Original Research Article

Chemical Composition of *Abrus precatorius* seeds

Abstract

Aims: *Abrus precatorius* (AP) seed powder is used as Ayurvedic tablet (*Sarivadi Vati*) in treating hearing problems. The objective of present work is to describe oil, starch, protein, polyphenol and mineral composition of *Abrus precatorius* seeds.

Methodology: The legume of AP was collected, and seeds were separated manually. The dried seeds in powered form was employed for the oil, starch, polyphenol and mineral analysis. The solvent extraction technique was used for elucidation of oil percentage value. The starch content was determined by the enzymatic method. The total polyphenol and flavonoid contents were analyzed spectrophotometrically using Folin-Ciocalteu reagent and aluminum chloride as color developing reagent, respectively. The X-ray fluorescence (XRF) spectrometry technique was used for monitoring of the minerals.

Results: The seed kernel was composed of stored oil (3.2%), protein (92.0%) and starch (4.8%). The total polyphenols and flavonoid content were 24710 and 2520 mg/kg (dw). A remarkably high content of polyphenols in the seed coat and seed pot was observed. Mineral nutrients as P, S and (mainly) K were hyper-accumulated by the seed kernel. The seeds showed a glass transition at -21 ^{0}C, two endothermic peaks at 109 ^{0}C (dehydration and protein unfolding) and at 209 ^{0}C, and a calorific value (~ 406 kcal/100

DM) which exceeds the food energy value of *Pisum sativum*, *Lens culinaris* and other common pulses.

Conclusions: The seed kernel was mainly composed of stored protein with lower content of oil and starch. The high content of polyphenol, K, Mg, Ca and Fe in the seeds was stored. The heavy metals were observed under limits for the safe herbal uses of seeds.

Keywords: *Abrus precatorius* seed, Thermal properties, Oil, Starch, Protein, Polyphenols, Mineral.

1. INTRODUCTION

Abrus precatorius L. is a perennial high-climbing, twining woody toxic vine commonly known as Gunja or Jequirity, which can be abundantly found all throughout the plains of India as a weed. The roots, leaves and seeds of this plant have found medicinal uses (**1, 2**), and it has been reported to have anti-epileptic, anti-viral, anti-malarial, anti-fertility, antidiabetic, neuroprotective, neuromuscular, nephroprotective and immunomodulatory effects, immunostimulatory properties and anti-inflammatory activity (**3, 4**). The seeds are considered abortifacient, aphrodisiac, antimicrobial, diuretic and poisonous due to presence of *abrin*, and have been found to be useful in affections of the nervous system and for external use in skin diseases, ulcers and affections of the hair. Their antinutritional factors (total free phenols, tannins, trypsin inhibitor activity and hemagglutinating activity have also been investigated (**5, 6**). The seed proteins are rich in most of the essential amino acids, and are deficient only in cysteine and threonine, when compared to the WHO/FAO requirement pattern. In this work, nutritional potential and thermal characteristics of *A. precatorius* having scarlet coloured seeds are described.

2. MATERIAL AND METHODS

2.1.Chemicals and Reagents

AR-grade Folin-Ciocalteu reagent, aluminum chloride, tannic acid, gallic acid and quercetin –supplied by Sigma-Aldrich– were used for the analysis of the phenols. AR grade sodium maleate buffer, sodium acetate buffer, potassium hydroxide, amyloglucosidase, pancreatic-α-amylase, glucoseoxidase–peroxidase –purchased from Megazyme International Ireland Ltd.– were used for the starch analysis.

2.2. Sample Collection

The *Abrus precatorius* plant was botanically authenticated with the aid of standard monographs (**7**). The plant was ripened in the early summer and collected in May, 2017 from the area located in Pt. Ravishankar Shukla University, Raipur (21.25°N 81.63°E), India. The plants (0.5 kg) and surface soil (0.5 kg) were collected in separate polyethylene bags. They were transported to the laboratory and sundried for one week in a glass room. The seeds from the legume were manually separated. The *Abrus precatorius* fruit parts and soil were further dried in an oven at 50 ^{0}C overnight. The seed pod, seed coat, kernel and soil samples were crushed into fine power and sieved at 0.1 mm mesh size.

2.2. Drying of Seeds

The moisture content of the seeds was determined by drying seeds at 105 ^{0}C in an air oven for 6 hrs prior to the analysis, and mean values are reported. All characterization results are presented on a dry weight (dw) basis.

2.3. Measurement of Mass

The mass of seeds was weighed by using the Mettler Toledo electronic balance (AG245). Three seeds were randomly selected for the weighing and their mean mass was reported.

2.4. Thermal Characterization

A DSC 204 F1 Phoenix apparatus (Netzsch, Selb, Germany) was used for the differential scanning calorimetry (DSC) characterization. Data collection was conducted in the 25-300 ^{0}C range with constant heating rate of 10 ^{0}C per min. The analytical parameters were determined using the in-built proprietary software.

