# Classification of drying methods for macadamia nuts based on the glcm texture parameters

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***Abstract*****—**Texture is an important feature in the definition of the external appearance of a material. In this study, Gray-level co-occurrence matrix (GLCM) was used in the analysis of image texture without the destruction of the two varieties of macadamia nuts , KRG-15 and MRG-20, that are dried using seven different methods. Using the Imagej software, four GLCM features were computed in order to define the effect on drying methods on quality of the two varieties. These GLCM features were contrast, Angular Second Moment (ASM), homogeneity and correlation. The aim of this study was to investigate the influence of drying methods on the quality of macadamia nuts for the two varieties: - KRG-15 and MRG-20 with reference to texture quality. The highest classification accuracy of 77% was attained for correctly identifying influence of drying method at direction at angle of 0˚ and displacement, d=1. Solar tent drying method produces superior quality macadamia nuts for both varieties comparable to drying methods; with GLCM feature values (contrast, Homogeneity, Correlation and ASM) of 8,179, 0.048, 0.798 and 0.009 respectively for KRG-15 and 10.238, 0.789, 0.007 and 0.047 respectively for MRG-20. Combination drying of solar tent and Microwave drying produce the least quality,

*Keywords—Image texture, GLCM, Angular Second Moment, Homogeneity*

## 1. INTRODUCTION

Macadamia nuts grown in Kenya originated from Australia. Other countries growing macadamia nut are U.S.A, which is the leading world producer of the nuts, followed by Australia, Kenya and South Africa [1].

The annual production of these nuts in Kenya are approximated to be at 4,000 metric tonnes of nuts-in-shell. After processing, these reduces to about 800 metric tonnes of marketable kernels for commercial importance; though the shells have gain their use as a bio-fuel in most homes in Kenya. Macadamia nuts production according to [2]projected to increase from the current two thousand metric ton to thirty thousand metric tons by the year 2020. With this projection, it is necessary to develop dryers that can handle the large quantity of macadamia nuts at once or that can dry same volume as present but at a shorter drying time without spoilage. This would entail increasing handling volume or reducing handling time.

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The choice of dryer should be one that produces high quality nuts for commercial viability. The quality according to [3] and [4] includes appearance of the nut (size, colour and freedom from defects), texture (firmness and crispness) and chemical value. In addition, good quality macadamia nuts should contain at least 72% oil since less than this value means that the nuts are immature and hardy. These nuts tends to over brown during roasting.

The most commonly used texture measure that is non-destructive according to [3] and [5] is the Gray-level co-occurrence matrix (GLCM). This is because GLCM features that are computed are based on the assumption that the texture information extracted from the image is found in the entire spatial relationship of pixel to its neighbors.

## 2. MATERIAL AND METHOD

### *I. Sample preparation*

Two macadamia nut varieties (MRG-20 and KRG-15) Grown in Embu, Kenya were used in this study. The nuts were dehusked immediately after harvesting and transported to Juja in onion nylon bags. These were the air dried in a shade to a moisture content of 10-12.5 (d.b) for a period of two weeks.

### *II. Experimental set up*

A Color digital camera, CDC, (model Samsung WB150F ,Samsung, South Korea), with a wide-angle lens 24 mm and high resolution of 14.2 megapixel was located vertically over the back ground at a distance of 30 cm. The camera was fixed on a static table, as shown in Fig. 1. The adjustment of the camera was standardized in manual mode with the lens aperture at f = 4.5 and speed 1/80, no zoom, no flash, intermediate resolution of the CDC (1280×720) pixels, and storage in JPEG format. The camera connected to the USB port of a PC for downloading, to analyze the digital pictures taken. The angle between the camera lens and the lighting source was 45°. Sample illuminators (Bulb light (D65000K) and the CDC was placed in a dark room to avoid the external light and reflections.

### *III. Data processing of imaging*

This involved the capturing of images of the two varieties of macadamia nuts, KRG-15 and MRG-20.This was achieved by capturing six images from a nut and repeated three times for those particular nuts dried under the same condition for the two varieties. The nuts were subjected to seven different drying methods during this experiment. These were:-Initial condition, solar tent drying, oven drying at 50˚C, oven drying at 60˚C, oven drying at 50-60˚C, solar tent-60˚C and solar tent-MW drying. These images were fed to Imagej software, which extracted the colour features in RGB.

