DEVELOPMENT OF SORGHUM POLISHER FOR VILLAGE LEVEL

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ABSTRACTS

Sorghum (*Sorghum vulgare*), in Indonesia has a good prospect as a substitute for staple food, as poultry feed, and as a commodity for export.

In the post-harvest handling, sorghum will be threshed, cleaned and sorted, sun-dried, polished and kept in the storage. The polishing of sorghum is a critical step since sorghum contains high level of tannin in its outer skin (epidermis) which is detrimental both for human-being and cattle. Usually, to remove the tannin content, the sorghum polishing process will be carried out until the grains reaches 60 percents of their formal weight.

In Indonesia, farmers do the sorghum polishing traditionally by pounding the grains placed inside a stone-mortar with a long tubular wood pounder. This kind of process takes a long time, gives a low quality of sorghum, and increases the grain losses. It is important to develop a sorghum polishing system mechanically to help the farmers in raising the quality and decreasing the losses.

A prototype of sorghum polisher was designed, built, and tested in the laboratory. The construction materials used in developing the polisher are local goods easily found in the market. The machine consists of a series of stone disk (110 mm diameter) on a central shaft placed inside a tubular screen in a tubular plate. The engine power utilized for the polisher is 3 HP. The engine could be either an electrical engine or a gasoline engine.

The principal of the sorghum polishing is significantly different from the rice polishing process due to the grain fragility. The function of the stone disks is not to do the abrasion process but mainly to create the rotation and the flow movement in the sorghum bed. The rotation movement in high speed causes the rubbing and abrasing mechanisms among the surface of the sorghum kernels themselves. This will result in whole polished grains without broken kernels.

The grain was fed through a hopper mounted at the upper end of the tubular plate, then run through the polishing process while passing along the disk series to the tubular lower end. The sorghum bran was removed through the tubular screen at the same time the polishing process took place.

During the performance test, various critical factors were studied such as 1) the numbers of the stone disks and the distant among the disks, 2) the rotation speed, 3) the sorghum water content, and 4) the number of passing the grains into the machine.

It was found that the prototype will perform optimally in a capacity of 15 kg/hour when the number of the stone disks is 18 with 30 mm distant between disks, the rotation speed is 3000 RPM, the sorghum water content is 12 percents and twice passing the grains into the machine. The yield of the polished sorghum is 59.8 percents with 39.0 percents sorghum bran and 1,2 percents losses.

INTRODUCTION

Sorghum is one of the important grains for both human food and animal feed. In Indonesia sorghum has good prospect because 1) it has been familiar as human consumption in the Central and East Java, 2) it grows on the dry land in the dry season, 3) it has been also utilized as animal feed, and 4) it becomes as an export commodity.

In improving the sorghum production and the sorghum quality, the problems lie not only in the pre-harvest handling systems but also in the post-harvest as well. In the post-harvest handling, the common treatment of sorghum are dry-milling, pelleting and steaming.

Dry-milling of sorghum is proposed since sorghum grains can be kept in the storage before milling for a longer time (about six months) compared to the results of the steaming process. The cost of drying and grinding is lower than the cost of pelleting.

Sorghum will be threshed after the harvest, dried, kept in the storage, cleaned and ground. The milling process of sorghum is the critical step because some varieties have high level of tannin content which is harmful for both human and cattle. For example, 40% part of the brown sorghum grains contains tannin. The tannin content is in the epidermis and the horny endosperm of sorghum.

This paper will discuss the polishing process which is required to remove the tannin from the sorghum grains before grinding.

SORGHUM GRAINS

Sorghum grains (*Sorghum vulgare*) grow in a malay 7.5 cm to 50 cm length with a diameter of 3.75 cm to 20 cm (Figure 1). The sorghum kernel has an oval shape (Figure 2) with a body diameter of 8 to 35 mm. The good variety yields into 24—60 thousands kernels per one kg of sorghum.

The kernel consists of 84% endosperm, both floury and horny endosperm, 10% germ, and 6% pericarp or epidermis. The pericarp is slippery outside and attached stickily to the horny endosperm. The floury endosperm is brittle.

