after pre-treatment (Patel et al., 2001). But, all these pre-treatments do not permit easy removal of seed coat during the subsequent processing operation of pigeon pea milling. Moreover, these pre-treatments lead to higher processing cost, longer processing time and labour consuming for pigeon pea milling. This necessitated finding out the suitable pre-treatment for pigeon pea milling.

Dehulling quality is highly dependent on physical properties of seeds and pre-treatments. Dhal with a lesser or no husk, yellow in colour and sharp edges of splitted cotyledons, can be sold in the market at a higher price. Further, pre-treatments given to pigeon pea grains before dehulling considerably influence the cooking time. The
cooking quality of pigeon pea is basically assessed by its cooking time (Singh et al., 1992).

A novel pre-dehulling technique involving enzyme is prospective to improve dehulling efficiency upon reducing the dehulling loss and improving cooking quality of pigeon pea (Bhowmik et al., 2014; Sangani et al., 2014b). Partial hydrolysis of the mucilaginous bonds (in the interface of hull and cotyledon) by enzymatic reactions facilitates the easy dehulling of legumes. Enzyme mediated degradation of cell wall poly-saccharide of pigeon pea resulted in expansion of the grain with improved nutritional and functional properties upon thermal treatment as documented by Sreerama et al. (2009). Optimization of dehulling properties of pulses by hydrolytic enzymes, e.g. cellulases, xylanases, pectinases, etc. (Bhowmik et al., 2014).

The amount of husk removed due to enzymatic pre-treatments on different aspects were reported by Verma (1991), Bharodia (2004), Deshpande et al. (2007) and Sreerama et al. (2009). The mechanism of enzymatic activity is governed by four interacting parameters, i.e., seed moisture content, enzyme concentration, reaction time and incubation temperature (Sarkar et al., 1998). Optimum levels of these parameters are necessary to get maximum recovery and better quality of dhal. Information on the effect of above parameters on dehulled fractions and cooking quality appears to be lacking. Hence, it is necessary to optimise the parameters of enzymatic hydrolysis pre-treatment on different aspect, i.e., seed moisture, pH, enzyme concentration, incubation time, incubation temperature of pigeon pea to get maximum recovery with good quality of dhal.

**Practical utility of the research**

In view of above, it has been felt to develop a suitable enzymatic pre-treatment which is helpful in easy dehusking giving higher recovery of better nutritional, milling and cooking quality of dhal. The research finding of this project was suggesting the best suitable enzymatic pre-treatment for loosening of seed coat of pigeon pea. The suggested method is expected to save time, energy consumption and labour, thereby helping the pulse mills. Moreover, following the innovative treatment, the higher abrasive force required to dehusk the grain may get reduced and thereby operation and maintenance cost of dhal mill may be reduced to a great extent. Finally, it is expected that the recovery of better quality of dhal, i.e., nutritional and cooking quality with higher milling efficiency can be obtained. Further, it was increase the
profit of the pulse milling industries/processors and reduces losses so as to increase availability of dhal. Hence, this research work is proposed to be undertaken with following objectives.

In view of the above facts, the present research work was undertaken with the following objectives.

**Objectives**

1. To study the proximate composition of pigeon pea grains
2. To determine the effect of enzymatic pre-treatments on dehulling efficiency, protein content and cooking quality of dhal
3. To optimize the enzymatic process parameters for better recovery and quality of dhal