These were converted using the same software into gray scale imaging in order to compute the image texture features. GLCM Texture Too plugin was used in the computation of the following texture features: - Contrast, Angular Second Moment (ASM), Homogeneity and Correlation in all directions (0˚, 45˚, 90˚ and 135˚) at a certain displacement of the GLCM (d=1). This displacement [6] is the distance between two pixels whose repetition is to be examined


Figure 1: Imaging set up

## 3. RESULTS AND DISCUSSION

### *a)* Statistical Texture Parameters Extraction from GLCM

#### *I. KRG-15*

Fig. 2 shows the means of the four texture parameter (contrast, angular second moment, homogeneity, and correlation) of KRG-15 dried using different drying methods in all direction (0˚, 45˚, 90˚ and 135˚). Contrast for KRG-15 nuts dried using oven dryer at 50˚C and 50-60˚C where much higher compared to the KRG-15 nuts dried using other drying method in all the directions. This meant that these drying methods triggered high local variation in KRG-15. The same conclusion observed that nuts dried using oven dryer at 50˚C and 50-60˚C were less homogeneous as compared to those dried using both solar tent dryer and solar tent-MW.

For ASM, solar tent–MW was the highest followed by Initials, solar tent dryer, solar tent-60 ˚C, oven drying at 50-60˚C and 60˚C but was least in oven drying at 50˚C for directions. This indicate that KRG-15 nuts dried using solar tent and microwave have uniform local texture distribution as compared to the other drying methods. However, the low correlation values of krg-15 nuts dried using solar tent-MW indicate that these nuts had rough texture compared with initial KRG-15 nuts before drying and those dried using solar tent dryer (highest correlation values) which are smooth in their texture. Solar tent-60˚C and oven drying at 60˚C gave nuts with good texture.

#### *II. MRG-20*

Fig. 3 shows the means of the four texture parameter (contrast, angular second moment, homogeneity, and correlation) of MRG-20 dried using different drying methods in all direction (0˚, 45˚, 90˚ and 135˚). Contrast for MRG-20 nuts dried using solar tent-MW and oven dryer at 50˚C where much higher compared to MRG-20 nuts dried using other drying method in all the directions. This means that these drying methods triggered high local variation in MRG-20 nuts. However, the nuts dried using oven dryer at solar tent-MW and 50˚C were less homogeneous as compared to those dried using solar tent dryer.

ASM value for solar tent –MW was the highest followed by Initials, solar tent dryer, oven drying at 50-60˚C, solar tent-60˚C and 60˚C but was least in oven drying at 50˚C for the direction. This indicate that MRG-20 nuts dried using solar tent and microwave have uniform local texture distribution as compared to the other drying methods. Fig 4.25, the low correlation values of MRG-20 nuts dried using solar tent-MW indicate that these nuts had rough texture compared with initial MRG-20 nuts before drying and those dried using solar tent dryer had the highest correlation values) which are smooth in their texture. Solar tent-60˚C and oven drying at 60˚C gave nuts with good texture.

Fig. 4 and 5 shows that the KRG-15and MRG-20 at initial (before drying) and those dried using solar tent dryer had the lowest contrast value at 0˚ direction. The lesser the contrast value the better the nut texture. KRG-15 dries using oven 50˚C, oven 50-60˚C and solar tent-MW had the worst texture in comparison to solar tent drying alone. However, for MRG-15, this was observed when drying using solar tent-MW.

