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Fabrication of a device to measure stickiness of rice for cracker production

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Abstract - This study includes fabrication of a device named 'stickiness meter' to determine the stickiness of rice which is a major requirement in developing good quality rice crackers. This parameter should be measured in incoming rice prior to production of rice crackers in industrial level to avoid wastage. The device was developed using stainless steel. It consists of two discs to place cooked rice, a compressing wheel to compress the discs, and a horizontal scale to get the reading of the force required to separate the discs. The optimum cooking time of rice was measured by cooking rice and pressing in between two glass slides until the opaque core disappears. The diameter of the discs was determined by placing 5g of cooked rice on a paper and drawing the outline. The clearance between the discs and the length of horizontal scale were determined through trial and error. Local rice samples AT 306, AT 405 and Samba were tested using the 'stickiness meter'. The results revealed that the optimum cooking time was 15 minutes. The discs needed a diameter of 8cm and a clearance of 0.2mm. The stickiness values of AT 306, AT 405 and Samba were 9kg, 10.5kg and 0.5kg respectively.

Index terms – Amylose, Cooking time, Gelatinization, Rice varieties, Rice crackers, Stickiness, Stickiness meter

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1. INTRODUCTION

RICE is the single most important crop occupying 34 percent (0.77/million ha) of the total cultivated area in Sri Lanka. On average 560,000 ha are cultivated during maha and 310,000 ha during yala making the average annual extent sown with rice to about 870,000 ha [5]. About 1.8 million farm families are engaged in paddy cultivation island-wide. Sri Lanka currently produces 2.7 million tones of rough rice annually and satisfies around 95 percent of the domestic requirement.

Rice provides 45% total calorie and 40% total protein requirement of an average Sri Lankan [5]. Rice is a unique crop of great antiquity and akin to progress in human civilization. Its rich genetic diversity encompasses an enormous range of geographic – ecologic adaptation.

Commercial rice varieties are divided into three market classes long, medium and short grain. They differ in many characteristics beside grain length. Long grain rice tends to be bland, flaky and dry when cooked, whereas the short and medium rices tend to be sticky, moist and flavorful. Medium and short grain classes are generally referred to as the "sticky rices", and correspond to the japonica varieties. The long grains correspond generally to the indicas.

Among the cereals, rice and wheat share equal importance as leading food sources for humankind. Rice is a staple food for nearly one-half of the world's population. In industrial usage, rice is also gaining importance in the making of infant foods, snack foods, breakfast cereals, beer, fermented products, rice bran oil, and rice wine.

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Rice crackers are considered as a snack food produced using rice. The rice is washed and soaked in water prior to production. Then it should be milled and the flour is steam cooked with other ingredients like salt, colors, sugar etc. This produces a dough and it should be sticky in order to produce good quality rice crackers. The dough is then extruded and a dough sheet is formed. The sheet is cut into pellets and they are stored in room temperature for 24 hours. Next they are dried in a dryer and baked using and oven. The flavoring can be done finally by spraying the required flavor in powder form onto the baked crackers. The major requirement of rice to produce rice crackers is the stickiness. In the industrial level, it is important to check the stickiness of rice prior to production in order to avoid wastages.

The main objective of the study was to develop a device named the stickiness meter to select sticky rice varieties for rice cracker production.

2. MATERIALS AND METHODS

In this study, local rice varieties AT 306, AT 405 and Samba from Rice Research and Development Institute, Sri Lanka were selected as sample material. The optimum cooking time of rice was measured by cooking 5 g of rice in 50 ml of distilled water. Few rice kernels were taken out time to time and pressed in between two glass slides until the opaque core disappears. This time was considered as the optimum cooking time of rice.

The stickiness meter includes two discs, a compressing wheel and a horizontal scale. The diameter of the discs to be developed were determined by placing 5g of cooked rice on a paper and measuring the area of which that rice occupies. Based on that the discs were developed using stainless steel and the friction of discs were minimized by polishing. Fixing of all parts was done in a way that the discs can be compressed to each other. The compressing wheel was fixed to the top disc and the horizontal bar was fixed to the bottom disc.

The clearance between the two discs were determined by cooking the rice to optimum conditions and placing it in between the discs and compressing to find out the minimum clearance needed for the discs to be glued to each other. A pillar gauge was used to measure the clearance.

