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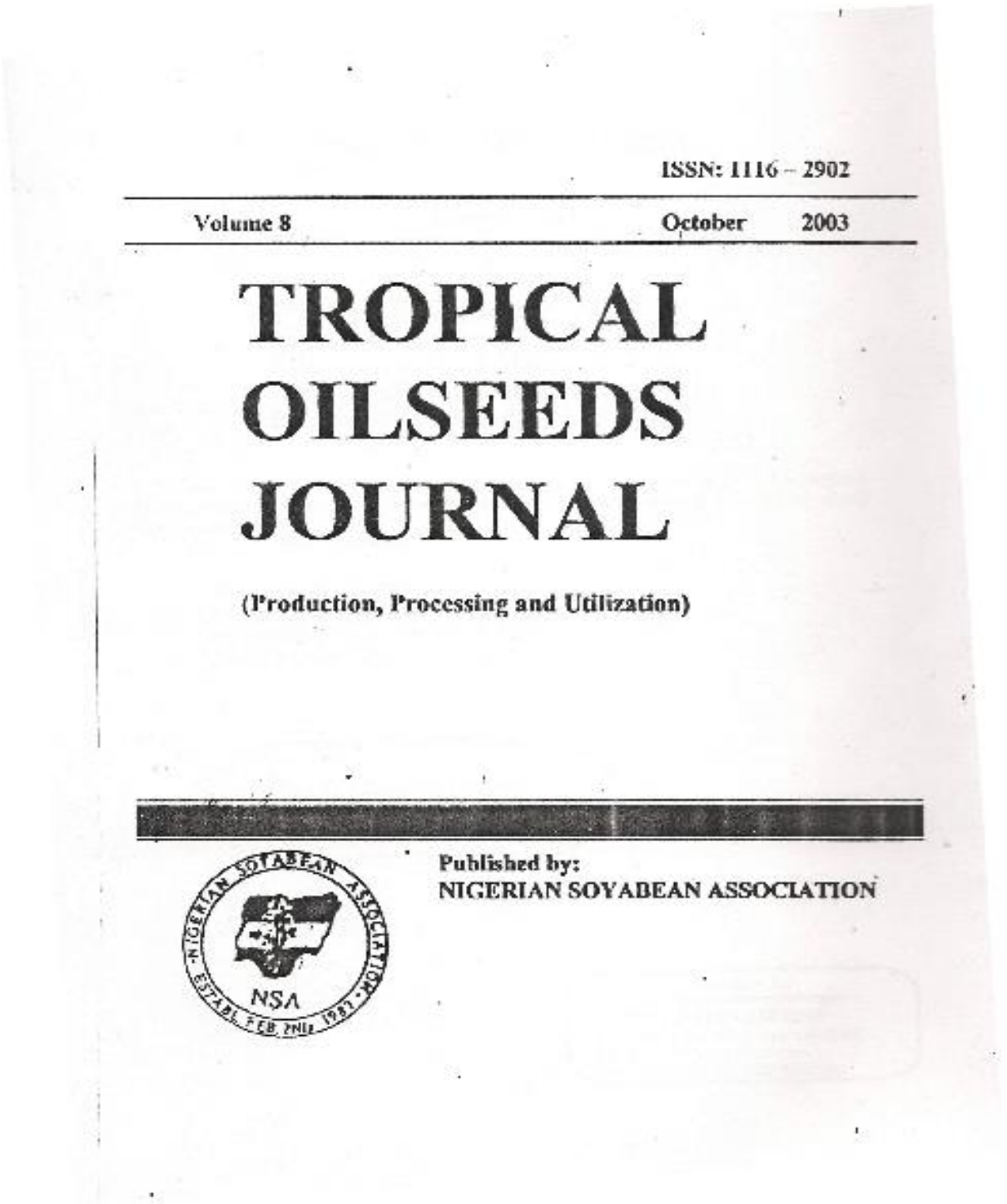

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Mechanical Dehulling of Beniseed: Process and Equipment

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Abstract

The removal of hulls from beniseed in the production of edible oil and cake has continued to attract greater interest in recent times. This is because the hull contains oxalate, which binds calcium and thus renders the cake unnutritious after oil expression. A mechanical dehuller and a hull separator were therefore developed for the seed.

