Design and development of fissure detection and imaging techniques for brown rice kernels to improve quality of rice miller

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Abstract: One of the major problem faced by the rice millers and farmers is breakage of rice during milling processes like whitening, polishing etc. For reducing the breakage of different rice varieties while milling processes, it is important to know the initial quality of rice grains. Rice quality is in terms of internal fissures present in rice kernels. In this study, an innovative technique is found out for detection and imaging of fissures present in brown rice kernel with the use of digital single lens reflex DSLR camera. The DSLR Nikon D5200 camera with secondary close-up numex close-up lenses was used for capturing images of fissures of rice kernels. The captured images were edited in open source image processing application Lightroom CC application for better clarity of fissure. Four different arrangements were used for detection and capturing of fissures, out of which two arrangements were giving best results. With the help of those two arrangements model of fissure detection box is developed. The fissure detection box was designed in a such a way that it can be easily used by millers for detection of fissures in brown rice after de-husking which can help to adjust milling pressure so that optimum milling with a reduction in breakage of rice can be possible.

Keywords: Kernels, Milling, Fissures detection, Image Processing, Fissures detection box.

I. INTRODUCTION

Today, Rice is the seed of the grass species Oryza sativa and it is one of the most important cereals in the world. The worldwide production of rice in 2014 was 741 million tonnes. India is one of the world's largest producers of rice. India's rice production is 20% of all worldwide rice production. In India rice is pre-eminent crop and the staple food of the people of the eastern and southern parts of the country. For the year 2013-2014 India's rice production was 106.54 million tonnes. In India rice is a major crop and staple food for more than 70 % of the population, thus plays a vital role in the grains. The economic value of the rice is mainly depending on the percentage of unbroken grains. [2] The percentage of breakage is more in whitening and polishing process than dehusking process, therefore for reduction of rice breakage in whitening and polishing process it is necessary to adjust milling pressure accurately. This can be possible only if the initial quality of rice grains is known to Millers. The rice quality is good if rice kernels are fissured free. If fissures are present in rice kernels breakage percentage will definitely more than fissured free rice kernels. For checking the quality of brown kernels it necessary to the developed new technique for detection damage in terms of fissures and chalkiness present in rice kernels. This research work focuses on innovative fissure detection and imaging technique using a DSLR camera.

So far many researchers have been dealing with image analysis techniques to quantify some quality rice kernels. Earlier days, in the seventies the quality of rice grains were determined by visual examination[3]. In the late eighties CCD camera with computer system was preferred for imaging of rice grain for analysis of quality[4]. Later a standard flatbed scanner, a personal computer with appropriate software were used for image analysis of rice grains [5]. In the study done by Francis Courtois et al, the images of parboiled rice grains were captured using a standard flatbed scanner. The estimation of fissures of rice grains and breakage ratio measurement was done using image analysis of rice grains samples [6]. Dental X-ray machine was used by Lakshmi GR et al to acquire images of paddy rice and image is processed using an image processing technique. Dental X-Ray machine emerges less radiation, therefore, preventing any possible damages to rice kernel [7]. Another study by Zephania R. Odek et al. in which fissure detection in rough rice was done with the help of X-ray Imaging Technique. An extensive study was carried out for detecting which rice grain was fissured and which rice grain by Abud Archila et al [8]. Digital X-ray imaging was used for observation of healing of fissures before

soaking, after soaking and after drying processes by Patindol et al in his study [9]. The work was carried out by Matthieu Faessel et al to develop a light and fast solution to extract individual properties such as length, width and differentiate broken, cracked and whole rice grains from a rice grain sample [10].

The main aim of this study was the detection and imaging of fissures present in brown rice grains with the help of a new technique developed using a DSLR camera. Another goal of the study was to developed low-cost fissures detection box to observed fissure present in brown rice for analysis of quality of brown rice grains.

II. MATERIALS AND METHODS

2.1 Rice Samples:

The brown rice grains of different varieties were obtained from one of the rice mills from Palghar, Maharashtra, India. Different varieties of rice samples used for imaging fissures, therefore typology of fissures can be studied. All rice grains were de-husked by using hands so external stresses can be avoided.

2.2 Detection and imaging of fissures:

In this study a new technique for detection and imaging of fissures in rice grains was developed. Imaging of the fissures in rice kernels was done with the help of DSLR Camera. Camera used was Nikon D5200 with 18-55 primary lens and close up lenses/secondary lenses (numex 52 mm close up +1 +2, +4, +10) were additionally attached for better zooming. For better zooming without the use of secondary lenses can be achieved by attaching a primary lens in reverse direction to the camera. For better results, the camera was on a tripod stand. The light source was white LED bulb (Wipro LED, 9W). All samples were placed on plain black colored glass and images were captured using a DSLR camera.

