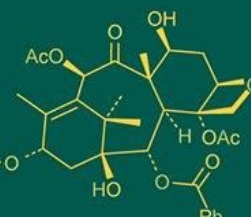
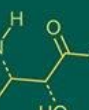
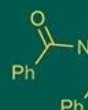


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## Study about dependent and independent parameters before selling *Char (Buchanania lanzan)* nuts

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### Abstract

The presence of hard seed coat of *char* is one of the shelling problems in decortications of *char* nuts, its small size let's to damage the seed at the time of decortications and spoil the seeds which reduce its economical value and also deteriorate the shelf life of it which leads to low storage stability. These challenges overcome by adopted standard dependent and independent parameters.

**Keywords:** Performance, evaluation, *char* decorticator, hulling, milling, efficiency, coefficient, fractions and husk

### Introduction

*Char* (*Buchanania lanzan*), belongs to family Anacardiaceae. It is a medium sized tree, with straight, cylindrical trunk, up to 10-15 m height and tomentose branches. This multipurpose tree provides food, fuel, fodder, timber and medicine to the local community. The *char* seed is small sized slightly flattened and has an almond-like flavor and highly nutritious. There is a problem in the storage due to high oil content and an association of fungi with seeds (Sharma, 1998) [6].

Propagation and agro. Technology status of commercially important medicinal plant species of the project area (14 districts) of Andhra Pradesh community forest management project. *Char* seeds have a hard and stony seed coat, hence the following seed pre-treatment options are considered necessary:

1. Soaking in cold/tepid water for 4-6 days.
2. Immersion in hot water (80-100 °C) then allowing it to cool followed by soaking for 24 hours.
3. Mechanical disruption of seed coat.
4. Soaking in concentrated sulphuric acid.
5. Soaking in GA3 5 ppm for 24 hours.

Traditional processing and some properties of *char* nut (*Buchanania lanzan*) and kernels. Seed is collected and kernel is extracted either manually at home or in the large quantity taken to the local market for mechanical extraction of kernel by breaking the nut using manually. To remove the skin the fruit is soaked in water for 10-12 hours and rubbed to remove the outer skin. To get clean nuts it is further washed with clean water and dried. The dried *char* nuts are shelled by rubbing with a stone-slab on a rough surface for breaking of nuts and manually separate the seeds after decortications of nuts.

### Materials and Methods

#### Pre-treatments of *char* nuts

Pre-treatment is required to facilitate mechanism decorticating and reduce material damage. Pre-treatments such as drying, soaking and boiling were imposed with a main focus to soften the shell and result in easy decortications.

#### Drying

In drying process the raw *Char* nut was taken in a rectangular aluminum tray and dried further for about 30 min at 60 °C by using tray dryer. After drying, the sample was cooled to room temperature and the moisture content was determined. The moisture content of dried sample was 7.83 percent (wb).

**Table 1:** Different pre-treatments of *Char* nut

| Different pre-treatments of <i>char</i> nuts | Pre-treatments | Temperature (°C) | Moisture content % (wb) |
|----------------------------------------------|----------------|------------------|-------------------------|
| 30 min. drying                               |                | 60               | 7.90                    |
| 20 min. boiling                              |                | 100-80           | 8.30                    |
| 24 h soaking                                 |                | 100-80           | 8.60                    |
| 30 h soaking                                 |                | 100-80           | 8.70                    |

**Fig 1:** Measurement of moisture content by hot air oven

### Soaking

The process of water absorption is known as soaking. In soaking process the raw *Char* nut were taken in plastic bucket and soaked for 24 and 30 h. After soaking, the sample was shade dried to room temperature and the moisture content was determined. The moisture content of soaked sample after drying was 8.57 and 8.68 percent (wb).

### Boiling

The raw *Char* nut was immersed in hot water at temperature 90-100 °C for about for a minutes and sample was shade dried to room temperature. The moisture content of boiled sample after drying was 8.34 percent (wb).

**Fig 2:** Boiling of *Char* nut.

### Cylinder speed

The rpm was measured using a hand-held tachometer with a light sensor. A piece of tape was placed on the shelling cylinder disc for the light sensor to read the rpm at which the roller pulleys were rotating. Three different rpm were tested and analyzed using the counting method. The step pulley of 50.8, 63.5 and 76.2 mm, diameters provided on the shelling cylinder shaft helped to vary the speed of shelling cylinder between 197 to 286 rpm.

