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Effects of some Pretreatments of African Locust Bean Seeds (*Parkia biglobosa*) on Delivered Efficiency of a Devised Dehuller

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Abstract

In West Africa in general and especially in Benin, African locust bean seeds (Parkia biglobosa) were processed and manufactured as various condiments extremely prised and consumed predominantly in sauces. Such condiments, variously named afitin, soumbala, netetu, iru, sonru, depending upon producer countries or zones, were processed using endogenous ten to twelve operation-steps technology including seeds precooking, dehulling of precooked seeds and cotyledons fermentation. Of all these operations, seeds husking constituted the most strenuous or painful and the less hygienic. Another consumers' exigency to accounting for was a particular prized afitin formulation made of entire cotyledons only. To overcome these raised constraints, an experimental sheller plant was devised and realized. The actual article was devoted for analyzing the effects of different applied pre-treatments to locust bean seeds on technical efficiency of this designed mechanical dehuller. The seeds underwent, either hot-water cooking for 1, 2, 3 to 6 hours or fresh water soaking at 30±1°C for 24h, 48h and 72h else hot-air drying at 105°C for 1h, 2h and 3h. Evaluated performance parameters were the dehulling index (I_D), cotyledons yield (R_D), dehulling rate (T_D) and ratio of broken cotyledons (T_B). The results showed that devised apparatus had provided its best performance on the cooked seeds for 4 to 6h. The dehulling indices stabilized around 0.94-0.95, the dehulling rate to 98-99.44%, as ratio of broken cotyledons stagnated below 5% and dehulling yields at 48-52%. The corresponding values from traditional processing method were respectively of 0.93, 97%, 0% and 48.41%.

Keywords: locust bean, precooking, drying, water soaking, dehulling, index, broken ratio.

Introduction

Legumes were usually important proteins source and thus might help increasing proteins intake in African population diet and fight against malnutrition[1-3]. The locust bean tree *(Parkia biglobosa)* was known as leguminous forest widespread in West Africa. Its importance lied in the fact that its seeds provided to West African populations, a range of products used in medicine, traditional medicine and especially in human food following fermentation process in condiments known under different names throughout West Africa countries: *dawadawa* or *iru* in Nigeria, *soumbala* in Mali and Guinea, *netetou* in Senegal and afitin, iru or sonru in Benin[4-6]. This finished product called afitin was widely consumed in Benin, specifically by low-income populations. Locust bean seeds were rich in proteins (30-40%). They also provided significant amounts of carbohydrates (10-15%), fats (15-20%), minerals (4%) and vitamins mainly from Group B[7, 8].

The traditional processing of locust bean seeds in *afitin* followed many operations' steps including: seeds water precooking, dehulling by feet pressing, hull and cotyledons separation, seeds rinsing and sorting, cotyledons boiling and alkaline fermentation. Among these operations, dehulling was known as most tedious and least hygienic. Feet pressing method for dehulling seeds was a main source of contamination of *soumbala* due to introduced animal and biological impurities[9-12].

In attempt to modernize and standardize technology of afitin production, researches have been carried out in several sub-regional countries including manufacture of dehuller for locust bean seeds[13-16]. However, efficiency index of those designed machines did not exceed 0.71 showing that the shelling of locust bean seeds remained highly laborious. Moreover, output values of existing apparatus were relatively low compared with that ensuing from traditional feet shelling process and ratio of broken cotyledons still higher. In Benin, investigations were oriented towards mechanical techniques for reducing the linked difficulties with the traditional process of shelling such seeds. These led to the design of a sheller for dry locust bean seeds[17, 18]. Elsewhere, it's known that the Cajanus cajan and Vigna radiata were classified as leguminous seeds difficult to shell because of the contained mucilage and gum which created an adhesive bridge between hull and cotyledons[19]. It seemed to be the same case for locust bean seeds in which the skin/hull strongly adhered to cotyledons[1]. To husk the locust bean seeds and other leguminous seeds of the same family, the hulls must primarily be disconnected or released from cotyledons before being separated by abrasive means[20]. Releasing of the hulls could be done by submitting such the seeds to appropriate pretreatments such as wet or dry heating or chemical treatments[21]. Once the seeds were dry-heating, their hulls became brittle and could then be easily removed by means of regular frictions on abrasive surfaces[22,23].

This article was devoted to analysis of the effects of three applied pretreatments (water precooking, water soaking and hot-air drying) to locust bean seeds on efficiency characteristics of mechanical dehuller in order identifying the most suitable to be insured for collecting the best sheller performances.