In Indonesia, the common varieties of sorghum planted are Kempul Putih 103, Mutiara Yogya, Cantel Jatinom Klaten 118, Cantel Abrit Wonogiri, Katengu and Cempaka. The sorghum production is 3—4 tons per ha. The uniqueness of shorghum grains is they can be harvested three to four times. The development of sorghum production in Central and East Java is presented in Table 1.

Table 1. The sorghum production in Central and East Java, 1973–1977*.

Year	Areal of Plant, Ha	Production, Ton
1973	15,854	12,829.3
1974	16,509	13,573.6
1975	20,640	26,116.8
1976	31,002	47,534.0
1977	33,685	47,075.0

* Research Report on Corn, Sorghum and Wheat Breeding, LP_3-Bogor, 1978/1979.

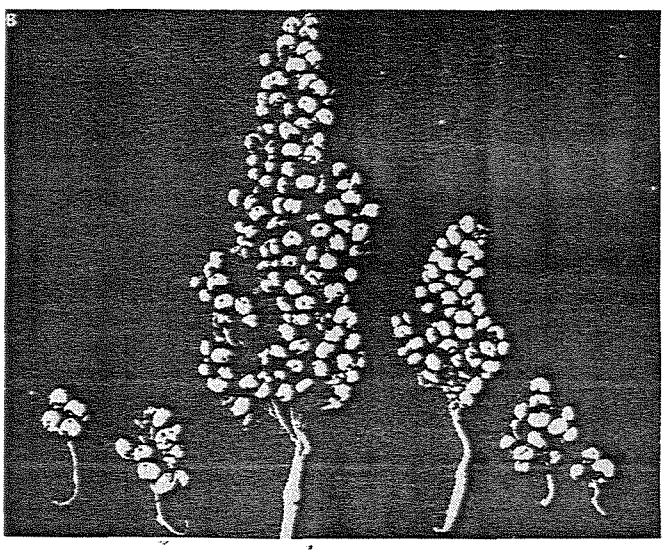

Fig. 1. The sorghum malay, arrow type.

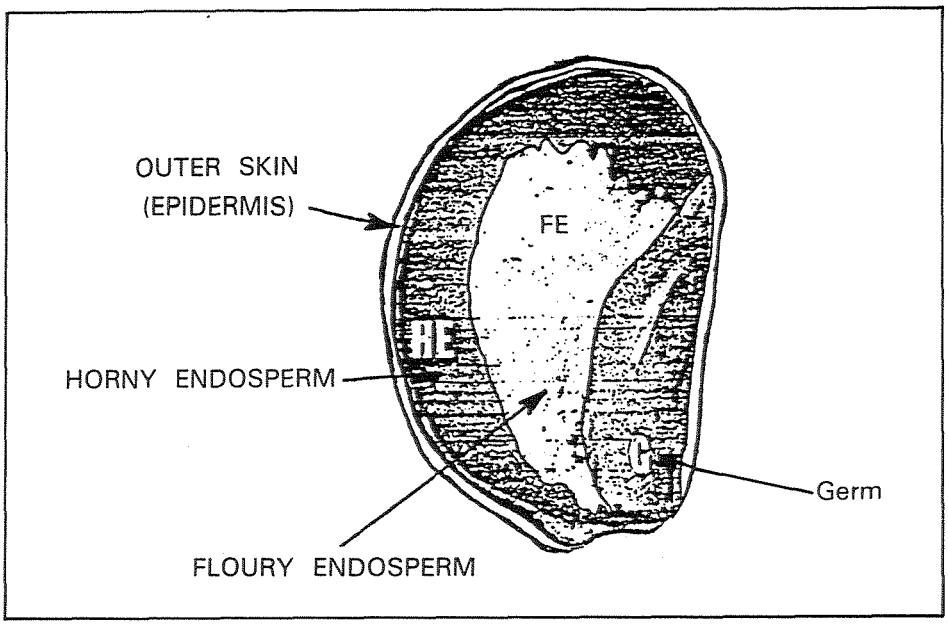

Fig. 2. The component of a sorghum kernel.

POST-HARVEST HANDLING OF SORGHUM FOR DRY-MILLING PROCESS

In Indonesia sorghum is usually harvested manually by sickle with 20 cm of stem. Sorghum is assumed mature when the moisture content of grain achieve 20% (wet basis). In dry lands, sorghum is sometimes harvested at 14—16% moisture content (wet basis).

