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Physicochemical properties, mineral composition, FTIR spectra and scanning electron microscopy of wild apricot kernel press cake

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Abstract
Wild apricot a temperate fruit comprises of pulp and stone. Stone containing kernels rich in oil and after oil extraction around 60 per cent of remaining residue called press cake, having different physicochemical properties. The wild apricot kernel press cake had moisture content 8.89 per cent, crude protein 33.60 per cent, soluble per cent 5.65 per cent and crude fibre 9.50 per cent. Wild apricot kernel press cake is light yellow with tint of redness (L*25.45, a*6.27 and b*25.91) and had higher in potassium 647.00 mg/100g, magnesium 210.00 mg/100g and calcium 195.00 mg/100g. The Fourier-transform infrared spectroscopy (FTIR) spectra of wild apricot kernel press cake was basically indistinguishable in the wave-number range of 4000–400 cm^{-1}. The absorption band at 1541.18 cm^{-1}, 1458.18 cm^{-1} and 717.54 cm^{-1} were assigned to amide II, amide III and amide IV. These amide were the protein units and most prominent vibration bands of the protein backbone. Whereas, the Scanning Electron Microscopy (SEM) was conducted at magnification of 1000 x and 1200x for wild apricot kernel press cake. Polygonal and irregular shape which represent the presence of starch molecules in the sample and some cracked surface represents the presence of protein.

Keywords: wild apricot kernel Press cake, FTIR, SEM, amide, protein, minerals

Introduction
Wild apricot (*Prunus armenica* Linn.) belongs to family Rosaceae, commonly known as chulu, chulli, sarha and zardalu is grown in temperate regions of world including USA, Spain, France, Italy, Turkey, Iran, Africa and Australia (Gupta *et al*., 2012) [10]. It is being grown commercially in India in the mid hills of Himachal Pradesh, Jammu and Kashmir, Uttarakhand and to a limited extent in the hills of North-Eastern states. It can be grown successfully at an altitude from 2000-2500 meter above mean sea level (Gupta and Sharma 2009a) [8]. Total area under apricot cultivation in Himachal Pradesh is 3660 hectares with a production of 4705 metric tonnes (Anonymous 2017) [2]. In Himachal Pradesh, it is grown in the district of Shimla, Mandi, Kullu, Chamba, Sirmour, Kinnaur and Lahaul-Spiti (Gupta and Sharma 2009b) [9]. Apricots are mostly consumed fresh and small amount is used for preparation of different value added products such as squash, appetizer and jam. The apricot stone which are broadly classified into two categories on the basis of taste of kernels; these are sweet kernel known as Nyarmo and bitter kernel known as khanate (Ahmed *et al*., 2015) [1].

Materials and Methods
Procurement of raw materials
Wild apricot kernel press cake was procured from the Department of Food Science and Technology Solan. Whereas other materials purchased from the Solan market (HP) and brought to the laboratory of Department of Food Science and Technology for the further studies.

Physicochemical properties analysis
The chemical composition in terms of moisture, ash, fat, crude fibre and protein was determined as described by AOAC (2000) [4]. The protein content of press cake was calculated based on nitrogen content (N%X6.25). Whereas, Colour of samples was measured in a Lovibond Colour Tintometer Model PFX-I series spectrocolourimeter in which RYBN colour units were obtained along with CIE readings i.e. L^* a^* and b^* values.

Minerals estimation
The dry ashing method was used for mineral estimation. The ground sample was placed into a crucible overnight in an electric muffle furnace; the temperature was maintained between 410 to 440^0 C. Ashing was done to destroy all of the organic materials present in the sample. The ash was removed from the crucible and allowed to cool in desiccators. Two gram of ash was digested with a mixture of HCl and nitric acid in the ratio 1:3. The digested sample was dissolved in 50 ml of distilled water and used for the assay of trace elements such as iron, calcium, zinc, copper, cobalt, manganese and magnesium through atomic absorption spectrophotometer (Rajasekaran *et al.*, 2005) [13].

Fourier transforms infrared (FTIR) spectroscopy Analysis
For the qualitative analysis of different samples subjected to FTIR analysis (Shimadzu 8400S FTIR spectrometer, equipped with KBr beam splitter) using approximately 5 mg of each sample along with 5 mg KBr. FTIR spectrophotometer was operated at a spectral range of 4000–400 cm^{-1} with a maximum resolution of -0.85 cm^{-1}. The spectra so obtained for the respective samples were interpreted as per the guidelines given by Stuart (2004) [16].