Material and Methods

The reported experiments were partly conducted in laboratory of Programme on Agricultural and Food Technology (PTAA) of National Institute of Agricultural Research of Benin and complementary to a certain extent in Laboratory of Applied Mechanics and Energy (LEMA) of Polytechnic School of Abomey-Calavi (EPAC) / University of Abomey-Calavi (UAC).

Vegetable materials: origin and packaging: The used vegetables seeds were those of African locust bean of Parkia biglobosa variety acquired at International market of Dantokpa - Cotonou (Benin). Such the seeds, as shown on figure 1, belonged to those of all coming quality originated from N'Dali region, in Northern Benin. Approximately 100kg of these seeds were cleaned, sorted and stored in polystyrene bags and kept in laboratories at controlled room temperature of 25±2 °C. The raw seeds of these used variety have been sizes characterized enlightening average dimension values for entire seeds of respectively length 9.26±1.05mm, width 7.59±0.87mm and 4.98±0.55mm thickness[24].

Figure-1
Photography showing the African locust bean: 1- fruits, 2- crude dry seeds in a plate, 3- zoom on crude dry seeds, 4- dehulling of precooked seeds by women in plenty practice of traditional foot pressing method

Experimental equipments: Seeds were dried using a ventilated hot-air oven HOH-EXPRESS HE-50 PFEIFFER. The illustrated apparatus on the photography of figure 2 was the new designed and manufactured dehuller through synergy of researchers from both the University of Abomey-Calavi (UAC) and the National Institute for Agricultural Research of Benin (INRAB). It consisted of a welded frame (WF), a thermal 5-hp internal combustion motor (M) coupled to a shelling cage (SC) by gear transmission mechanism and a feed hopper (FH). The shelling system, main body of produced machine, contained two active plates: a fixed one and a mobile. On each plate, was fixed a grid made of high strength stainless perforated metal sheet. In running, the motor drove the moving plate through gear transmission and the seeds, poured in hopper, were fed into annular space between the two abrasive grids where they were shelled by shear. A mechanism, made of pulley-belt-pulley assembly, drove a fan (FA) that generated sufficient air-flow allowing the separation of the removed slight hulls from the valuable more heavy cotyledons.

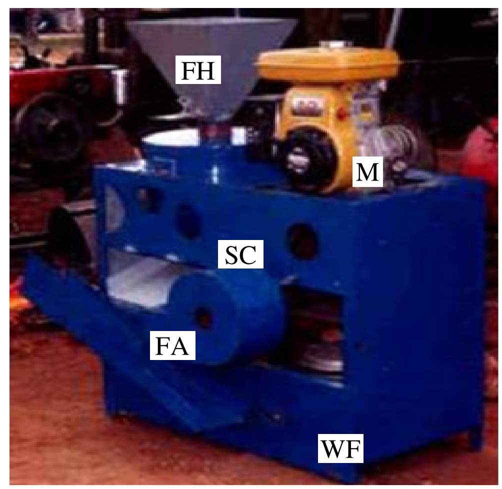

Figure-2
Photography of the new designed dehuller/sheller for the African locust bean seeds with indication of different component

Seeds precooking: The locust bean seeds, taken from the packaged clean stock, were poured in unionized water at a temperature of 30±2°C and rate of 2.5 liters per kilogram and heated on wood fire in aluminum pots. The water and seeds mixture had been carried to boiling point after about 15 min and maintained during each experimental cooking time.

Seven (07) batches of samples, made of 3 kg seeds, coded C_0, C_1, C_2, C_3, C_4, C_5, C_6, were made from packaged stock. Samples in batch C_0 represented the witness and were not subjected to precooking. Batches C_1, C_2, C_3, C_4, C_5 and C_6 were precooked in boiling water, respectively during 1h, 2h, 3h, 4h, 5h and 6h. The cooking time was counted from the boiling point instant.

Seeds soaking: Soaking of seeds was carried out using unionized water at rate of 2.5 liters of water per kilogram seed at room temperature (30±2° C). Four (04) batches of samples of 3 kg seeds (T_0, T_1, T_2, T_3) were made from the same cleaned stock. The seeds sample T_0 was the witness and not subjected to the fresh water soaking. The batches T_1, T_2 and T_3 were water soaked respectively for 24 h, 48 h and 72 h.