2.3 Different arrangements for detection and imaging of fissures:

Arrangement A: In this arrangement, camera is placed vertically downward and a light source is along a lateral side of rice grain as shown in fig 1. Image of brown rice grains by arrangement A is shown in fig 2.

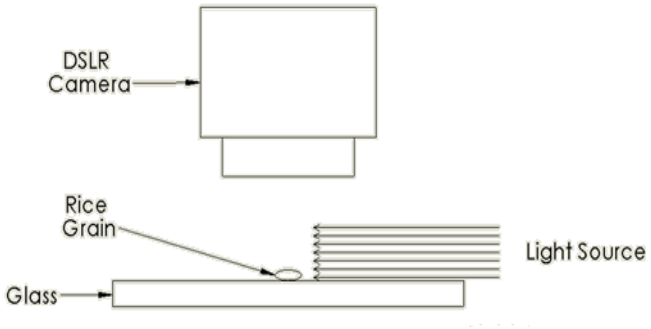
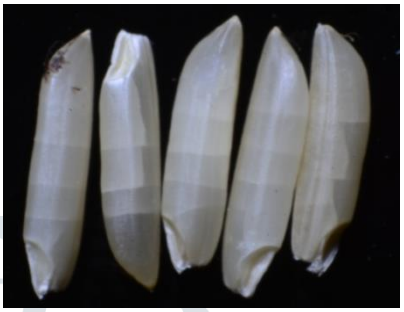


Fig.1. Schematic diagram of Arrangement A



a) Real image

b) After image processing

Fig. 2. Image of Fissures in brown Basmati Rice by arrangement A

The digital camera has the properties were set to (18-55 mm Lens with 4 macro filters & Shutter Speed = 2.5″, ISO = 150, Aperture =15)

Arrangement B: In this arrangement the camera is placed vertically downward and light source place vertically upward but below the glass on which rice grains were placed as shown in fig 3. Image of brown rice grains by arrangement B is shown in fig 4a and 4b.

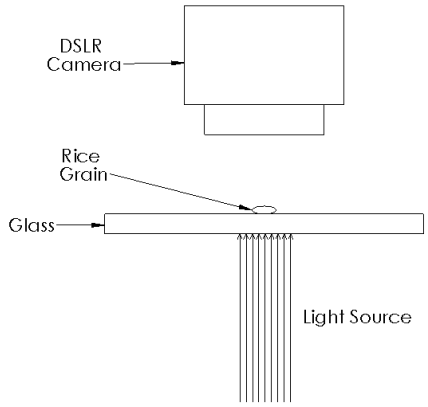


Fig. 3. Schematic diagram of Arrangement B.

a) Real Image

b) After image processing

Fig. 4. Image of Fissures in brown Basmati Rice by arrangement B

The digital camera has the properties were set to (18-55 mm Lens with 4 macro filters & Shutter Speed = 1/40″, ISO = 125, Aperture =4.8)

Arrangement C: In this arrangement, the camera is placed inclined and a light source is along a lateral side of rice grain as shown in fig 5. In this arrangement angle of inclination of a camera with horizontal is about 40 º - 50º. Image of brown rice grains by arrangement C is shown in fig 6a and 6b.

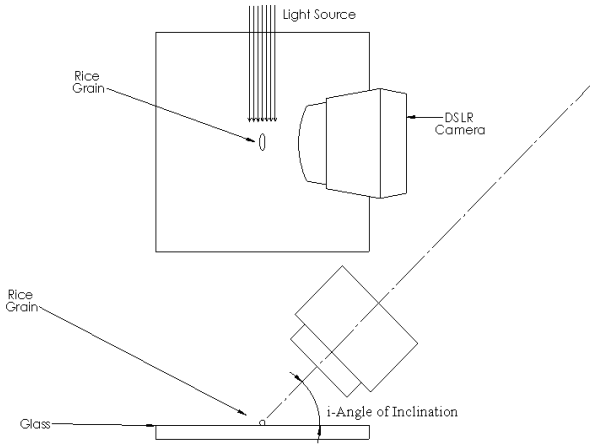
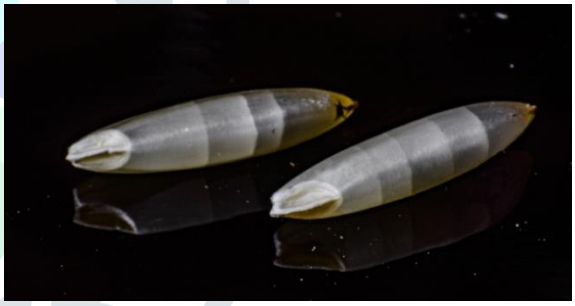


