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Morphology of kidney bean varieties by scanning electron microscopy of different regions of Himachal Pradesh, India

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Abstract

Legumes occupy an important place in human nutrition, especially popularized among population of the developing countries. The current study used scanning electron microscopy to investigate the morphology of kidney bean varieties (*Kanchan*, *Jwala*, *Him1*, *Baspa*, *Triloki*, and Chamba Landrace) from various regions of Himachal Pradesh, India. The smooth surface topography of various kidney bean types (*Kanchan*, *Jwala*, *Baspa*, *Him1*, *Triloki*, and Chamba Landrace) was observed at various resolutions (10 μ m, 20 μ m, 50 μ m, and 100 μ m). The forms and sizes varied from round to ovoid to spherical to dispersed. The scanning electron micrographs of kidney bean starch granules revealed round, elliptical, irregular, and oval forms with smooth surfaces. Scanning electron micrographs was used at 10, 20, 50, and 100 μ m to investigate the external morphology of various Kidney bean cultivars.

Keywords: Kidney beans, scanning electron microscopy, morphology, legumes

Introduction

The name legume is derived mostly from the Latin word 'legumen', which refers to seeds collected in pods. Legumes are referred to as pulses, peas, or members of the bean family in some countries (Sindumathi *et al.* 2019) ^[11]. Beans are members of the Fabaceae family, which also includes legumes. They are important food crops, both commercially and nutritionally, and are grown and consumed all over the world (Rehman *et al.* 2001; Reyes-Moreno *et al.* 1993) ^[7, 8]. Legumes' edible seeds serve a significant role in the diet, delivering vital nutrients with medium to high calorie values ^[1].

Kidney beans (*Phaseolus vulgaris*) are one of the most important legume crops in the world and an important component of human nutrition due to their high protein content (20%-25%), complex carbohydrates (50%-60%), and high levels of vitamins, minerals, polyunsaturated fatty acids (Rehman *et al.* 2001; Reyes-Moreno *et al.* 1993), as well as an adequate amount of folate and fiber (Shi *et al.* 2007) ^[7, 8, 10]. The size and form of starch granules influence its technical features, especially paste viscosity. The scanning electron microscopy (SEM) micrographs of kidney bean starch granules revealed round, elliptical, irregular, and oval shapes with smooth surfaces (Wani *et al.* 2010) ^[14], as well as some indentations or hollows at one end.

Materials and Methods

Materials

Certified seeds/grains of six kidney bean varieties (*Kanchan*, *Jwala*, *Baspa*, *Him1*, *Triloki*, and Chamba Landrace) were obtained from Agriculture Research and Extension Centre in Sangla, district Kinnaur, Himachal Pradesh, India. Seeds were cleaned to remove dirt, foreign materials, and other contaminants before being stored in an airtight container in a dark spot for future usage at room temperature. The seeds were then pulverized into fine powder using a Philips mixer-cum-grinder, sieved through 150-micron screen to produce fine uniform particles, and kept in airtight containers.

Methods

Morphology of Kidney beans (Scanning Electron Microscopy) (Price 2002) ^[5]

The flour was applied to an adhesive tape affixed to a circular aluminum specimen stub, and then vertically coated with gold palladium. A scanning electron microscope was used to photograph the samples at a 20-kV accelerator voltage.

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To analyze the exterior and interior appearance, different types were inspected and photographed using a Scanning Electron Microscope (SEM) at various magnifications. For the microscopy investigation, dried flour from various species of kidney beans was placed over the stubs with double-sided conductive tape and a thin layer of gold was added to the samples using an automated sputter coater for around 3 minutes. The materials were examined with a scanning electron microscope at various magnifications in GB Pant University, Pantnagar, Uttarakhand, India.

Results

Scanning Electron Microscopy is used to understand the exterior morphology. It's utilized to investigate specific forms, shapes, and structures. SEM was performed at 10, 20, 50, and 100 μm to examine the exterior morphology of different Kidney bean cultivars.

Figure 1-6 shows the smooth surface topography of various kidney bean types (*Kanchan*, *Jwala*, *Baspa*, *Him1*, *Triloki*, and Chamba Landrace) was observed at various resolutions (10 μm , 20 μm , 50 μm , and 100 μm). The forms and sizes varied from round to ovoid to spherical to dispersed.