The dehuller consists of 3 blades, each in a disc form having saw – teeth periphery and a shaft driven by a 2.5kW, 1500rpm electric motor. It has a capacity of 10kg of undehulled beniseed with the addition of 60 litres of water per batch of 3 minutes. The dehulling efficiency was found to be 95%. Separation of the hull from the seed is carried out by mixing the blend seed with saline water and allowed to settle under gravity. The degree of salinity of the water used is about 15%.

Keywords: Beniseed, Dehulling, Separation, Efficiency, Salinity
* Corresponding Author

Introduction

Beniseed or sesame seed is a prized seed in the world because of the by-product that are derived from it – the dehulled seed, the oil and the cake. It is free from undesirable components such as protease inhibitors in soybean, gossypols in cotton, lectins in peanuts and ricin in castor beans (Share, 1998). Beniseed oil contains natural antioxidants in the form of sesamol and tocopherol which make it the most resistant to oxidative rancidity among several vegetable oils (Yen and Shyu, 1989; Jaswant and Shukla, 1991).

In conventional processing where beniseed oil is the major product, the whole seed is usually crushed and the oil is extracted. The by-product (cake) is usually fed to animals as a protein source (Inyang and Ekanem, 1996). However, in areas where the cake is eaten by human beings or used to produce proteinised infant weaning food, dehulling is necessary. This is because the hull contains oxalic acid (2-3%), which binds calcium

and reduce its availability (Kinsella and Mohite, 1985). The hull also contains undigestible fiber, which imparts a dark colour to the cake.

According to Gupta (1998) dehulling improves the nutritional and flavour characteristics of the meal and leads to the production of a glossy white product irrespective of the hull colour (black, white or red). From analysis pf expresses beniseed oil (Table 1), it has also been discovered that dehulling of beniseed, leads to a higher oil yield, increased protein content, and reduced fiber content (Johnson et al., 1979; Oresanya and Koleoso, 1990; Olayanju, 2002). However, the small size of beniseed makes its dehulling difficult.

Table 1: Proximate Analysis of Mechanically Expressed Beniseed Oil

Constituent	Undehulled Seeed %	Dehulled seed %
Protein (Nx6.25)	25.0	29.9
Ash	5.42	3.46
Fat Ether Extractable	53.0	57.5
Crude Fibre	4.08	3.04
Oxalic acid	2.71	0.36
Calcium	0.98	0.23

Source: Olayanju, 2002

Several investigators have reported various methods of dehulling the seeds. Toma *et al.*, (1979) as reported by Oresanya and Koleoso (1990) used lye solution to dehull five varieties of beniseed. They stated that 6% sodium hydroxide at 60°C with seed to lye ratio of 1:3 (w/v) was sufficient to decorticate all the beniseed varieties in 10 seconds. Another method according to Moharam (1981) consisted of contacting beniseed with boiling solution of 0.6% sodium hydroxide at 96°C for 1 to 2 minutes to facilitate the rupturing of the outer coat. The coat was then removed by washing. A yield of 85% of dehulled material on the weight of raw seeds was obtained. However, beniseed dehulling by alkali treatment is

associated with the following problems: the difficulty of having to source the chemical locally, hazards of handling the alkali during processing, and high cost of processing

Tontisirin *et al.* (1980) subjected water soaked beniseeds to a rubbing action of two vertically mounted discs in order to peel off the hull, which was then separated by floatation in brine. Traditional method of dehulling beniseed involves soaking in cold water overnight followed by partial drying and rubbing against a rough surface. The hulls separated from the kernels are removed by winnowing (Gow-chin, 1990; Badifu and Abah, 1998). This method is laborious and suitable for handling only small batches of seed.

Consequently the best option for consideration is mechanical dehulling. Hence, the objective of this work is to identify and select appropriate unit operation equipment for a pilot scale dehulling of beniseed and to develop the identified equipment.