After the development of the equipment, it was used to determine the stickiness of rice. The rice was cooked to optimum conditions and placed on the lower disc. The discs were compressed until they were glued to each other. A known weight was hung on the horizontal bar and was dragged along the bar until the discs were separated. The reading of the bar (in kg) was considered as the force (F) required to separate the discs and it was proportionate to the stickiness (S). Please refer to (1)

$$F \propto S \qquad (1)$$

The amylose content of the rice samples were determined by the method developed by Juliano, 1971 [3]. The results were compared with the values obtained by the stickiness meter. Further a graph was developed to identify the relationship between the amylose content and stickiness value obtained by the stickiness meter.

3. RESULTS AND DISCUSSION

The optimum cooking time of rice is very important when the rice is being tested in the stickiness meter. It is because the endosperm of the rice should be fully gelatinized. This will affect the stickiness. When it is fully gelatinized, the stickiness will be high. The time at which 90% of the kernels are translucent is considered to be the cooking time [2]. The optimum cooking time of the samples was 15 minutes.

The diameter of the discs was 8 cm. The upper disk (fig. 1a) and lower disk (fig. 1b) were developed using stainless steel. The area of the disks is very important. It is because the cooked rice should be placed on the disk and there should be space for the rice to be pressed and pressurized on the disk. The friction of the disks should be zero. The reason behind this is to reduce the error of the force of friction coming into the calculation. The force should be only the force required to separate rice which was glued on to the disks, and not the friction.