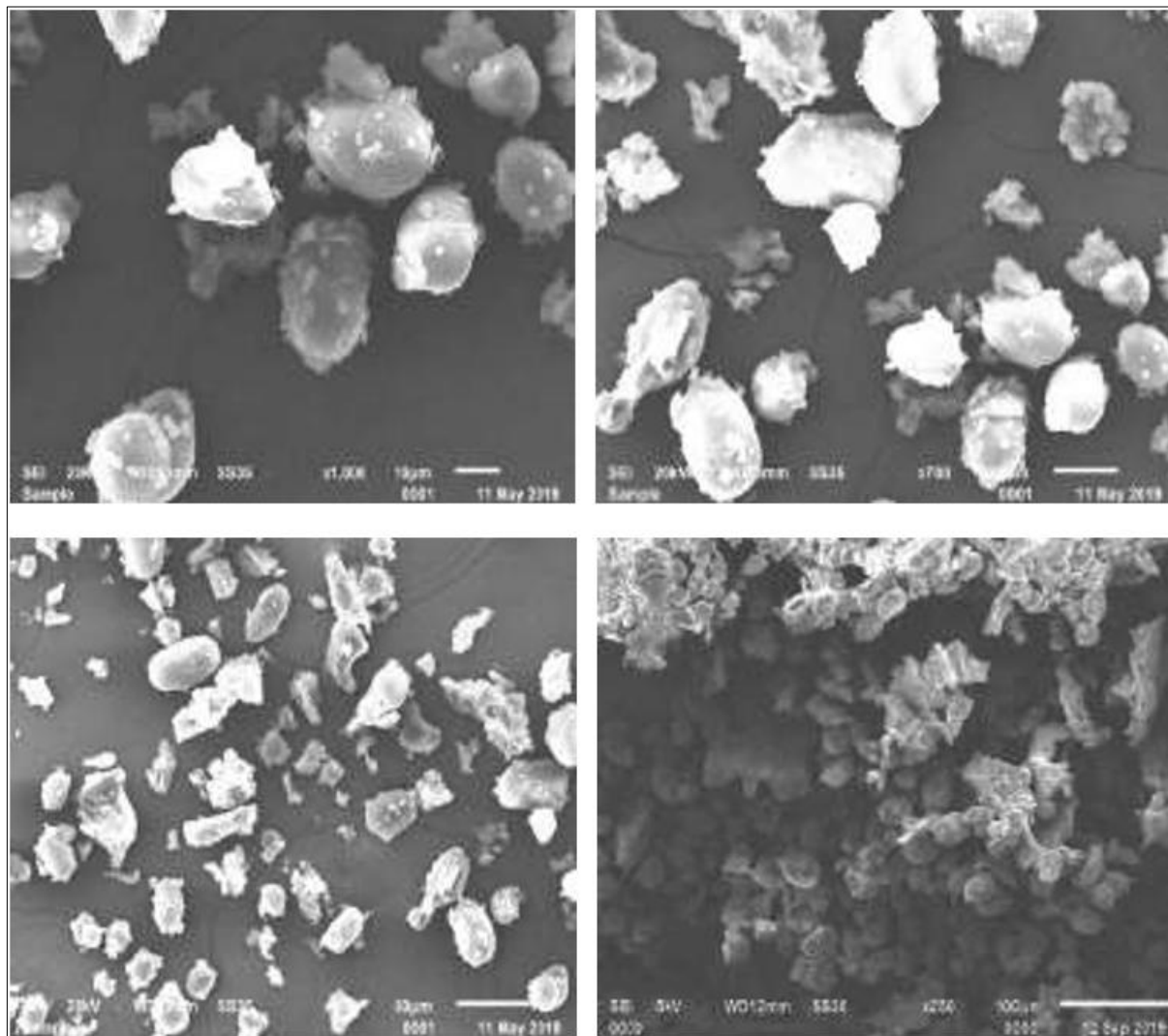


Fig 1: Scanning Electron Photomicrograph of variety *Kanchan* of Kidney bean flour at different resolutions (10 μm , 20 μm , 50 μm and 100 μm)