Threshing is done in the similar way as rice threshing. The sorghum malays are hit onto the bamboo mat or fed into pedal threshers. The next step is cleaning the sorghum using the traditional winnower such as "tampah", a round bamboo-woven plate with 60—75 cm diameter. Mechanic winnower with blower for paddy cleaning is also used for sorghum.

Sun-drying is the general way to remove a part of the sorghum moisture content. The thickness of the sorghum grains layer is 0.5—0.7 cm. Under good weather, sorghum is dried in two days from 20% initial moisture content to 12% final moisture content.

Polishing in the village level is done by farmers using. The results yield into whole grains, broken grains and flour, and fail to remove all the part containing tannin. Rice cone-polishers will reduce the broken sorghum grains and remove all part containing tannin, however, the percentage of broken grains or the floury part is considered high, 20—30%.

MECHANIC SORGHUM POLISHER

Mechanic sorghum polisher has several advantages compared to the traditional system 1) the polishing quality is better (the broken and floury part is reduced into 3% or lower, 2) the polished grains is free from the tannin content, and 3) the polishing efficiency is improved.

The Food Technology Development Centre, Bogor Agricultural University (FTDC-IPB) has developed a small capacity of sorghum polisher (15 kg/hour) for the village level (Figures 3 - 10). The principle of the polishing mechanism is to create a movement which stimulates the rubbing motion among the sorghum grains themselves.

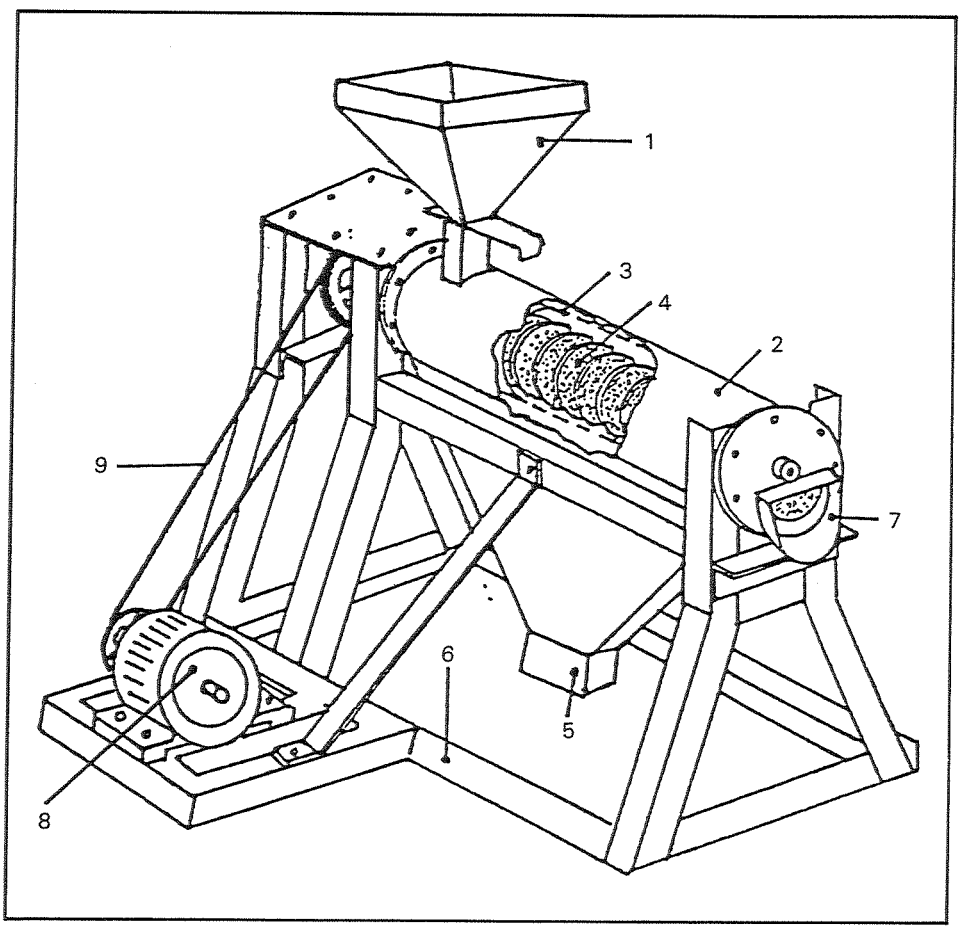

Fig. 3. The sorghum polisher in perspective.