Materials and Methods

Process Technology

The sequence of processing beniseed into dehulled form is given in Figure 1 and briefly described below:

Cleaning

The Federal Produce Inspection Service (FPIS) enforces FAO prescribed grades and standards recommended by International Commodities Board for beniseeds intended for export (Hockman, 1998; Sahay, 1998). The standard for the two types of beniseeds produced in Nigeria- the Kano and Benue varieties have the same quality standards termed as " Exportable Quality" which means beniseeds which contain:

- not more than 2% by weight of stones, laterite and other vegetable matters and
- not more than 5% by weight of seed other than sesamum indicum.

Beniseeds that fail to maintain this standard is rejected for export.

At the cottage scale level, the seeds are cleaned using two sieves of 2.5mm and 1.5mm apertures to remove dust, sand, dry leaves twigs and empty capsules of the fruits. The cleaned seeds are then washed in excess water to remove empty seeds as well as separation from stones. However, simple machines such as air- screen cleaners and specific gravity separators are available for medium scale processing (Classen, 1992; Olayanju *et. al.*, 1999).

Debittering

Beniseed has bitter taste that remains even after dehulling and oil extraction. The bitterness contains alkaloids such as caffeine in coffee and tea (Oresanya and Koleoso, 1990). It is extractable in boiling water. In processing, the raw beniseed is cooked in excess water for about 20 minutes in a covered container. The water is drained off and the seed washed in two changes of cold water. This was cooked again for another 20 minutes to completely remove the hitterness.

Dehulling

The debittered seeds are poured into a mechanical dehuller consisting of 3 blades rotating in a container of excess water. It is powered by a – 2.5kW, 1500rpm electric motor. The high speed of the blade brings about dehulling without breaking the seeds.

Hull Separation and Drying

Separation of the hulls from the seeds is done by draining the hull-kernel mass on a 1.2mm sieve and then poured into a container of brine (11.5% solution) and mixed thoroughly. This is allowed to stand for about 30minutes. The hulls sink while the kernels float on water. The floating kernels are run off unto a sieve for draining. The drained kernels are dried using an aspirator.

Machine Description

Mechanical Dehuller

The mechanical dehuller consists of the following main components:

- Three chopper blades, each in a disc form having saw-teeth periphery,
- A main shaft of 20mm diameter and 1500mm long. This carries the blades and it is driven by a – 2.5kW electric motor rotating at a speed of 1500rpm.
- A main tank of 400mm diameter and 1100mm deep. This has a gate valve at the lower end for discharging the product after processing.

Figure 2 shows the isometric view of the dehuller. The capacity of the dehulling tank is 100litres and it is to process 10kg of beniseed with the addition of 60 litres of water per batch.