2.5. Oil Extraction

The ground seeds (5.0 g) were agitated in *n*-hexane (25 mL) in a centrifuge for 1 min, according to the procedure described by Górnaś et al. (**8**). The combined supernatant liquids were evaporated in a vacuum rotary evaporator at 40 ^{0}C until constant weight was obtained. The oil content was expressed in % (w/w) on a dry weight (dw) of the seed basis.

2.6. Analysis of Starch and Protein

The starch in the seed kernel was determined by the enzymatic method (**9**). The seed kernel was made of stored oil. Protein and starch. The protein content was computed by subtracting the value of the oil and starch to a value of 100 to get result in the percentage (**10**).

2.7. Caloric Value

The energy content of the seeds was estimated from by multiplying the percentages of protein, fat and carbohydrate by the factors proposed by Meiners et al. (**10**).

2.8. Polyphenol Analysis

A sample in powder form (100 mg) was dispersed in 5 mL of an acetone and water mixture (70:30, v/v), which was sonicated in an ultra-sonic bath for 20 minutes at 20 ^{0}C, according to the procedure reported by Bertaud et al. (**11**). The total phenolic content (TPC) of each extract was determined as tannic acid by using the Folin-Ciocalteu reagent as tannic acid (**12**). The flavonoid content was determined by the aluminum chloride method as quercetin (**13**).

2.9. Mineral Characteristics

A Bruker (Billerica, MA, USA) III Tracer SD portable spectrometer equipped with a 4W rhodium anode and Xflash SDD 2028 channels was used for the X-ray fluorescence (XRF) elemental analysis of the samples. The calibration was carried out by using standard brown and white cowpea (*Vigna unguiculata* (L.) Walp.) seeds and standard soil sample (NCS DC 73382 CRM).

2.10. Statistics

Total polyphenol, flavonoid, resistant starch, soluble starch and oil content analytical variables were analyzed only for the seeds, while the contents of Cl, P, S, K, Rb, Mg, Ca, Sr, Mn, Fe, Cu and Zn were determined both soil and seeds. All analyses were carried out in triplicate.

3. RESULTS AND DISCUSSION

3.1.Physical Characteristics of Seeds

A group of 6 *Abrus precatorius* seeds were enclosed in the oblong, flat and truncate shaped yellowish colored seed pod (**Figure 1**). The seeds were scarlet colored with black spot in globose shape, and a 125±3 mg per seed weight (n = 3) was obtained for the samples under study. The seed coat was found to be relatively thick (representing 29±1% of the seed weight), while the kernel fraction was 71±2%. The average water content of the seeds was found to be 3.2±0.1%.

Figure 1. Image of Abrus precatorius L. seed.

3.2.Thermal Characteristics

The DSC thermogram of the kernel (**Figure 2**) showed a glass transition at -21 ^{0}C (onset at -25.6 ^{0}C) and two endothermic peaks at 109 ^{0}C and 209 ^{0}C. The glass transition probably reflects rotational mobility of side chains within seed glasses (β-transition or rotation of hydroxyl groups on sugars), although a melting of the stored proteins cannot be excluded. The main endotherm at 109 ^{0}C corresponds to dehydration and protein denaturation. The second endotherm, with a peak at 209 ^{0}C, can be attributed to melting of the carbohydrates and other components. The enthalpy of these effects was found to be 174.4 and 36.17 J/g, respectively.