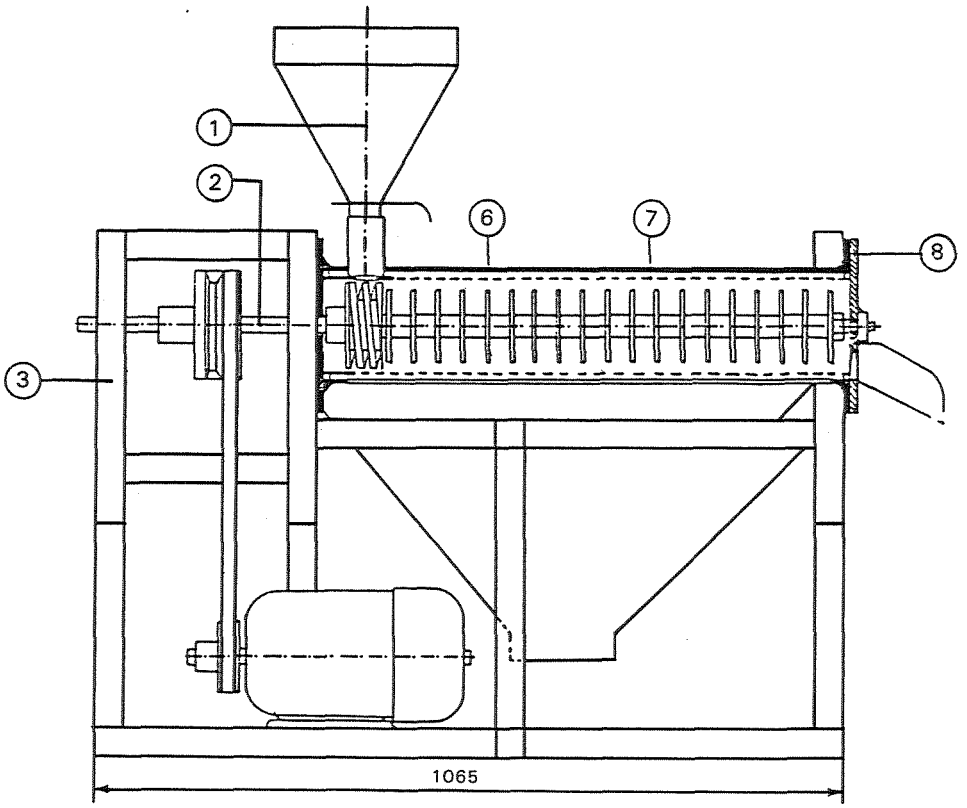

Fig. 4. The sorghum polisher, front view.

The aberasive stone disks are used in the sorghum polisher not to polish the grains surface but to create sufficient rubbing motion among the kernels (Figures 5 and 6). The bran resulted from the polishing of sorghum passes out of the screens, while the polished grains flow inside the tabular screen to the right direction. The result of the polished sorghum grains is showed in Figure 11.

The influence of multi-passing, rotation speed increase, and sorghum content are illustrated in Figures 12, 13 and 14 respectively.

The optimum condition for the polishing process utilizing the sorghum polisher is 3000 RPM rotation speed, 12% sorghum moisture content (wet basis), and two times passing of sorghum. The yield of polished sorghum is 60% which is required to meet the standard for removing of 40% part of the grains containing tannin (brown sorghum variety). The power used by the polisher is 1.85 HP.