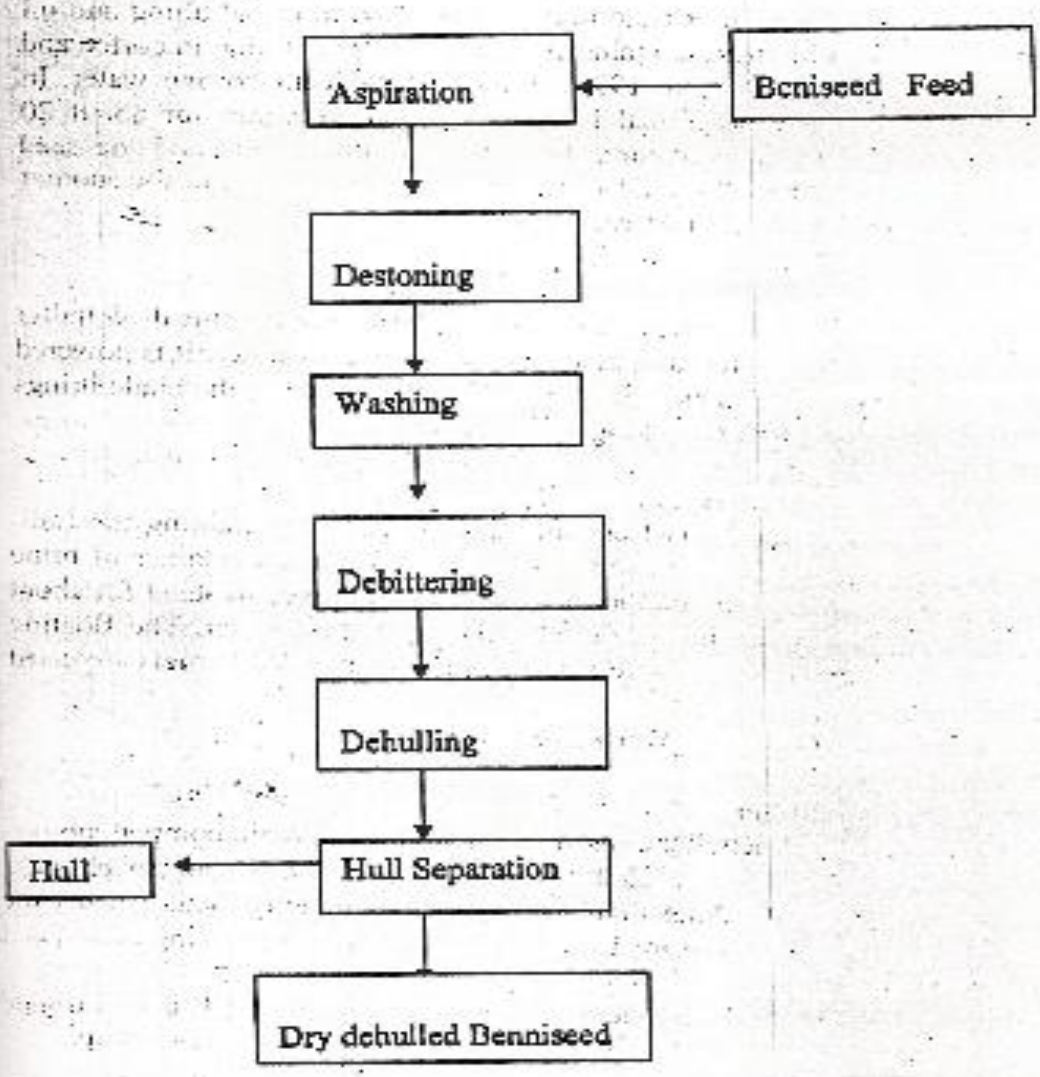


Figure 1: Flow Chart for the Dehulling of Beniseed

Hull Separator

From laboratory experiments, it was discovered that separation of seed and hull took place when blend beniseed was mixed with saline water and allowed to settle. The degree of salinity of the water used was 15%. Also the mode of separation was studied and found to follow the pattern of hull at the bottom, water column on top of the hull and clean seed column at

the topmost part. The ratio of the heights was 7:5:3. It was therefore easy to collect the clean hull-free seed by decanting from the top column. This is illustrated in Figure 3. The experience from the laboratory guided in the sizing of the separation tanks for the 100 litres dehuller. These are:

- 250 litres cylindrical tank with 100mm-diameter gate valve at the bottom used for the hull separation.
- Another 250 litres cylindrical tank can also be used to wash the clean hull-free seed after the separation exercise.
- The material of the two tanks is plastic. Galvanized or stainless steel can also be utilised.

The draining of water from the hull – free seed can be carried out by collecting it in a container having a bottom wire mesh of about 500 microns. The size of this sieve is 1,000mm diameter and 500mm high. Further removal of trapped water in the seed is done by using an aspirator.