Seeds hot-air drying: Hot-air drying of seeds was done in ventilated oven at temperature value of 105±2°C. Four (04) batches of 3 kg seeds (S_0, S_1, S_2, and S_3) were also made from the cleaned stock. Batch S_0 represented the witness while S_1, S_2, and S_3 were oven dried respectively during 1 h, 2 h and 3 hours.

Traditional dehulling process: foot crushing / pressing: The precooked locust bean seeds in a vessel during 12 hours were shelled using the traditional foot-pressing method (reference) as done by shown women in figure 1.4 after addition of sand for improving particles friction.

Each of the described seeds pretreatments, coupled with, as well the mechanical as the traditional dehulling processes, were six (06) times repeated for insuring reliability of the reached results.

The recorded performance characteristics, using this mechanical dehuller, were finally compared to those obtained from the traditional shelling method taken as reference in field. Its choice was linked with the fact that this practice was known as available process coupling satisfactorily the best afitin quality and production yield.

Performance parameters evaluation: For each experimental test series, a seeds sample weight of M_s=500 g was taken. Those collected seeds samples were then manually shelled with the aid of a pair of pliers and separated into four (04) fractions respectively weighed for determining the values of following parameters: mass of whole cotyledons or those cracked in two (M_C), mass of undehulling or partially dehulled seeds (M_U), mass of broken cotyledons (M_B) and mass of resulting hulls (M_H).

One considered that, a seed was dehulled, when about 90% of its hull/shell was removed [25]. The efficiency of a dehuller was evaluated on the basis of the performance parameters such as the dehulling Index (I_D), dehulling Rate (T_D), Ratio of broken cotyledons (T_B) and the dehulling yield (R_D) calculated using the respective following formulas[20, 24-27, 30]:

$$I_D = \left[\left(M_C + M_H\right) - \left(M_U + M_B\right)/M_S\right] \quad (1)$$

$$T_D = \left[\left(M_S - M_U\right)/M_S\right] \times 100 \quad (\%) \quad (2)$$

$$T_B = \left[M_B/\left(M_C + M_B\right)\right] \times 100 \quad (\%) \quad (3)$$

$$R_D = \left[\left(M_C + M_B\right)/M_S\right] \times 100 \quad (\%) \quad (4)$$

The dehulling Index (I_D) was known to allow appreciating global efficiency of a sheller. Theoretical values of I_D lied within [-1, +1] interval. It's equal to -1 in case of a total break of seeds and +1 when perfectly dehulling i.e. without any broken cotyledon and unshelled seed[20, 25-27].

For each set up pretreatment, the water content of seeds was determined according to ISO-662. A seeds sample M_i=5g, ground in a RETCH mill, was taken and subjected to differential oven hot-air drying at temperature of 103±2°C for at least 8 hours, until a constant mass (M_f) reached. The dry basis water content was afterward calculated using initial mass of sample (M_i) and final mass (M_f) with the followed formula:

$$W_{bs} = \left[\left(M_i - M_f\right)/M_f\right] \times 100 \quad (\%) \quad (5)$$

Statistical analyses: The collected data were processed through determination of the mean-values, standard deviations and the corresponding frequencies using the MINITAB-14 software. The dehulling index and rate, the ratio of broken cotyledons and dehulling yield which not followed Ryan-Joiner normality tests and Levene test of variance homogeneity were subjected to the Kruskal-Wallis nonparametric test[28, 29].

Results and Discussion

Effects of applied pretreatments on water content of locust bean seeds: The applied different treatments to the locust bean seeds induced physical changes of which an increase of seeds volume due to waterlogging during tests times. The resulting effects of precooking, drying and soaking treatments as function of time were respectively shown on figures 3, 4 and 5.

During 0 to 6 precooking hours, the seed structure recorded an increase in water content of about 17.60 times its initial value, going from 16.14% to 284.62% (db). The water absorption behavior as function of cooking time ($H_e(t)$) could be modeled by the following trend equation:

$$H_e(t) = 1.215t^5 - 18.12t^4 + 93.03t^3 - 192.0t^2 + 187.8t + 16.14 \quad R^2 \approx 0{,}994 \quad (6)$$

Hot-air drying of the locust bean seeds conversely generated a water content reduction passing from 16.14% to 6.64% (db). Its kinetics ($\boldsymbol{H_S(t)}$) could also be modeled by the trend equation:

$$H_S(t) = 0.966t^4 - 7.232t^3 + 18.45t^2 - 19.51t + 16.14 \quad R^2 \approx 1 \quad (7)$$