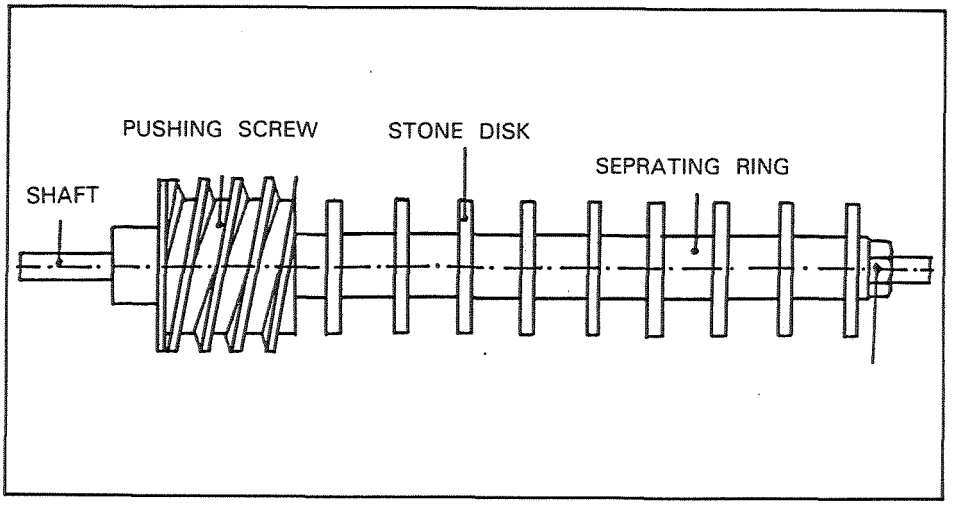

Fig. 5. The details of the sorghum polisher.

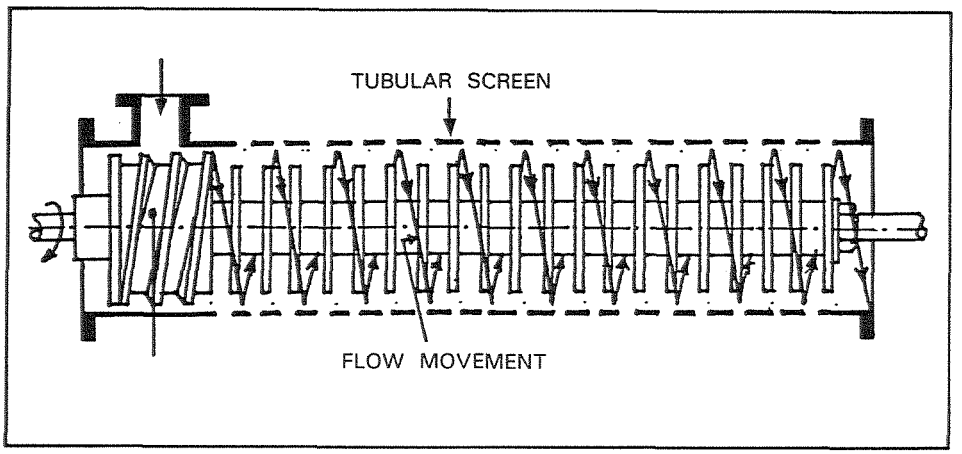

Fig. 6. The flow of grains in the polishing process.

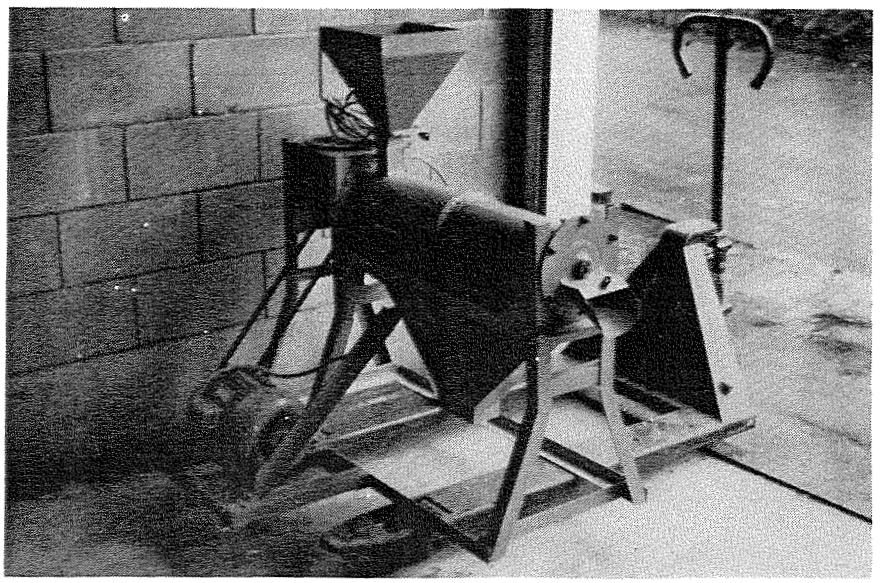

Fig. 7. The sorghum polisher.