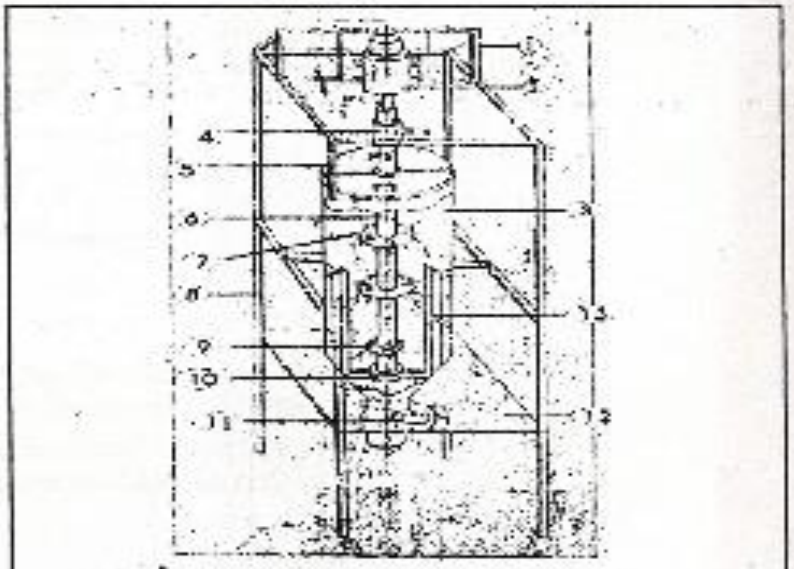


Figure 3 Isometric View of the Mechanical Dehuller

1– Motor mounting bracket; 3– Electric motor; 3– Stainless steel container; 4– Coupling; 5– Container's cover; 6– Shaft; 7– Big blades; 8– Structural steel frame; 9– Small blade; 10– Shaft bottom support; 11– Gate valve; 12– Base plate; 13– Inner bracket

Experimental

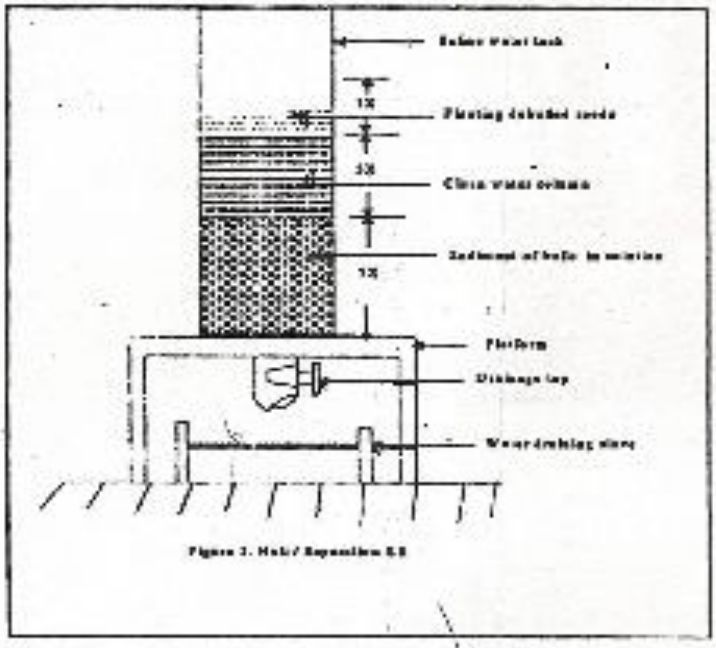
Ten kilograms of beniseed was poured into the mechanical dehuller which is three - quarter filled with water (Plate 1). The switch was turned on and the shaft rotates for about 1 minute. The high speed of the blad

brought about the dehulling of the seeds without breakage. Separation of the hulls from the seed was done by draining the hull-kernel mixture on a 1.2mm sieve and then pouring such into a container of brine (15% Solution) and mixing thoroughly (Figure 3). This was allowed to stand for about 30 minutes. The hulls sink while the kernels float on water.

The hulls were first emptied through the bottom valve into an emptied mesh that drains the water. Another mesh was used to collect the floating hull free seed at the top column. Drying of the wet kernels was done on a clean concrete slab under a shade in order to ensure gradual drying of individual kernels. This was preferred to open sun drying because of stress gradient in the dried kernels, which may result in high breakage.

Results and Discussion

The results of the tests are as shown in Table 2. It was observed that when the dehulling operation was performed for 1 and 2 minutes, the dehulling was incomplete. 3 minutes operation gave complete dehulling. Above 3 minutes, the seed becomes over – processed and got pulverized.