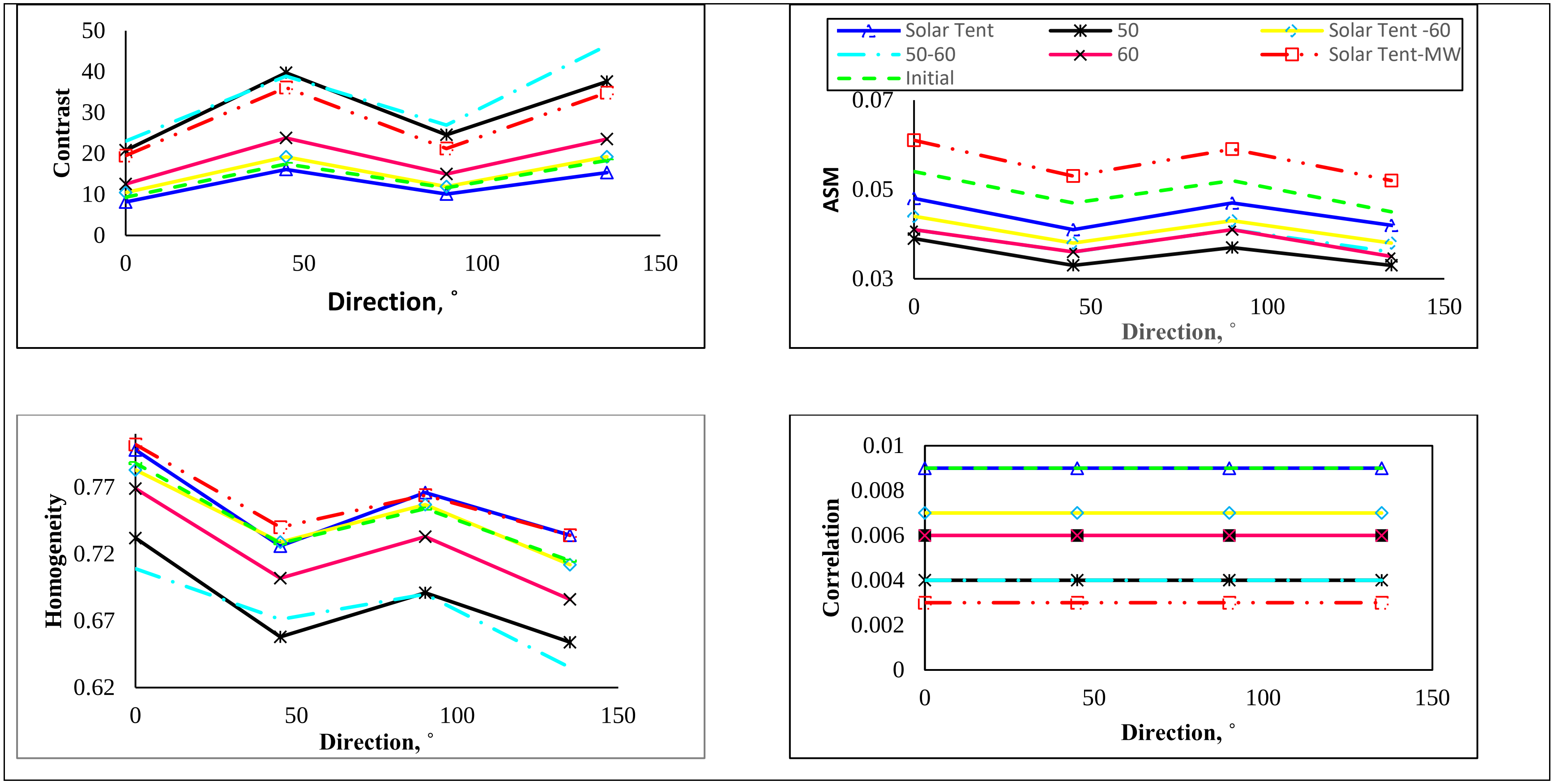


Figure 2: KRG-15 macadamia nut's Texture parameter for different drying methods using GLCM