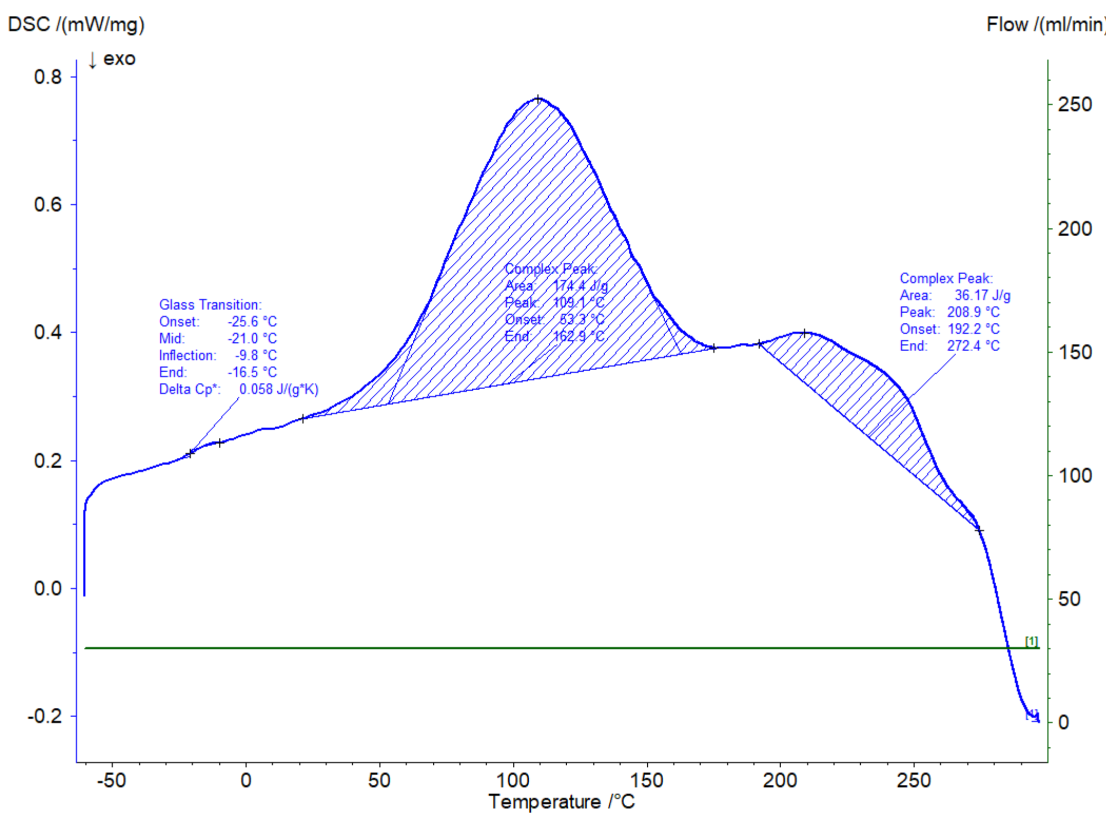

Figure 2. *Abrus precatorius L.* seed kernel thermogram scanned.

3.3. Caloric Value

The energy content of the seeds, estimated by multiplying the percentages of protein, fat and carbohydrate by the factors proposed by Meiners et al. (**10**) was *ca.* 406 kcal/ 100 kg (DW).

3.4. Oil, Starch, Protein and Polyphenol Contents

The seed reserve food consists of oil, starch, protein and other constituents, such as trace elements and bioactive compounds. The oil, starch and protein contents of the seed kernel were found to be 2.2±0.1, 4.8±0.2 and 93.0±1.8%, respectively. The concentrations of the soluble and resistant fractions of starch were 0.60±0.06% and 4.2±0.2%. The TPC and flavonoids content (Fla) in the seed kernel were found to be relatively low: 14200± and 1900± mg/kg, respectively. In contrast, the TPC (Fla) concentration in the seed coat, seed pod and leaf were found to be 24710±290 (2520±51), 3082±62 (3560±66) and 10230±21 (8000±155) mg/kg, respectively. These values were higher than those reported by Jain et al (**14**) for seeds collected in the Mumbai region.

3.5. Mineral Composition

The concentrations of P, S, K, Rb, Mg, Ca, Sr, Mn, Fe, Cu, Zn, Mo and Pb in the kernel of *A. precatorius* seed were found to be 2302, 1841, 11132, 4.0, 1046, 975, 1.0, 25, 213, 13, 48, 1.0 and 1.0 mg/kg, respectively. The values for P, K, S, Mg and Ca in the seed kernel may be regarded as high, while those of other micronutrients (Cu, Mn, Zn and

Fe) was moderate, and those of Rb, Sr, Mo and Pb was low. It is worth noting that the concentration of Mg was higher than that of Ca. The concentrations of Ca, Mn, Fe and Zn were higher than those reported for seeds from another region in India Pani et al. (**15**).

3.6. Bioaccumulation Factor

The soil was brown colored with a pH value of 7.7. The mean concentration of Cl, P, S, K, Rb, Mg, Ca, Sr, Mn, Fe, Cu and Zn was found to be 135, 147, 238, 1370, 7.2, 1480, 6330, 49, 1250, 16700, 48 and 24 mg/kg, respectively. The soil was found to be dominated with elements i.e. K, Mg, Ca, Mn and Fe. Among them, the highest concentration of Fe was detected.

The bioaccumulation factor (BC), which describes the accumulation and enrichment of an element in the seed kernel with respect to the soil, was found to be for 15.7, 7.7 and 8.1 for P, S and K, respectively, indicating an hyperaccumulation of these three nutrients. The BC values for Rb, Mg, Ca, Sr, Mn, Fe, Cu, Zn, Mo and Pb were 0.6, 0.7, 0.2, 0.02, 0.02, 0.01, 0.3, 0.9, 1 and 0.04, respectively.

4. CONCLUSIONS

The results of the present study reveal a low concentration of oil and starch in *A. precatorius* seed kernel (featuring a lipid content similar to that of fenugreek seeds, and a carbohydrate content is similar to fava beans). The major fraction of the kernel is composed of protein. P, S and K mineral nutrients were found to be strongly bioaccumulated in the seed, and at least a 1.9-fold molar excess of Mg over Ca was detected in the kernel. As regards polyphenol and flavonoid contents, lower concentrations were present in the kernel than in the seed coat and seed pod. The calorific value of *A. precatorius* seeds exceeds the food energy value of other *Fabaceae*. The deletereous effects of antinutritional substances may be minimised by cooking, since they are heat labile.

CONSENT

Not applicable.

ETHICS APPROVAL

Not applicable.

CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

COMPETING INTERESTS DISCLAIMER:

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

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