### Cylinder clearance

The shelling cylinder clearance was measured using a digital vernier caliper at least count 0.001 mm. An outside jaw of vernier was placed in the between the cylinder. Three different clearances (6, 7 and 8 mm) were tested and analyzed using the counting method.

### Feed rate

Feed rate of the machine was calculated by noting the time required to decorticate *Char* nuts and expressed as kg-h<sup>-1</sup>.



### Independent parameters

#### Decorticate procedure

Decorticate was done in the Department of Agricultural Processing and Food Engineering, Raipur; only sound nuts

were used for the experiment, the moisture content of the various samples was determined, before decorticating. The initial moisture content of the sample was 9.04% and after pre-treatment moisture content was 7.83, 8.34, 8.57 and 8.68% (wb). All samples were subjected to decortications/shelling in *Char* decorticator. A sample size corresponding to 5 kg of *Char* nuts fed to the decorticator has fixed operating parameters. The weights obtained were recorded after each operation. The weights were used to determine the decorticating characteristics such as total kernel recovery (TKR) percent, whole kernel recovery (WKR) percent, broken kernel recovery (BKR) percent, dust percentage (DP), decortications efficiency (De), decorticator capacity (Dc) and electricity consumption *etc.* of the various samples. The above procedure was adopted for all the samples and then estimation of various decorticating properties for each sample was done.

This is the quantity of the *Char* nut that passes through the machine per unit time. The capacity of the machine was calculated using the equation:

$$D_c \text{ (kg/h)} = \frac{\text{Weight of total sample}}{\text{Decortications time}}$$

Where,

Dc = Decorticator capacity, kg-h<sup>-1</sup>.

### Decorticating efficiency

This is the ratio of total weight of nut decorticated to the total weight of nut fed into the machine for decorticating and expressed as a percentage. The overall efficiency of the decortications was calculated by Kupritz formula, by the following expression (2001 and Kate *et al.*, 2014) [4].

$$De\% = \frac{(\text{Weight of total seed}) - (\text{Weight of un-decorticated seed})}{\text{Weight of total seed}}$$

Where,

De = Decorticating efficiency, %.

### Electricity consumption

Electricity consumption is the electric energy usage during machine operation. Equation expressed the power consumption as:

$$\text{Electricity consumption kWh} = \frac{\text{Motor input watt} \times \text{operation time (h)}}{1000}$$

### Total kernel recovery

Decorticating recovery is the mass of the total kernels recovered from the seeds after cracking. It is the ratio of the weight of the kernels to that of the seeds. It was computed using the relation:

$$\text{Where, TKR}\% = \frac{\text{Weight of total kernel}}{\text{Weight of total sample}} \times 100$$

TKR = Total kernel recovery (whole + broken kernel), %.

### Whole kernel recovery

Whole kernel recovery was defined as the ratio of the weight of head or whole kernels to that the weight of total sample. It is computed in percentage as follows:

$$\text{WKR}\% = \frac{\text{Weight of whole kernel}}{\text{Weight of total sample}} \times 100$$

Where,

WKR = Whole kernel recovery, %.

### Broken kernel recovery

This is a kernel or piece of kernel having less than seventy five percentage of the average length of the whole kernel. It was also defined as the ratio of the weight of broken kernels to that the weight of total sample decorticated.

$$\text{BKR}\% = \frac{\text{Weight of broken kernel}}{\text{Weight of total sample}} \times 100$$

Where,

BKR = Broken kernel recovery, %.

### Dust percentage

The dust percentage of *Char* nut was determined by using the following expression:

$$D_p\% = \frac{\text{Weight of dust}}{\text{Weight of total sample}} \times 100$$

Where,

DP = Dust recovery, %.

## Results and Discussion

The initial moisture content of *Char* nut was determined by hot air oven methods found to be 9.04 percent (wb). The moisture content of *Char* nut after pre-treatments was found in the range of 7.83 to 8.68 percent (wb).

### Decorticating efficiency

The decorticating efficiency of the *Char* decorticator machine at different cylinder clearances, cylinder speeds and different pretreatments are presented in Table 2. The data shows that as the cylinder clearance increased from 6 mm to 8 mm the decorticating efficiency of the *Char* decorticator decreased gradually irrespective of cylinder speeds. The lower decorticating efficiency at maximum clearance is attributed to less impact force applied on to the *Char* nuts which lead to partially shelled or unshelled condition of nuts at the outlet. Ogunlowo and Bello (2005) [9], have also found similar results for finger millet processing, cowpea thresher and roasted groundnut machine, respectively.