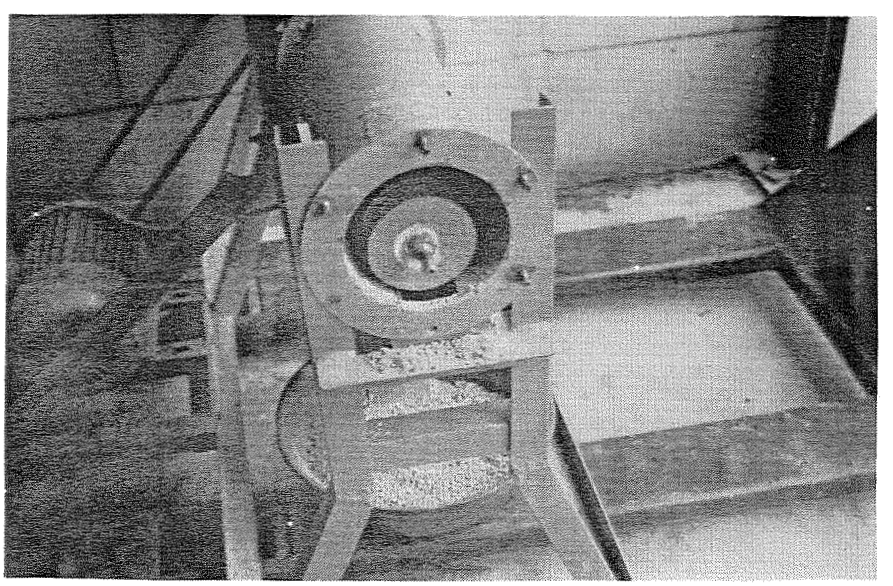

Fig. 8. The polishing process of sorghum.

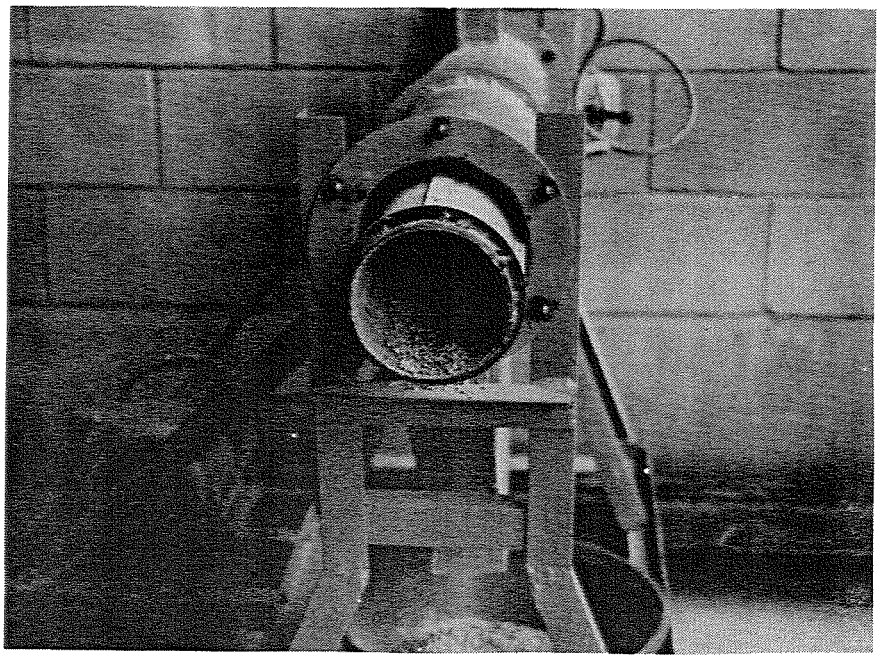

Fig. 9. The polisher with the part of the tubular screen slided partly outside.