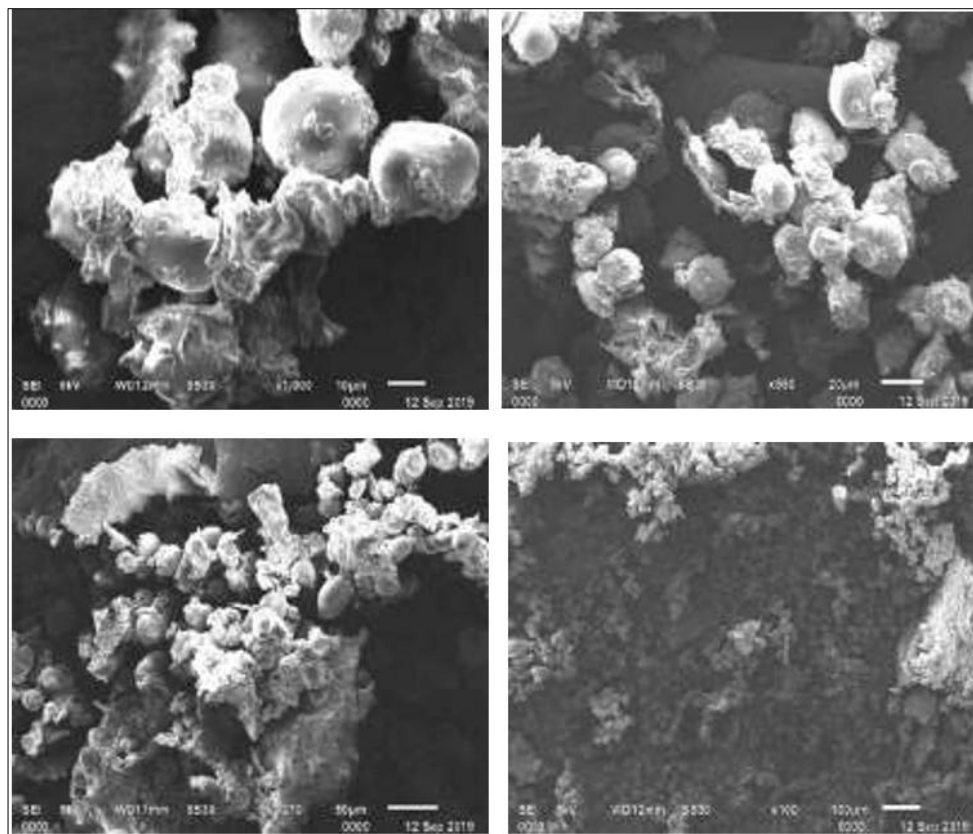


Fig 2: Scanning Electron Photomicrograph of variety *Jwala* of Kidney bean flour at different resolutions (10 μm, 20 μm, 50 μm and 100 μm)