The decorticating efficiency of the machine was average significantly highest at 5% level (93.90%) when the cylinder clearance was 6 mm and cylinder speed was 286 rpm, respectively. The decorticating efficiency was significantly lowest at 5% level (84.73%) when the cylinder clearance increased to 8 mm at the cylinder speed was 197 rpm, respectively. It was statically observed from the Table 2.

**Table 2:** ANOVA for decorticating efficiency at 6, 7 and 8 mm cylinder clearances at different speeds and pre-treatments of *Char* nuts.

| Treatments     | C <sub>1</sub>     | C <sub>2</sub>      | C <sub>3</sub>      |
|----------------|--------------------|---------------------|---------------------|
| T <sub>1</sub> | 89.17 <sup>e</sup> | 88.00 <sup>cd</sup> | 87.00 <sup>cd</sup> |
| T <sub>2</sub> | 89.60 <sup>d</sup> | 88.50 <sup>c</sup>  | 87.03 <sup>c</sup>  |
| T <sub>3</sub> | 90.87 <sup>c</sup> | 89.67 <sup>bc</sup> | 88.47 <sup>b</sup>  |
| T <sub>4</sub> | 91.90 <sup>a</sup> | 90.87 <sup>a</sup>  | 89.83 <sup>a</sup>  |
| T <sub>5</sub> | 91.37 <sup>b</sup> | 90.10 <sup>b</sup>  | 89.17 <sup>b</sup>  |
| CD at 5%       | 0.81               | 0.67                | 0.62                |
| Mean           | C <sub>1</sub>     | C <sub>2</sub>      | C <sub>3</sub>      |
| S <sub>1</sub> | 93.64 <sup>a</sup> | 92.30 <sup>a</sup>  | 91.28 <sup>a</sup>  |
| S <sub>2</sub> | 91.12 <sup>b</sup> | 89.90 <sup>b</sup>  | 89.00 <sup>b</sup>  |
| S <sub>3</sub> | 86.98 <sup>c</sup> | 86.08 <sup>c</sup>  | 84.62 <sup>c</sup>  |
| CD at 5%       | 0.23               | 0.74                | 0.93                |

| Treatments     | S <sub>1</sub>      | S <sub>2</sub>      | S <sub>3</sub>      | Treatments     |
|----------------|---------------------|---------------------|---------------------|----------------|
| T <sub>1</sub> | 91.00 <sup>cd</sup> | 88.43 <sup>cd</sup> | 84.73 <sup>c</sup>  | T <sub>1</sub> |
| T <sub>2</sub> | 91.43 <sup>c</sup>  | 88.53 <sup>c</sup>  | 85.17 <sup>bc</sup> | T <sub>2</sub> |
| T <sub>3</sub> | 92.67 <sup>bc</sup> | 90.50 <sup>b</sup>  | 85.83 <sup>b</sup>  | T <sub>3</sub> |
| T <sub>4</sub> | 93.90 <sup>a</sup>  | 91.57 <sup>a</sup>  | 87.13 <sup>a</sup>  | T <sub>4</sub> |
| T <sub>5</sub> | 93.03 <sup>b</sup>  | 91.00 <sup>ab</sup> | 86.60 <sup>ab</sup> | T <sub>5</sub> |
| CD at 5%       | 0.69                | 0.75                | 0.68                | CD at 5%       |
| Mean           | S <sub>1</sub>      | S <sub>2</sub>      | S <sub>3</sub>      | Mean           |
| C <sub>1</sub> | 93.64 <sup>a</sup>  | 91.12 <sup>a</sup>  | 86.98 <sup>a</sup>  | C <sub>1</sub> |
| C <sub>2</sub> | 92.30 <sup>b</sup>  | 89.90 <sup>b</sup>  | 86.08 <sup>b</sup>  | C <sub>2</sub> |
| C <sub>3</sub> | 91.28 <sup>c</sup>  | 89.00 <sup>c</sup>  | 84.62 <sup>c</sup>  | C <sub>3</sub> |
| CD at 5%       | 0.71                | 0.68                | 0.57                | CD at 5%       |