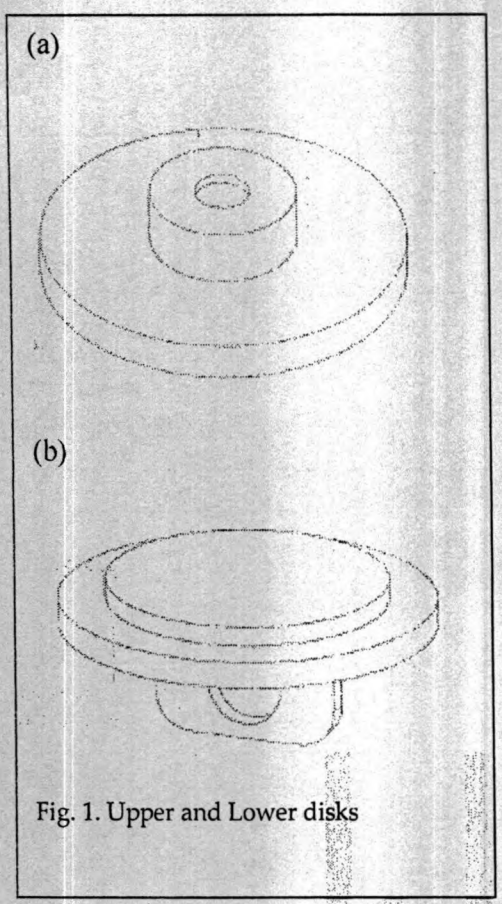

Fig. 1. Upper and Lower disks

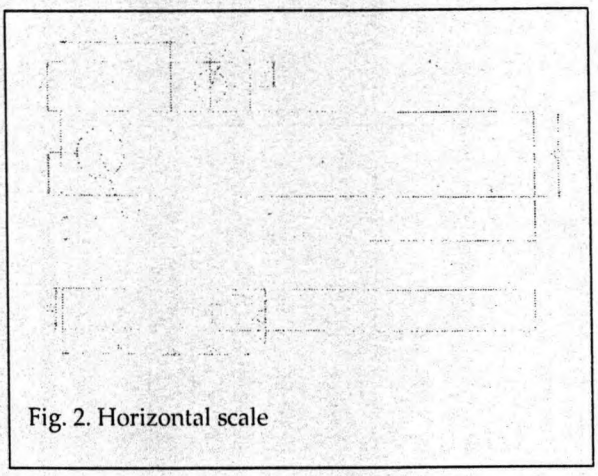

Fig. 2. Horizontal scale

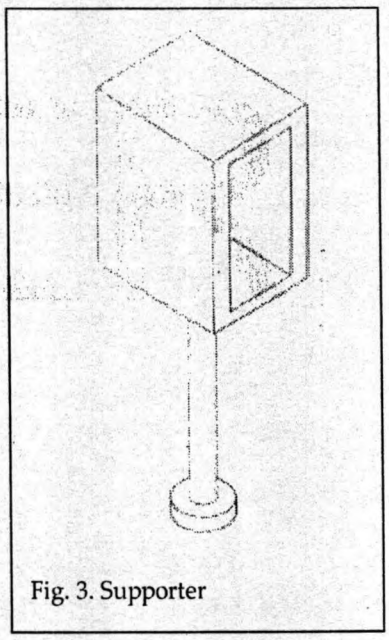

Fig. 3. Supporter

The clearance between the discs was 0.2mm. It should be uniform around the perimeter of the discs. It is because the force applied should be balanced equally among the discs, to ensure that the discs were separated by the force applied on to rice, and not due to the imbalance of the discs.

The horizontal scale is shown in fig. 2. The main purpose of it is to hang the respective weight and to drag it along the scale until the two disks separate. This point is considered as the force required to separate the disks. A supporter (fig. 3) is inserted into the horizontal scale to facilitate the hanging of the weights. It gives a direct reading of the stickiness value.

The stickiness meter developed is shown in fig. 4. A side view is shown in fig. 5 (a) and (b).