Microstructure (SEM)
The morphology of sample was evaluated using a EmCraft

(Korea): Table-top scanning electron microscope (SEM Cube-1000). Samples were dehydrated by putting them into critical point drying equipment or freeze dried. The mucilage powder was fixed in an aluminum plate (specimen holder), using an electrically conductive tap and a coating of gold at 10 mbar for 90 s was applied. Each sample was transferred to microscope for observation. The procedure was applied to gain information about the arrangements of particle that correlated with structure of samples. The microscope was operated at 5 kV and different levels of magnification: 1000X and 1200X.

Statistical analysis

All the analytical parameters were recorded in triplicates and the mean value of each parameter was described. The data of quantitative estimation of biochemical characteristics were assessed by RBD using two factors analysis of variance (AOVA) with the help of OPSTAT software (Cochran and Cox, 1967) [5].

Results and Discussion

Physicochemical composition

The physicochemical compositions of wild apricot kernel press cake are presented in Table 1. The moisture content of press cake was 8.89 per cent and water activity was 0.85. Whereas total ash, crude protein and soluble protein were 2.67 per cent, 33.60 per cent and 5.65 per cent, respectively. It also contained 9.50 per cent crude fibre, 9.48 per cent crude fat, 0.77 mg/100g HCN and 13.02 per cent amygdalin (vitamin B_{17}). The results were in conformity with the earlier findings of Gupta *et al.* (2012) [10] who reported that 4.90-7.20 per cent moisture, 34.30-44.50 per cent crude protein, 5.40-9.70 per cent crude fat, 4.90-5.10 per cent total ash, 7.00-10.80 per cent crude fiber, 27.50-32.70 per cent carbohydrates and 90 mg/100 g HCN content in apricot kernel press cake, respectively. The slight variation in data might be attributed to the variations in climatic conditions, type of cultivars and stage of maturity at harvesting that might have affected the quality parameters.

Table 1: Physicochemical composition of wild apricot kernel press cake

Parameters	Observations (Mean ± SE)
Moisture (%)	8.89 ± 0.01
Water activity	0.85 ± 0.03
Total ash (%)	2.67 ± 0.02
Crude protein (%)	33.60 ± 0.03
Soluble protein (%)	5.65 ± 0.02
Crude fibre (%)	9.50 ± 0.03
Crude fat (%)	9.48 ± 0.01
HCN (mg/100g)	0.77 ± 0.02
Amygdalin (%)	13.02 ± 0.01

Colour value of the wild apricot kernel press cake

Color or appearance properties are critical parameters in defining the uses and acceptability of products. The colour values L*, a * and b * of wild apricot kernel press cake are shown in Table 2. The press cake was light brown with L * 25.45, a* 6.27 and b* 25.91 (Fig 1). Similar Lab colour value reported by Viskelis *et al.* (2017) [17] in raspberry press cake and observed lightness (L *) 23.90, redness (a*) 2.10 and yellowness (b*) 0.40.

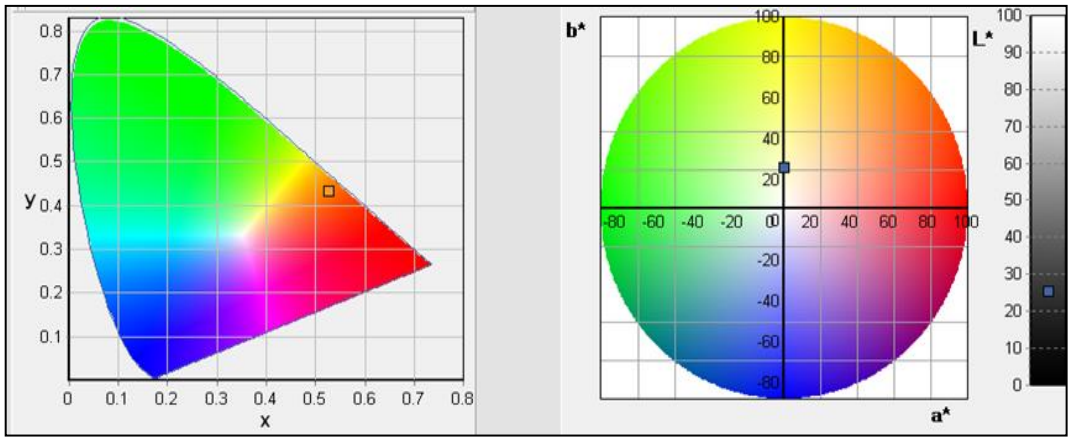

Fig 1: CIE readings of wild apricot kernel press cake

Table 2: Colour properties (Lab) of the wild apricot kernel press cake

Properties	Value
L * (Lightness)	25.45
a * (Redness-greeness)	6.27
b * (Yellowness- blueness)	25.91