During the soaking pretreatment, the seeds water content increased from 16.14 to 96.75% (db). The recorded behavior, as a function of the soaking time ($\boldsymbol{H_t(t)}$), could be modeled by the following trend equation:

$$H_t(t) = 0.00009t^3 - 0.003t^2 + 0.907t + 16.14 \quad R^2 \approx 1 \quad (8)$$

Analysis of technical performances of dehuller: The collected results from measurements of the dehulling rate and index, the ratio of broken cotyledons and the dehulling yield (machine yield) of the pretreated seeds, respectively by water precooking, drying and water soaking, as function of times were those gathered in the table 1.

The values of parameters were compared to those ensuing from the dehulling of locust bean seeds by traditional process using the feet crushing/pressing. Analysis of such the recorded results drove to the following three conclusions. First, the devised dehuller provided its best performance with precooked seeds during 3 to 6 hours compared to the other screened times in this applied pretreatment. Maximal values for performance parameters were those obtained from precooked the locust bean seeds during about 4 hours: I_D=0.95±0.01 and T_D=98.64±0.56%. Second, the recorded values for the shelling index (I_D) and shelling rate (T_D), using this devised dehuller were respectively I_D=0.81±0.11 to 0.95±0.01 and T_D=64.07 to 99.44±0.64%. They were slightly higher than those obtained from the traditional process: I_D=0.93±0.04 and T_D=96.59±1.02%. Ultimately, we could retain that the dehulling index resulting from 4 to 6 hours cooking times was approximately as the same order as that ensuing from the traditional feet crushing, taken as reference;

Third, the provided dehulling indexes (I_D) by the designed sheller, using the soaked seeds at 30°C during respectively 24, 48 and 78 hours on one hand, and the untreated (raw) seeds on the other, exhibited negative values.

This made known that, it had resulted in a very bad shelling which including a significant proportion of broken seeds and cotyledons. Nevertheless, it could be noticed that the dehulling indexes (I_D) of soaked seeds (-0.42 ± 0.14 to -0.58 ± 0.11) were higher than those for crude or untreated seeds: 0.69 ± 0.06. Such results appeared as normal and could be explained by the fact that, the soaking process had even so induced some slight effect on seeds especially through the water absorption compared with the not soaked.

The acquired value for dehulling rate (T_D) was quite low regarding to the untreated seeds (41.46 ± 3.19%) and soaked seeds (between 31.66% and 45.19%). The results confirmed that, both the two seeds kinds, untreated and soaked ones, were not suitable for the new devised dehuller.

The collected data, from the subjected seeds to drying process during 2 to 3 hours, seemed interesting for showing relatively high shelling rates: 89.50±2.88 and 98.02±0.02. However, those recorded values were antagonized because of the associated lower shelling indexes.

On the basis of those first two technical criteria (shelling index and rate), the obtained results revealed that, water cooking the studied seeds was the best pre-treatment to be ensured. However, the two criteria alone were not sufficient to absolutely adopting the water cooking process for African locust bean seeds. This could only be established if the previous performances parameters were enhanced by the two other important ones: feeble ratio of cotyledons broken (T_B) and higher dehulling yield (R_B) like reference.

The recorded experimental results for performance parameters T_B and R_D were those shown in the last two columns of the table-1. The analysis of those acquired data could permit us drawing the following two conclusions. Firstly, the dried seeds for 2 and 3 h and the cooked seeds for 3, 4, 5 and 6 h exhibited shelling outputs (R_D) similar to those from traditional process: between 47.76±2.91 and 51.91±2.94%. The highest values were those obtained using cooked seeds for 4 to 6 h. Secondly, the lowest shelling outputs values have been recorded from untreated crude seeds and soaked ones: between 13.26±1.66 and 20.43±2.26%; In addition, the dried seeds and soaked ones have shown higher ratios of broken cotyledons during their shelling. The recorded values were respectively from 31.92±3.19 to 61.95±0.96% and 71.51±1.76 to 82.64±2.79. The previous values were not comparable, neither to those ensuing from traditional process (almost zero), nor to resulting ones from water-cooking the seeds during 3, 4, 5 and 6 h which break rates inferior to 5%.