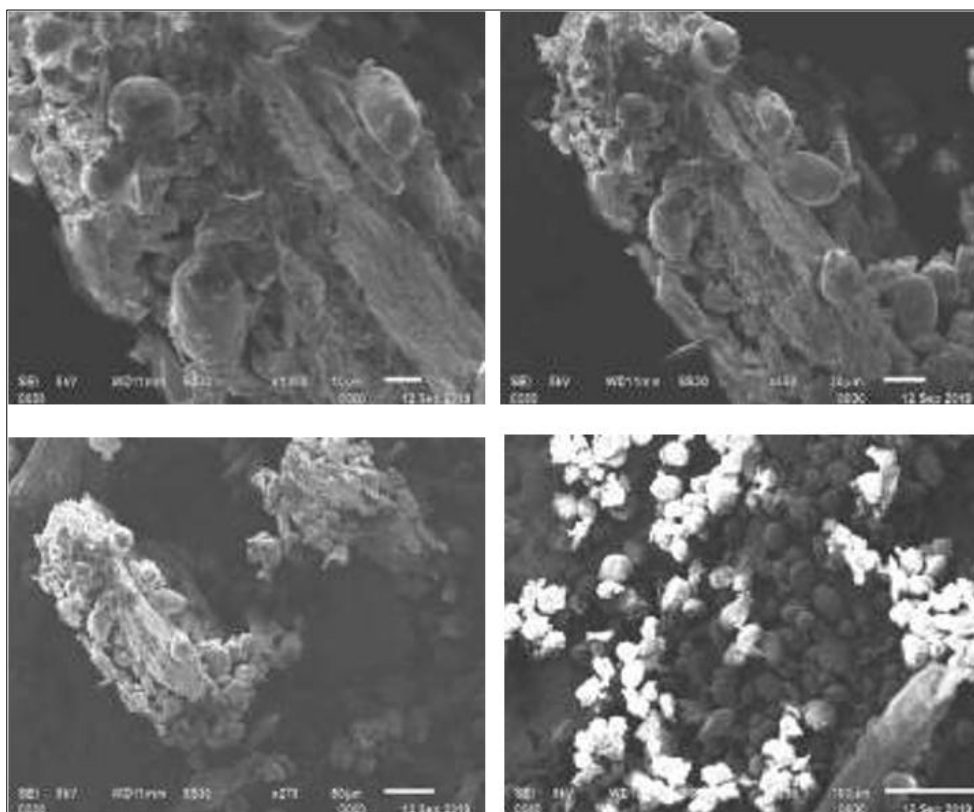


Fig 3: Scanning Electron Photomicrograph of variety *Baspa* of Kidney bean flour at different resolutions (10 μm, 20 μm, 50 μm and 100 μm)

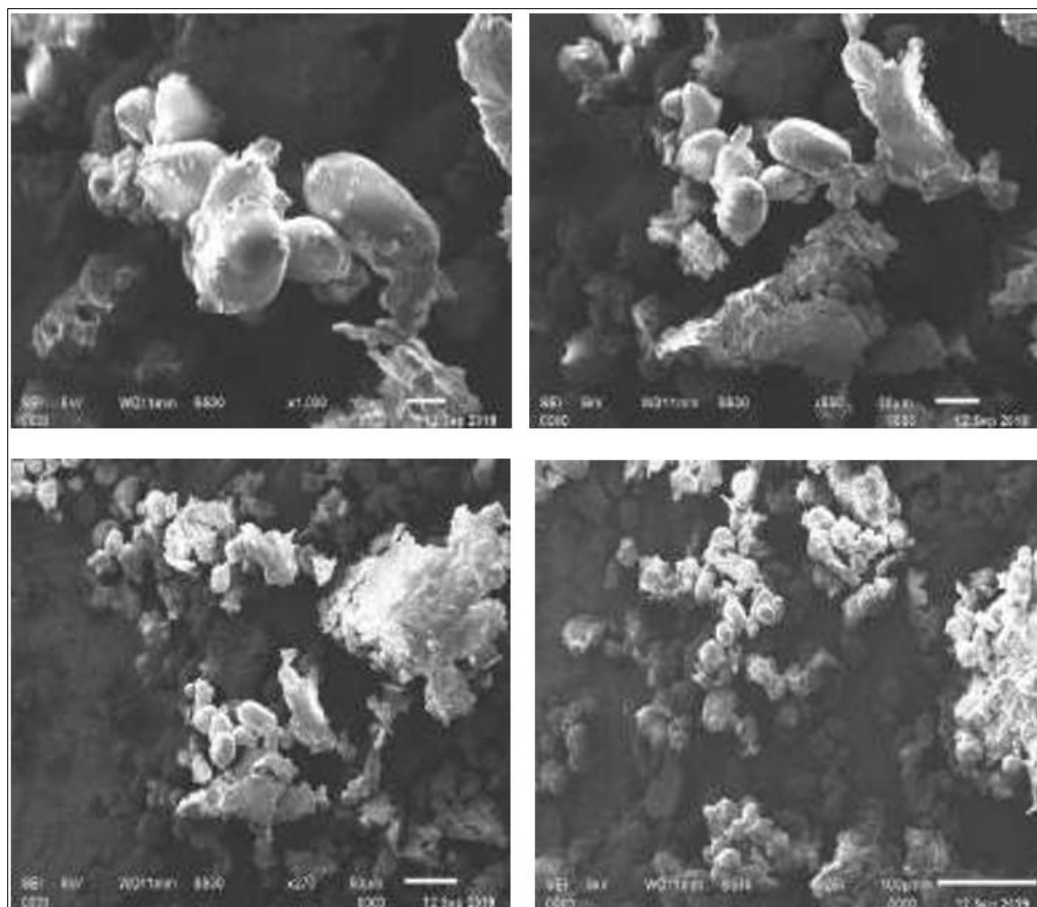


Fig 4: Scanning Electron Photomicrograph of variety *Him1* of Kidney bean flour at different resolutions (10 μm, 20 μm, 50 μm and 100 μm)