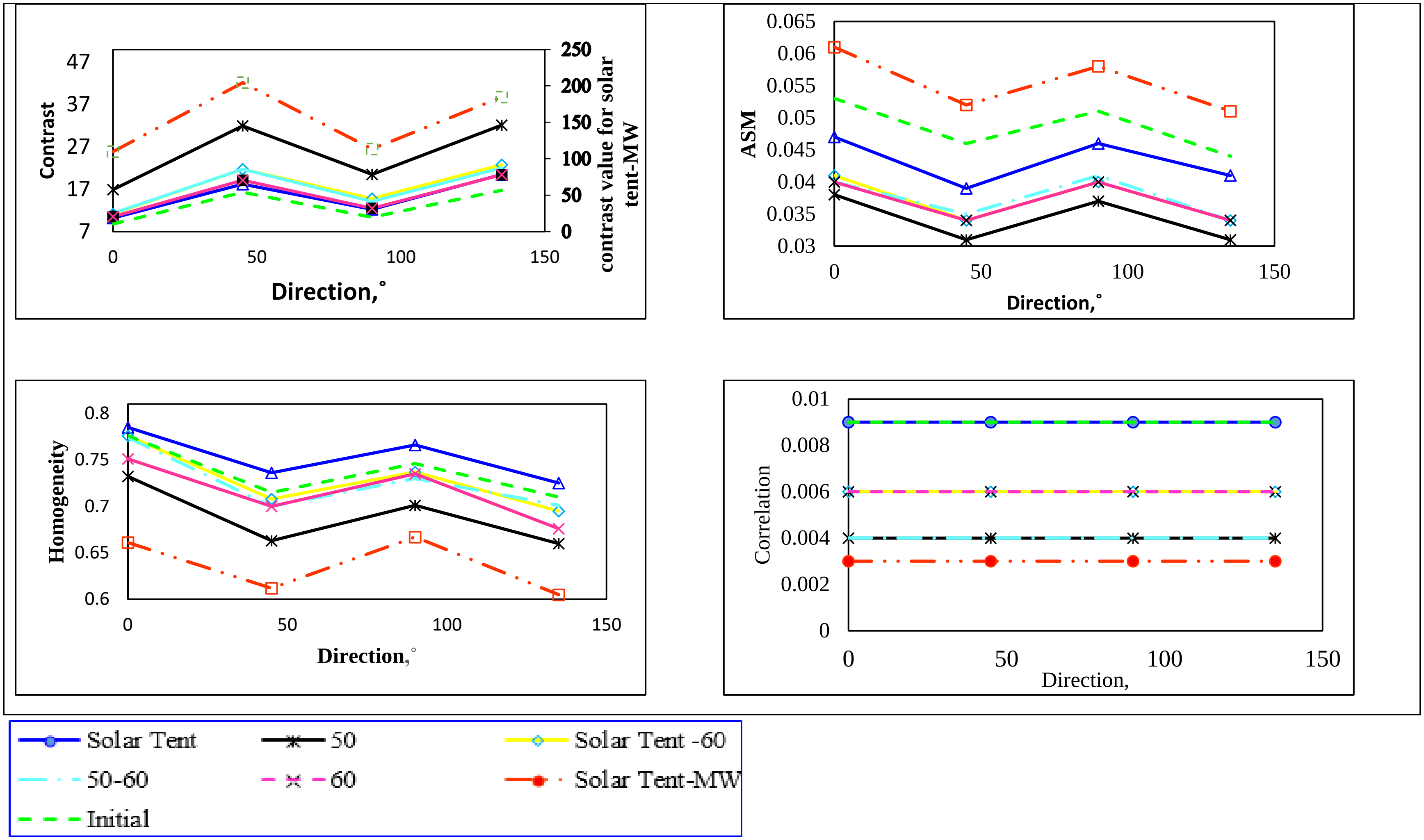


Figure 3: MRG-20 macadamia nut's Texture parameter for different drying methods using GLCM