Fig. 5. Schematic diagram of Arrangement C

a) Real image



b) After image processing

Fig. 6. Image of Fissures in brown Basmati Rice by arrangement C

The digital camera has the properties were set to (18-55 mm Lens with 4 macro filters, Shutter Speed = 2.5″, ISO = 150, Aperture = F 22)

Arrangement 4: In this arrangement, the camera is placed vertically upward and a light source is along a lateral side of rice grain but below the glass at an angle about 20-30 º grain as shown in fig 7. Image of brown rice grains by arrangement D is shown in fig 8a and 8b.

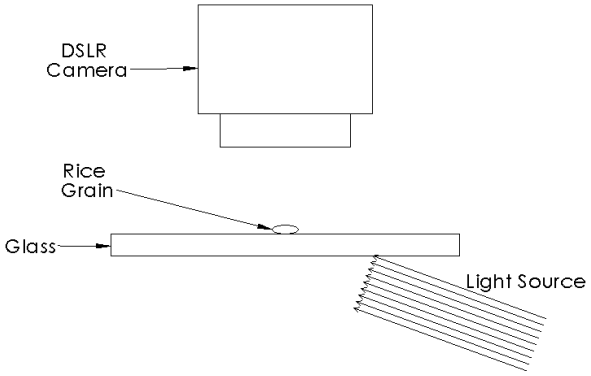
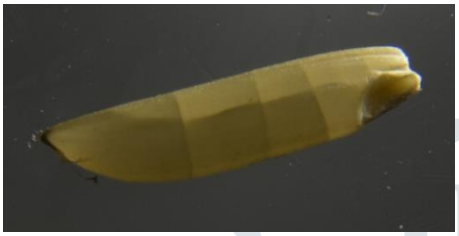
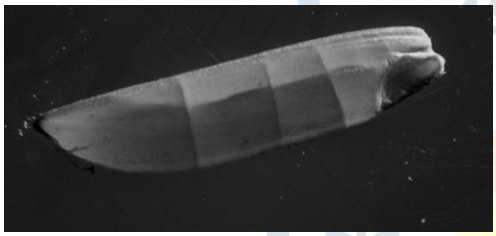


Fig. 7. Schematic diagram of Arrangement D



a) Real image



b) After image processing

Fig.8. Image of Fissures in brown Basmati Rice by arrangement D

The digital camera has the properties were set to (18-55 mm Lens with 4 macro filters, Shutter Speed = 1″, ISO = 100, Aperture = F 22)

2.4 Image Processing:

After capturing the images of rice grains all were processed/edited in Lightroom CC an open source image editing software version 3.4 for better clarity of fissures. While editing, clarity was increased to full value, highlights, shadow, and whites reduced to zero value and exposure, the contrast was adjusted according to images. Fig. 9 shows the algorithm for detection of fissures in rice kernels.

First image of brown rice kernels is captured with a DSLR Camera using principles of different imaging techniques/arrangement as discussed earlier. Captured images is imported in Lightroom CC open source software where image processing is done by giving effects like increasing exposure, reducing highlight, Black and White effect etc. Better fissure clarity is obtained with the help of image processing therefore observer can easily differentiate between Fissured kernels, non fissured kernels and kernels with chalkiness.

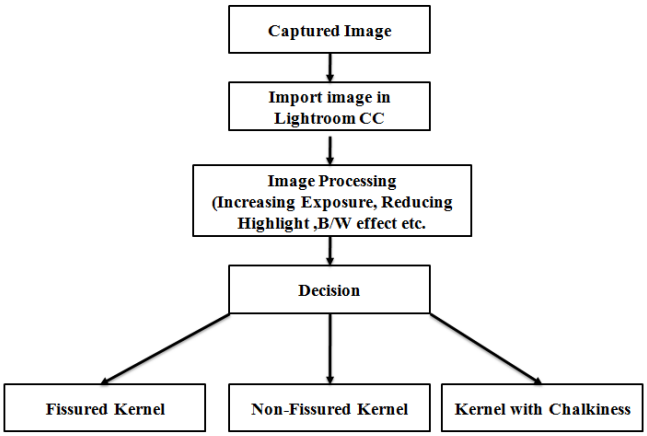


Fig. 9 The algorithm for detection of fissures in rice kernels.