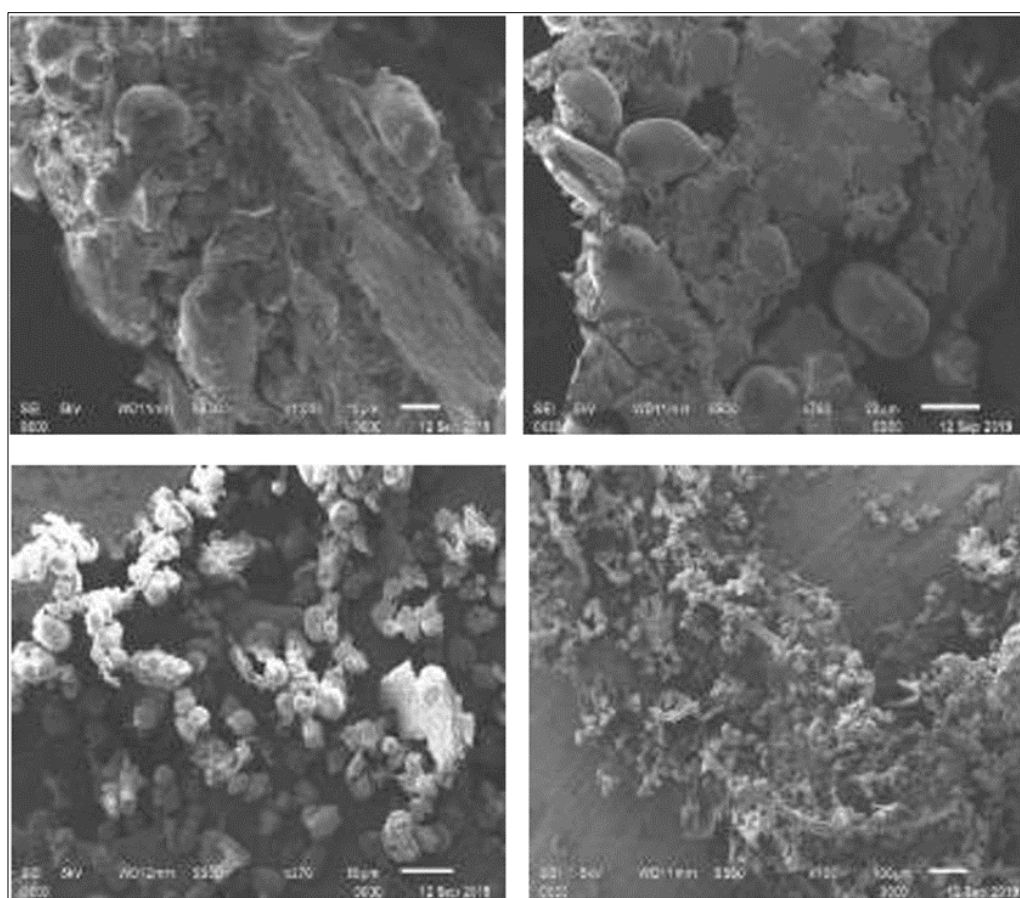


Fig 5: Scanning Electron Photomicrograph of variety *Triloki* of Kidney bean flour at different resolutions (10 μm, 20 μm, 50 μm and 100 μm)