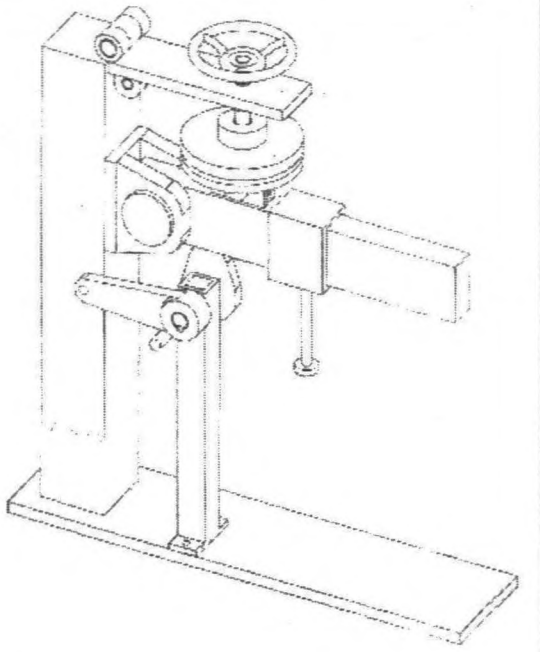

Fig. 4. Stickiness meter

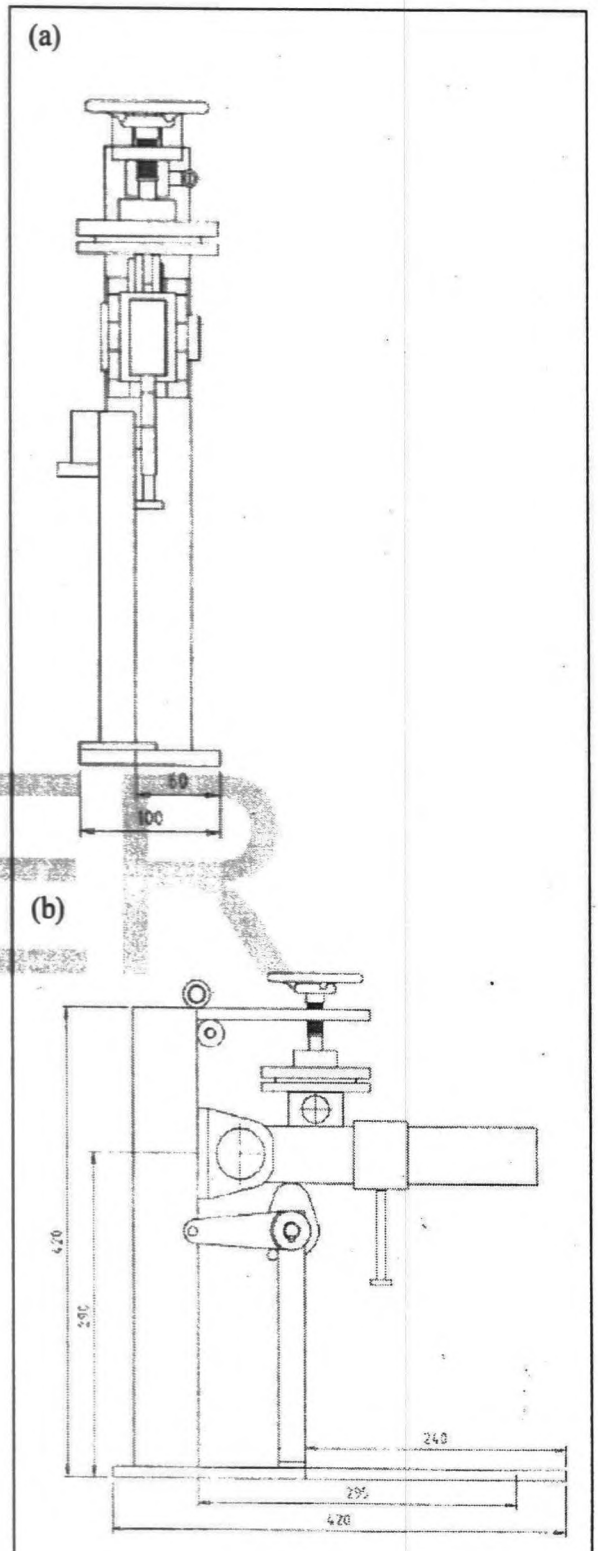

Fig. 5. Side view of stickiness meter

The results of the tests conducted using the stickiness meter is shown in table 1.

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TABLE 1

RESULTS OBTAINED FROM THE STICKINESS METER FOR RICE SAMPLES

Sample	Force required to separate disks (kg)
AT 306	9
AT 405	10.5
Samba	0.5

The Juliano method was carried out in order to get an idea about the quantitative measure of amylose. It was done as the amylose content and stickiness are inversely proportionate to each other. Rice varieties with low amylose have high stickiness.

The amylose percentages of rice samples calculated by Juliano method are shown in table 2.

TABLE 2

AMYLOSE PERCENTAGES OF RICE SAMPLES

Sample	Amylose percentage (%)
AT 306	19.16
AT 405	12.2
Samba	25.87

The chart of the relationship between amylose content and the stickiness value obtained by the stickiness meter is shown in fig. 6.

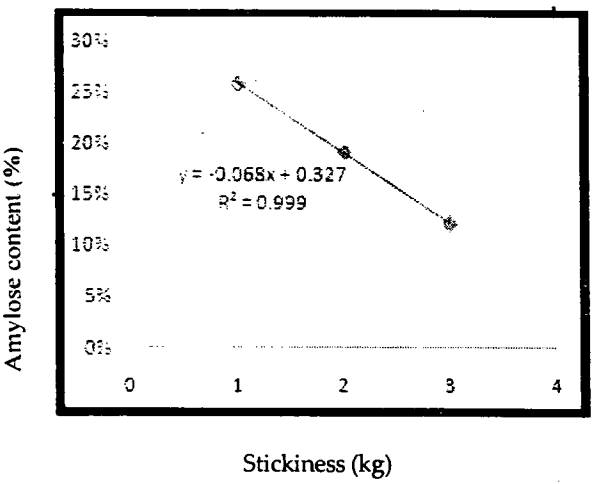

Fig. 6. Relationship between amylose content and stickiness value obtained by the stickiness meter

The graph above shows a straight line which confirms the negative linear relationship between the amylose content and the stickiness. Also the coefficient of determination (R^2) value is 0.999. It is very much closer to 1. This shows the accuracy of the stickiness meter.

4. CONCLUSION

This report consists of developing a device to measure the stickiness of rice. The Juliano method was done to determine the amylose content. Based on the results AT 306 and AT 405 are low amylose rice with high stickiness while samba is high amylose rice with low stickiness. The values obtained by the stickiness meter for AT 306 and AT 405 are 9kg and 10.5kg respectively. For Samba it was 0.5kg. It confirms that highly sticky rice needs a higher force to separate the discs. This concludes that the stickiness meter works accurately and it can be used to select suitable rice varieties for rice cracker production.

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