III RESULT AND DISCUSSION

***A*. Design and development of Fissures detection box**

Fissure detection box was developed on the basis of principles used in fissure detection techniques. Small LED bulbs (1.5 -3 V) were used as light source. Small circular glass of Dia. 52mm was used for keeping rice grains. Removable Glass was Neutral density filter of DSLR Camera. LED bulbs were placed at one side of a box with one set of LED below the glass and one set of LED above the glass. With the help of fissure detection box, it is easy to sort out fissured and non-fissured rice grains. Fissure detection box can also be used for sorting rice kernels according to a number of fissures. Rice millers can easily observe the fissures in a batch of rice kernels by examine some brown rice in fissure detection box and can set suitable pressure for whitening so breakage may be reduced to some extent. A schematics of fissure detection box is shown below in fig.10a and 10b and image of an actual basic model of fissure detection box is shown in fig. 11a and 11b.

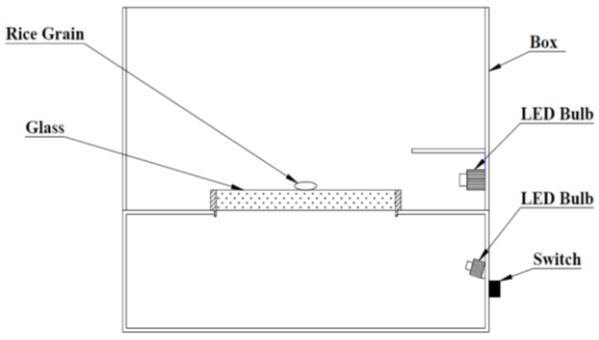


Fig. 10. Schematics of fissure detection box

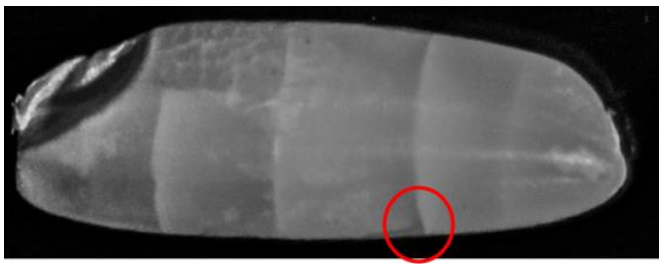
a) Upper LED ON

b) Lower LED ON

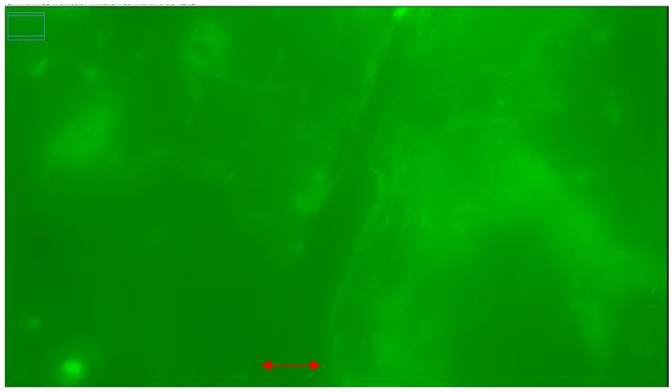
Fig. 11. Image of actual fissure detection box

B. Validation of rice kennel fissures using Confocal microscopy:

Confocal microscopy is an optical imaging technique for increasing optical resolution and contrast of a micrograph by means of using a spatial pinhole to block out-of-focus light in image formation. Here brown rice grain with fissures was taken for testing under confocul microscope at Bio-engineering department, IIT Bombay. Brown rice was soaked in water before testing therefore fissure easily visible in system. Fig.12 (a) shows the image of rice kernel captured by DSLR camera, in which fissures can be seen and Fig.12 (b) shows the image of fissure of rice kernel shown in red circle, captured in confocal microscope. Here even thickness of fissure can be measured.With the confocal microscopy it was easy to differentiate betwwen small fissures and large/big fissures in rice kernels.



a) DSLT camera image



b) Confocal microscopy image

Fig.12. Image of fissure in rice grain

IV Conclusions

The innovative technique was developed for detection and imaging of fissures present in brown rice kernel with the use of digital single lens reflex DSLR camera. The fissures present in rice kernels were easily observed with the help of this technique. Using the four arrangements of detection and imaging of fissures, the arrangements A, B, and D gives better results for imaging the fissures in rice kernels. For observing fissures without DSLR i.e. with naked eyes and magnifier, the arrangement A and D are better among four. Detection of fissures in rice grains plays a vital role in conducting various tests on rice grains according to a number of fissures present in rice grains.

This using a low-cost fissure detection box is easy to sort out fissured and non-fissured rice grains and the rice millers can easily observe fissures in rice kernels by examine brown rice in fissure detection box and can set suitable pressure for whitening and polishing process and thus the breakage of rice kernels may be reduced while milling rice before de-husking.

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