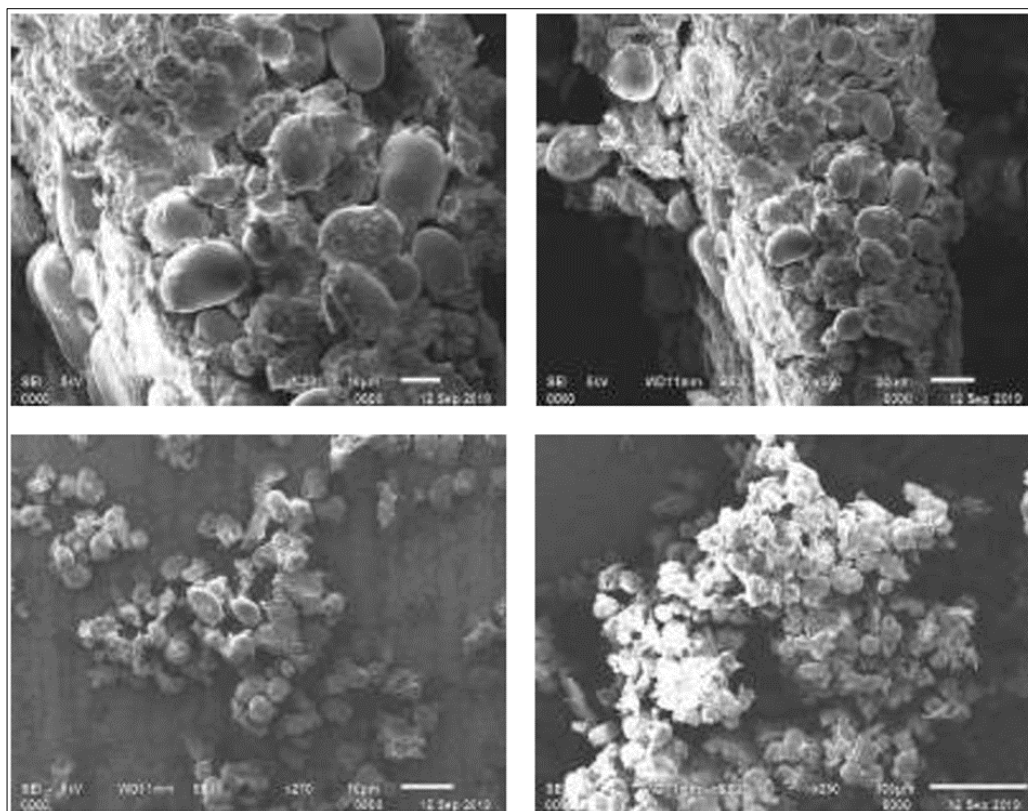


Fig 6: Scanning Electron Photomicrograph of variety Chamba Landrace of Kidney bean flour at different resolutions (10 µm, 20 µm, 50 µm and 100 µm)

Discussion

Scanning electron microscopy used to show that albumins had rod-like structures with very smooth surface topography, whereas globulins were of various shapes and sizes with somewhat rougher surfaces (Sathe and Salunkhe 1981) [9]. Protein concentrates and protein isolates, as expected, included both albumins and globulins, and hence possessed properties of both, whereas various studies found round, elliptical, irregular, kidney, and oval shapes with smooth surfaces (Reddy *et al.* 2013) [6]. V2 and V3 resemble an amorphous mass with cohesive structure, resulting in a loss of granularity.

Starch granules ranged in shape from ovoid to spherical, with diameters ranging from 10.0 to 35.0 µm in length and 6.7 to 24.0 mm in width (Wani *et al.* 2013) [13]. SEM photos of cross- sections for typical films were used to study this. Various studies discovered that granules were round, elliptical, and irregularly shaped, with smooth surfaces (Andrabi *et al.* 2016) [1]. Granule sizes for Shal Raj-1 ranged from 11.0 to 32.4 mm in length and 11.0-19.2 mm in width, whereas for SK-R-132 they ranged from 20-54 mm in length and 14-45.6 mm in width. Scanning electron micrographs analyzed native bean starch granules, which had round, elliptical, irregular, and oval forms.

Granule surfaces were smooth, but some had dents or hollows on one end. Native bean starches had mean granule lengths of 22.2-24.2 µm, ranging from 15.4-19.2 µm to 15.3-16.9 µm and 12.3-14.1 µm. These findings are consistent with prior findings on jack and black beans.

Various studies stated that the kidney bean starches under SEM and found no evidence of starch degradation or extraneous materials (Wang and Ratnayake 2014). Kidney bean starch granules measured 6-32 µm wide and 8-42 µm long (Hoover and Ratnayake, 2002; Wang and Ratnayake, 2014) [4, 12]. Kidney bean starches have a bimodal granule

size distribution, with peaks less than 10 and larger than 10 µm. Kidney beans have the highest number of granules larger than 10 µm (94.76%), followed by smaller granules (5.13%) (Bajaj *et al.*, 2018) [2].

Conclusion

From the present study, it was concluded the smooth surface topography of various kidney bean types (*Kanchan*, *Jwala*, *Baspa*, *Him1*, *Triloki*, and Chamba Landrace) was observed at various resolutions (10 µm, 20 µm, 50 µm, and 100 µm). The forms and sizes varied from round to ovoid to spherical to dispersed. With the use of the SEM method, one can observe variations in the starches of different bean varieties as well as changes to those starches following treatment, such as the loss of structural organization brought on by the gelatinization phenomenon, which happens when the matrix is heated above 50 C.

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