The observed behaviour is due to the fact that the water inside the container has a tempering effect on the seed. This allows the hull to swell up awaiting the cutting action of the sharp blades of the dehuller and the fast whirling movement of the water medium to unfold the hull and carry

it away leaving a smooth cleaned whole kernel. However, longer processing time will make the seed to be milled by the blades.

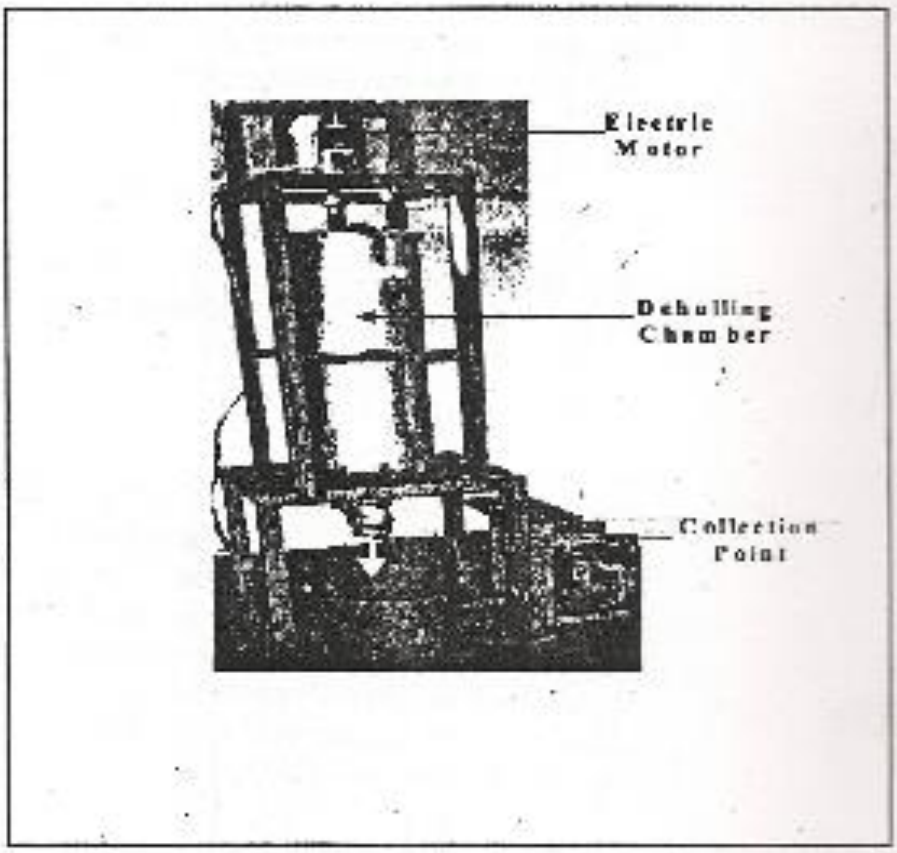


Plate 1: Mechanical Dehulling of Beniseed

Table 2: Performance Evaluation of Beniseed Dehuller and Separator

Sample	Weight (Kg)	Dehulling Time (min)	Dehulled Seed (%)	Salt-Water Solution (%)	Separated Hull (%)
1	10	1	50	5	30
2	10	2	65	10	45
3	10	3	95	15	95
4	10	4	100	20	96
5	10	5	100	25	96

The separation of the hull was found to be partial when the salinity of water is below 10%. At 15% salinity, the separation rose to 95%. There was no much difference in separation values when the salinity was above 15%. Separation of the hull must be quick to prevent excessive absorption of water, which will lead to softness of the seed, and thus longer drying time. It was also observed that after about 30 minutes of stagnation, hull free seed, clean water and hulls separated in column in the tank are in the ratio: 3:5:7. Further stagnation period up to one hour did not make any difference with separation column ratio.

Conclusion

It is expected that the development of this plant will be of immense assistance to the rural farmers willing to process their seeds and the exporters of beniseed who want a better quality and price for their products.

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