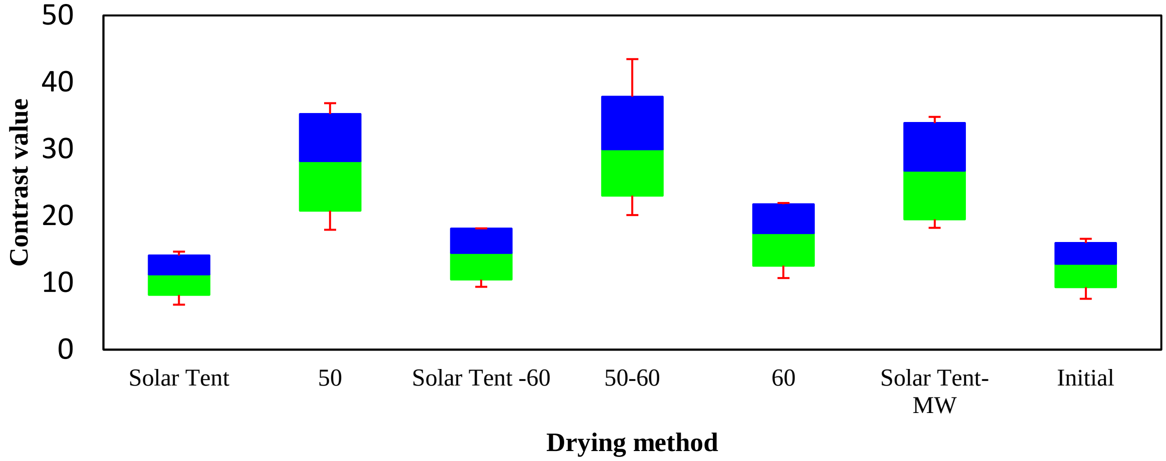


Figure 5: Contrast graph for KRG-15

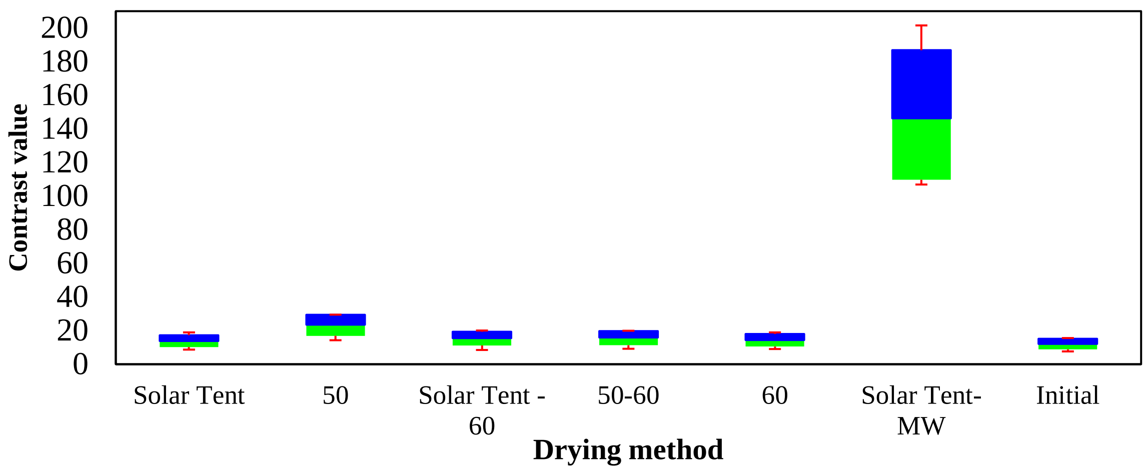


Figure 6: Contrast graph for MRG-20

### *b)* ***Classification of drying method based on the texture parameters***

*Table 1: Classification of Macadamia nuts variety at different direction*

| Direction | 0˚ | 45˚ | 90˚ | 135˚ | Mean |
|---|---|---|---|---|---|
| KRG-15 | 71% | 79% | 71% | 71% | 73% |
| MRG-20 | 82% | 68% | 71% | 71% | 73% |
| Mean | 77% | 74% | 71% | 71% | 73% |

The discrimination efficiency of the different varieties of macadamia nuts at different directions of 0˚, 45˚, 90˚ and 135˚ were found as shown in table 1. It is evident that the horizontal direction at angle 0˚ had the highest average discriminative efficiency of 77% as compared to the other directions

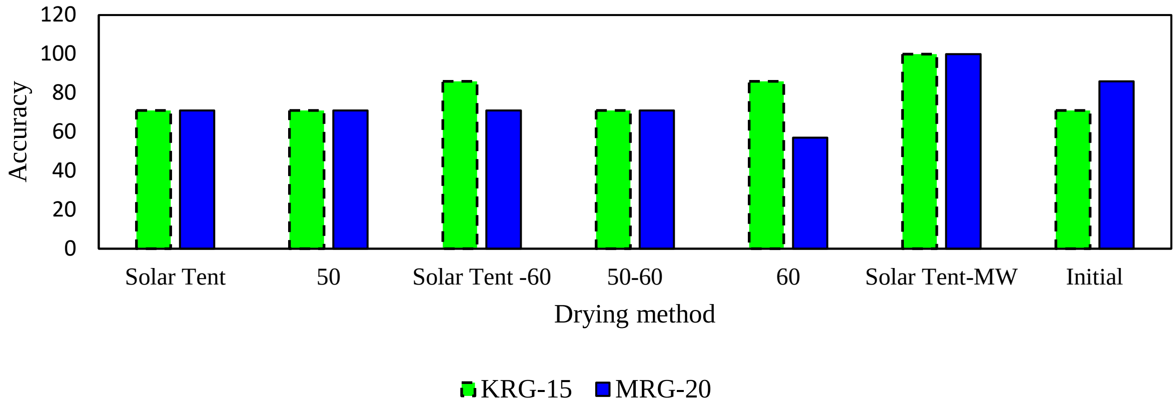


*Figure 7:* Classification of drying method based on the texture parameters at angle 0˚

Fig 3. Shows the classification of nuts dried using different methods at 0˚ direction. The accuracy was highest on nuts dried using solar tent-MW for both variety, KRG-15 and MRG-20.

## 4. CONCLUSIONS

Texture measures derived from the grey-level co-occurrence matrix (GLCM) of both KRG-15 and MRG-20 nuts images to identify the influence of drying methods on texture quality. High classification accuracy of 77% for correctly identifying influence of drying method was achieved using the GLCM features at horizontal direction at angle of 0˚, as observed by [3]. Solar tent drying method produced superior quality Macadamia nuts for the two varieties with the GLCM feature values (contrast, Homogeneity, Correlation and ASM) of 8,179, 0.048, 0.798 and 0.009 respectively for KRG-15 and 10.238, 0.789, 0.007 and 0.047 respectively for MRG-20. The dryer with the least quality in comparison to the other drying method was combination Dyer of Solar tent dryer and microwave (Solar tent -MW) for with a correlation value of 0.03 for both KRG-15 and MRG-20.

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