Finally, precooking of seeds for 4, 5 and 6 hours allowed reaching the highest values of shelling indexes: from I_D=0.94±0.04 to 0.95±0.01. Those obtained values for the dehulling indexes were higher than that ensued from traditional process: 0.93±0.04. It's important to notice that, these reached values for shelling indexes were better than that of 0.70 provided by all of the designed dehullers respectively in Nigeria for steamed seeds and in Burkina Faso for dried seeds[8, 13-16]. Let's notice that the latter value of shelling index (0.70) was similar to the one acquired in the current work using the dried seeds at 105 °C for 3 h showing I_D of 0.72±0.06.

Analysis of those experimental results suggested us that, during precooking of seeds, the latter were subjected to the combined actions of heat and excess water which generated weakening of seeds hulls and then facilitated their husking. Such conclusions well corroborated those postulated by Phirke and Bhole [21]. Hulls of leguminous seeds could be disjointed from their cotyledons before shelling, if pre treatments like drying or moist heating were applied to seeds, concluded the authors. Interest of actual results resided in the fact that, it was established that, through reduction of cooking time of about 50 to 66% on traditional method basis, the mechanical dehuller furnished the values of dehulling indexes as higher as that ensuing from the feet pressing. Approval of the devised equipment by producers women could permit, not only dehulling drudgery reduction, the original purpose of current work, but might also offered some economic and environmental advantages, chiefly through diminution of both the cooking time and subsequent equivalent wood-energy consumption.

From the done experiments series of hot-air drying the locust bean seeds at 105°C, those for 3 hours gave the most satisfactory results. At these set up operational conditions, the mean-values of dehulling index and dehulling rate were respectively of I_D=0.72±0.06 and T_D=98.02±0.02%. The acquired data for both two parameters showed generally very low values compared with those from precooking of the same seeds.

The series of tests whose results were disclosed in table 2 was to explore complementary therapies to ensure the dried seeds for improving the technical performance of the inner huller-grids. Indeed, those displayed results in table 2 confirmed that, all the applied pretreatments to African locust bean seeds in current investigation really improved, to some extent, the technical performances of mechanical dehulling process compared to those obtained from the untreated raw or crude seeds.

Table-1
Recorded values for delivered performance parameters of the designed dehuller for African locust bean seeds and those ensued from the traditional feet crushing method

Applied dehulling techniques	Seeds Pretreatments Time (hour)	Dehulling Index	Dehulling rate (%)	Broken cotyledons ratio (%)	Dehulling yield (%)
1-Designed dehuller	**Untreated** (-)	-0.69±0.06	41.46±3.19	39.86±2.06	13.26 ± 1.66
	Cooking (1h)	-0.32±0.15	45.15±13.67	36.18±4.55	23.09 ± 6.60
	Cooking (2h)	0.25±0.01	74.32±2.93	26.21±3.72	37.28 ± 5.70
	Cooking (3h)	0.81±0.11	94.07±5.07	1.20±1.38	48.38 ± 4.70
	Cooking (4h)	0.95±0.01	98.64±0.56	0±0	48.73 ± 3.12
	Cooking (5h)	0.94±0.04	96.17±2.00	4.12±1.05	48.67 ± 2.70
	Cooking (6h)	0.94±0.06	99.44±0.64	4.59±1.55	51.91 ± 2.94
	Drying (1h)	-0.23±0.01	65.63±3.03	61.95±0.96	38.68 ± 3.09
	Drying (2h)	0.09±0.07	89.50±2.88	60.25±2.59	49.00 ± 1.15
	Drying (3h)	0.72±0.06	98.02±0.02	31.92±3.48	47.76 ± 2.91
	Soaking (24h)	-0.42±0.14	40.22±9.44	77.50±2.80	14.02 ± 2.96
	Soaking (48h)	-0.58±0.11	35.66±3.11	71.51±1.76	13.52 ± 2.63
	Soaking (72h)	-0.50±0.05	45.19±3.75	82.64±5.79	20.43 ± 2.26
2-Feet crushing	**Cooking** (12h)	0.93±0.04	96.59±1.02	0 ± 0	48.41 ± 4.38
Probability		0.00	0.00	0.00	0.00

Table-2
Values of the technical performances of the designed grids dehuller and those ensued from the traditional foot husking method using the separate or combine/mix treated seeds.