Minerals content of wild apricot kernel press cake

Minerals are essential plant nutrients and directly incorporated into organic compounds synthesized by the plant. Potassium, phosphorus, calcium, magnesium and sodium are the most important to know quantitatively and are recommended for composition analysis (Anonymous 2004) [3]. Wild apricot kernel press cake was analyzed for potassium, sodium, iron, calcium, zinc, copper, manganese and magnesium (Table 3). The press cake had higher potassium 647.00 mg/100g, sodium 58.00 mg/100g, calcium 195.00 mg/100g and magnesium 210.00 mg/100g. Whereas iron, zinc, copper and manganese content were 3.82 mg/100 g, 3.87 mg/100g, 1.05 mg/100g and 0.95 mg/100 g, respectively. Similar results for apricot kernels were reported by Femenia *et al.* (1995) [6] contained 567-616 mg/100 g of potassium, 141-145 mg/100g of calcium, 3.2-5.1 mg/100g of zinc, 2.6-2.7 mg/100g of iron and 0.5-0.6 mg/100g of manganese, respectively.

Table 3: Mineral content of the wild apricot kernel press cake

Parameters	Observations (Mean±SE)
Potassium (mg/100g)	647.00 ± 5.15
Sodium (mg/100g)	58.00 ± 1.25
Calcium (mg/100g)	195.00 ± 3.62
Iron (mg/100g)	3.82 ± 0.45
Magnesium (mg/100g)	210.00 ± 3.52
Zinc (mg/100g)	3.87 ± 0.54
Copper (mg/100g)	1.05 ± 0.22
Manganese (mg/100g)	0.95 ± 0.10

FTIR spectra of wild apricot kernel press cake

FTIR spectroscopy has been used to study the structural composition, structural dynamics, conformational changes (effect of binding, temperature and pH), structural stability and aggregation of proteins. It has been used to identify functional group compounds, such as carbohydrate and esters, as well as inter atom chemical bonds in variety of sample (Smith 1979) [15]. The FTIR spectra of wild apricot kernel press cake was basically indistinguishable in the wave-number range of 4000–400 cm^{-1}, only with subtle differences in the intensity of bands/peaks (Fig 2). Infrared spectra of wild apricot kernel press cake indicated by the presence of narrow peak bands at 1743.71 cm^{-1} attribute to aldehyde and ketone C=O stretching. The position of the C=O stretching indicated the hydrogen bonding and conjugation within the molecules. High intense peak followed by peak at 2922.25 cm^{-1} and 2852.81 cm^{-1}, attributed to O-H stretching (carboxylic acid) vibrations and aldehyde C-H stretching. This O-H stretching vibrations may be due to carboxylic compounds in the polymer protein matrix. The carboxylic acids (RCOOH) exist as dimer, except in dilution solution, due to strong intermolecular hydrogen bonding (Widjanarko *et al*., 2010) [18]. The absorption band at 1541.18 cm^{-1}, 1458.18 cm^{-1} and 717.54 cm^{-1} (Table 4) as assigned to amide II, amide III and amide IV. These amide are the protein units and most prominent vibration bands of the protein backbone. Silverstein *et al*. (1981) [14] had reported amide I, II and III bands of protein at peak 1640, 1530 and 1440 cm^{-1} in bambara groundnut seed press cake. Similar identification of such groups has been reported by Garg *et al*. (2007) [7] regarding FTIR spectra of jatropha oil cake. The band at 1462 cm^{-1} was attributed to OH bending vibrations in association with phenolic groups.

Table 4: FTIR frequencies and their peak assignments for the spectra of wild apricot kernel press cake

Peak	Area	Compounds
441.71	23.59	P-S stretching
624.96	8.30	P= S stretching
717.54	12.41	N-H wagging (amide IV)
777.34	8.49	NH_2 wagging
1055.10	10.70	C=S thiocarbonyl
1139.97	3.12	SO_2 symmetric stretching
1232.55	2.48	P=O phosphonate
1396.51	2.89	S=O sulphate
1458.23	4.09	First overturn N-H stretching (amide III)
1541.18	1.36	Secondary amide N-H bonding (amide II)
1743.71	23.96	Aliphatic aldehyde C=O stretching (Aldehyde and ketone)
1955.88	1.00	Overtone and combination bands
2061.97	4.16	Combination N-H stretching, Combination O-H stretching
2366.74	14.97	B-H stretching
2852.81	16.27	Aldehyde C-H stretching
2922.25	34.47	O-H stretching (Carboxylic acid)
3743.96	4.37	O-H stretching (Water)