**Table 3:** Statistical analysis for kernel recovery at different cylinder clearances, cylinder speeds and pre-treatments of char nuts

| Speed (rpm)          | Pre-treatments | C <sub>1</sub> (6 mm) |                   | C <sub>2</sub> (7 mm) |                   | C <sub>3</sub> (8 mm) |                   |
|----------------------|----------------|-----------------------|-------------------|-----------------------|-------------------|-----------------------|-------------------|
|                      |                | Whole kernel (%)      | Broken kernel (%) | Whole kernel (%)      | Broken kernel (%) | Whole kernel (%)      | Broken kernel (%) |
| S <sub>1</sub> (286) | T <sub>1</sub> | 10.36                 | 9.20              | 11.50                 | 7.30              | 10.70                 | 6.18              |
|                      | T <sub>2</sub> | 10.14                 | 9.30              | 11.30                 | 7.40              | 10.56                 | 6.46              |
|                      | T <sub>3</sub> | 11.98                 | 8.78              | 13.00                 | 7.00              | 12.50                 | 5.66              |
|                      | T <sub>4</sub> | 13.96                 | 8.20              | 14.80                 | 6.26              | 14.40                 | 5.36              |
|                      | T <sub>5</sub> | 12.74                 | 8.84              | 13.20                 | 7.26              | 13.00                 | 5.80              |
| S <sub>2</sub> (246) | T <sub>1</sub> | 11.30                 | 6.90              | 12.00                 | 5.60              | 11.60                 | 4.24              |
|                      | T <sub>2</sub> | 11.00                 | 6.78              | 11.90                 | 5.40              | 11.34                 | 4.10              |
|                      | T <sub>3</sub> | 13.94                 | 5.98              | 14.90                 | 4.20              | 14.20                 | 3.70              |
|                      | T <sub>4</sub> | 14.80                 | 5.32              | 15.60                 | 3.90              | 15.10                 | 3.40              |
|                      | T <sub>5</sub> | 13.38                 | 5.70              | 14.00                 | 4.30              | 13.64                 | 3.62              |
| S <sub>3</sub> (197) | T <sub>1</sub> | 13.00                 | 4.58              | 13.60                 | 3.20              | 13.04                 | 2.43              |
|                      | T <sub>2</sub> | 12.90                 | 4.80              | 13.50                 | 3.50              | 13.20                 | 2.20              |
|                      | T <sub>3</sub> | 14.00                 | 4.60              | 15.00                 | 3.16              | 14.00                 | 2.34              |
|                      | T <sub>4</sub> | 15.20                 | 4.58              | 16.00*                | 2.88              | 15.50                 | 2.26              |
|                      | T <sub>5</sub> | 14.38                 | 4.40              | 15.40                 | 2.80              | 14.40                 | 2.00*             |
|                      | CD at 5%       | 0.39                  | 0.30              | 0.35                  | 0.30              | 0.36                  | 0.21              |

### Interaction (cylinder clearance, cylinder speed and pre treatment)

The data on interaction of cylinder clearance, cylinder speed and pre treatment are presented in Table 3. It was observed that, the maximum whole kernel recovery (16%) was recorded for 24 h soaked *char* nuts at 7 mm cylinder clearance and 197 rpm cylinder speed combinations (C<sub>2</sub>S<sub>3</sub>T<sub>4</sub>) followed by 15.50 percent at 8 mm cylinder clearance at the same cylinder speed and pre-treatment combinations (C<sub>3</sub>S<sub>3</sub>T<sub>4</sub>) and 15.20 at 6 mm cylinder clearance at the same cylinder speed and pre-treatment combinations (C<sub>1</sub>S<sub>3</sub>T<sub>4</sub>). The study indicates that broken kernel was the least (2%) at 8 mm cylinder clearance of C<sub>3</sub>S<sub>3</sub>T<sub>5</sub> combination followed by 2.80 percent at 7 mm

cylinder clearance of C<sub>2</sub>S<sub>3</sub>T<sub>4</sub> combinations and 4.40 percent at 6 mm cylinder clearance of C<sub>1</sub>S<sub>3</sub>T<sub>5</sub> combinations.

### Conclusions

The performance evaluation of the decorticator showed that nut moisture content; cylinder speed and cylinder clearance had significant effect on its performance indices. The study indicated that the *char* nuts had higher decortications efficiency (93.90%), capacity (30.15 kg·h<sup>-1</sup>). The total kernel recovery was also higher for 24 h soaked *char* nuts having 8.57% moisture content, 286 rpm cylinder speed and 6 mm cylinder clearance. Maximum whole kernel recovery was observed for 24 h soaked nuts at 197 rpm cylinder speed and 7 mm clearance. The data for minimum kernel

breakage was found for 30 h soaked *char* nuts at 197 rpm cylinder speed and 8 mm clearance, respectively.

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