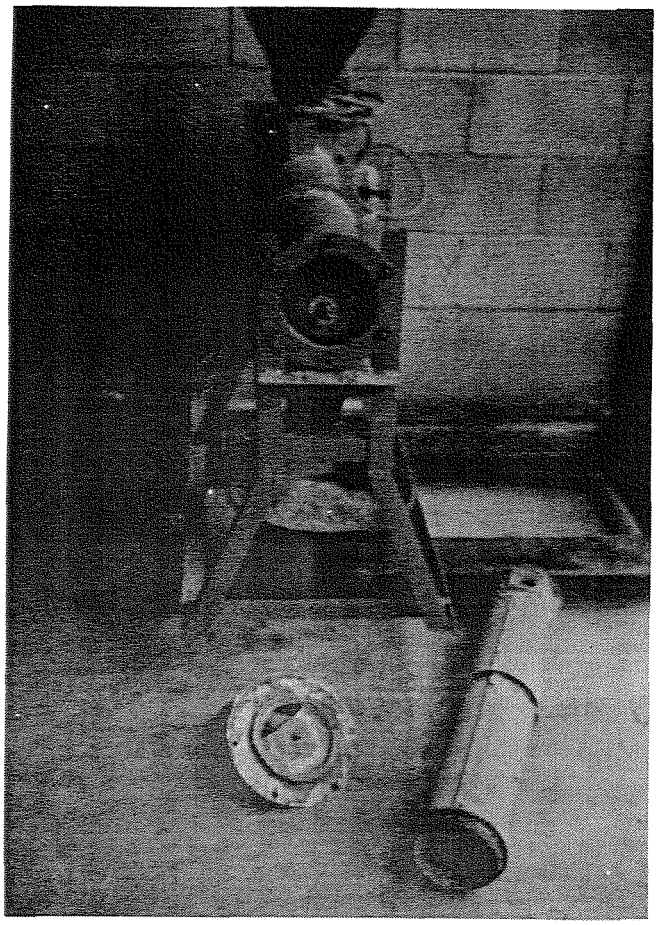

Fig. 10. The polisher showing the aberasive stone disk.

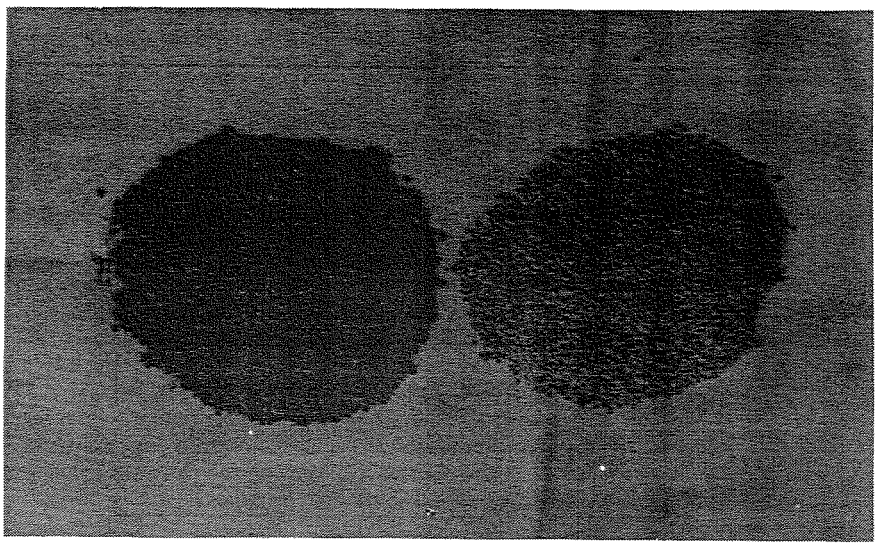

Fig. 11. The brown sorghum before (a) and after polishing (b).