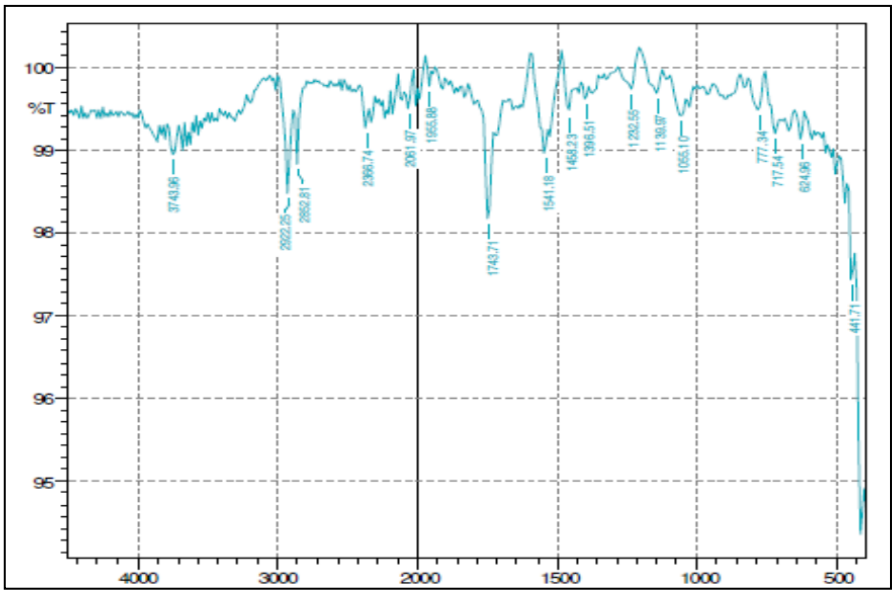

Fig 2: FTIR spectra of wild apricot kernel press cake

Scanning Electron Microscopy (SEM) of wild apricot kernel press cake

The scanning electron microscope (SEM) is one of the most versatile method for the examination and analysis of the microstructure, chemical composition and physical (size and shape) characterizations. It shows the arrangement of starch granules and protein network in the matrix. The SEM was conducted at magnification of 1000 x and 1200x. The image (Fig 3) for wild apricot kernel press cake reveals that, the press cake had some polygonal and irregular shape representing the presence of starch molecules in the sample. Whereas, some cracked surface represented the presence of protein. Starch granules seem to be surrounded by little pieces of other protein material, giving the appearance of rousing dust in apricot kernel press cake. The differences in the picture were the variations in the number of

individualgranules and compound granules or may be due to different processing conditions and extraction methods to form different structural aggregate (Newman *et al.*, 1990) [12]. Similar starch and protein structure arrangement were reported by Kaptso *et al*. (2014) [11] in bambara groundnut flour.

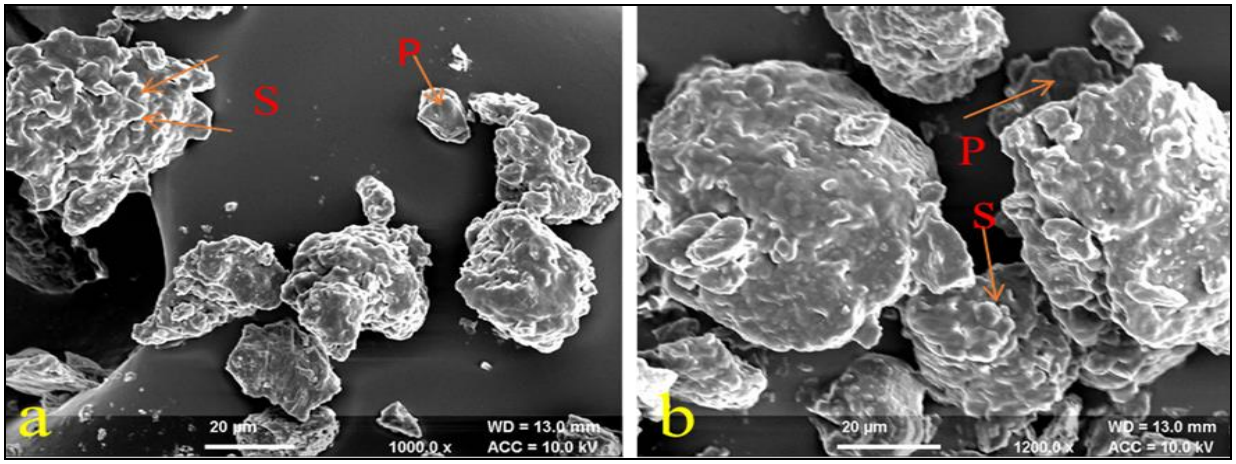

Fig 3: Scanning electron microscopy (SEM) of wild apricot kernel press cake (a) Magnification 1000x, (b) magnification 1200x: P- Protein, S- Starch

Conclusion

Wild apricot kernel press cake had good physicochemical properties, higher mineral composition and good FTIR spectra. Similarly, it also showed good scanning electron microscopy which indicate the presence of protein and starch content in the press cake. So, on the basis of these properties this press cake can also be successfully utilized for preparation of protein isolate.

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