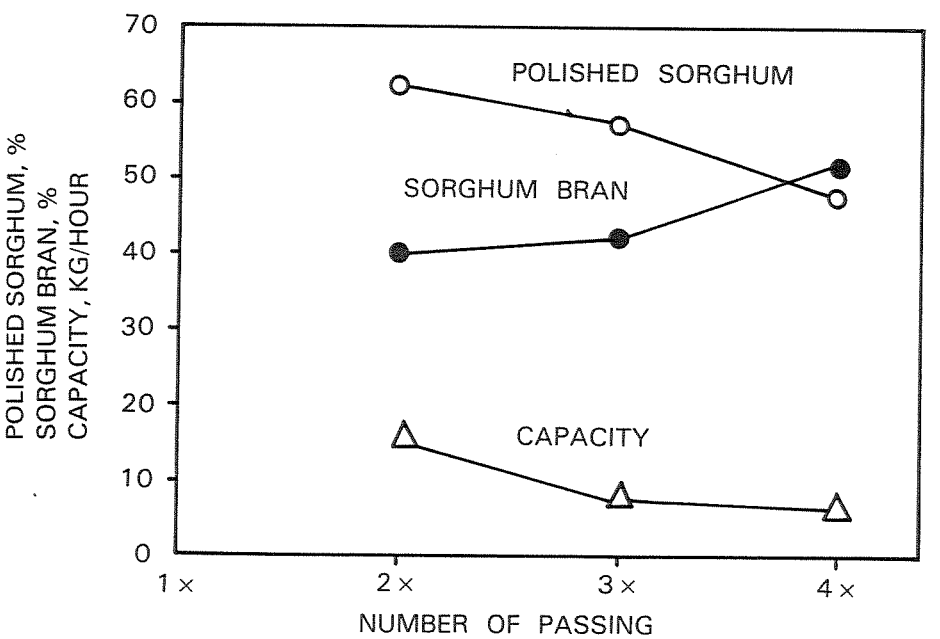

Fig. 12. The influence of the number of passing on the polished sorghum yield.

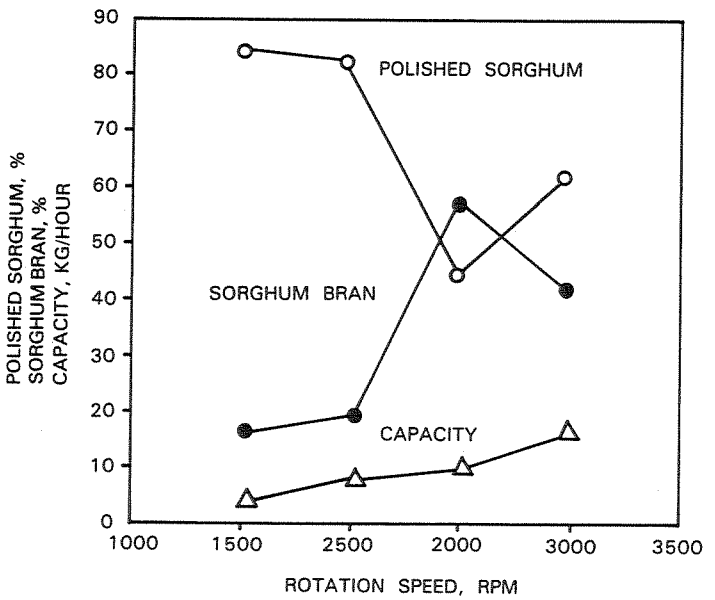

Fig. 13. The influence of the rotation speed on the polished sorghum yield.

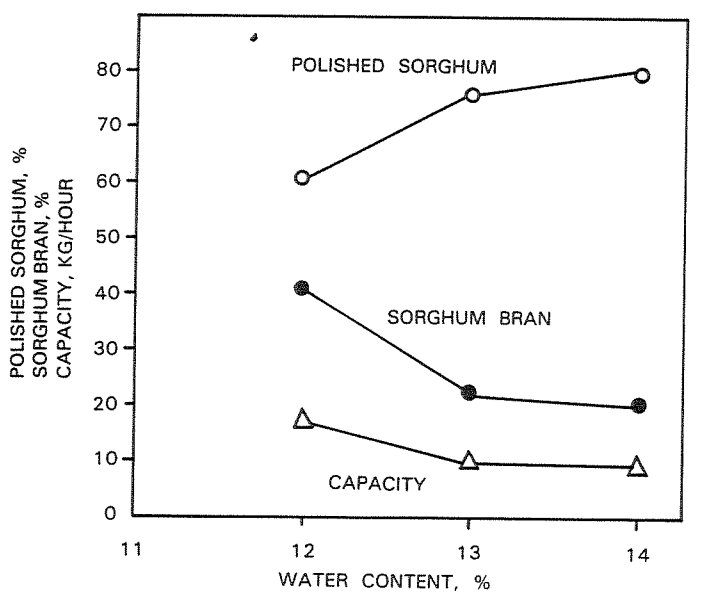

Fig. 14. The influence of the water content on the polished sorghum yield.