Applied dehulling processes	Applied treatments (separate or combine) to seeds	Dehulling index	Dehulling rate (%)	Broken cotyledons ratio (%)	Dehulling yield (%)
1-Designed dehuller	Untreated (-)	-0.69 ± 0.06	41.46 ± 11.19	39.86 ± 22.06	13.26±1.66
	Drying (3h)	0.72 ± 0.057	98.02 ± 0.019	31.92 ± 3.48	33.76±2.91
	Cooking (4h)	0.95 ± 0.011	98.64 ± 0.56	0.00	45.73±3.12
	Drying 1h + Soaking 24h	0.52±0.03	81.33±1.26	24.17±3.71	42.83±1.26
	Drying 2h + Soaking 24h	0.87±0.02	97.83±0.98	15.05±4.65	43.5±2.42
	Drying 3h + Soaking 24h	0.51±0.12	80±6.13	28.45±7.16	27.83±4.30
	Drying 3h + Cooking 1h	0.62±0.06	85.33±2.58	21.51±5.10	38.16±3.48
	Drying 3h + Cooking 2h	0.70±0.04	88.66±1.21	17.15±5.22	37.5±1.64
	Drying 2h + Cooking 1h	0.69±0.11	88.23±2.48	22.51±5.10	39.16±2.23
	Drying 2h + Cooking 2h	0.89±0.02	98.66±1.1	14.25±3.5	44.16±1.2
	Drying1h + Cooking 1h	0.57±0.06	75.33±2.51	19.22±4.10	39.26±1.65
	Drying 1h + Cooking 2h	0.71±0.11	87.24±2.23	25.57±4.15	40.16±2.54
2-Traditional feet crushing	Cooking (12h)	0.931± 0.02	96.59 ± 1.02	0.00	48.41±4.38
Probability		0.001	0.00	0.002	0.00

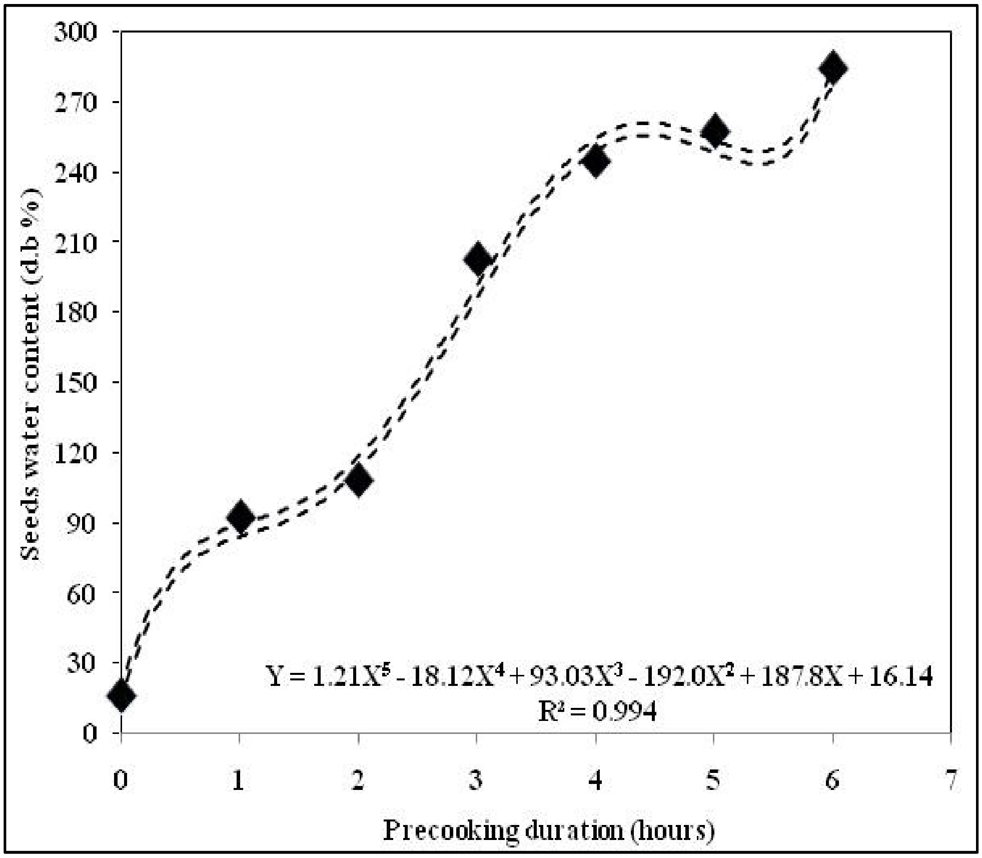

Figure-3
Effects of precooking, as function of time, on the water content of the cooked locust bean seeds

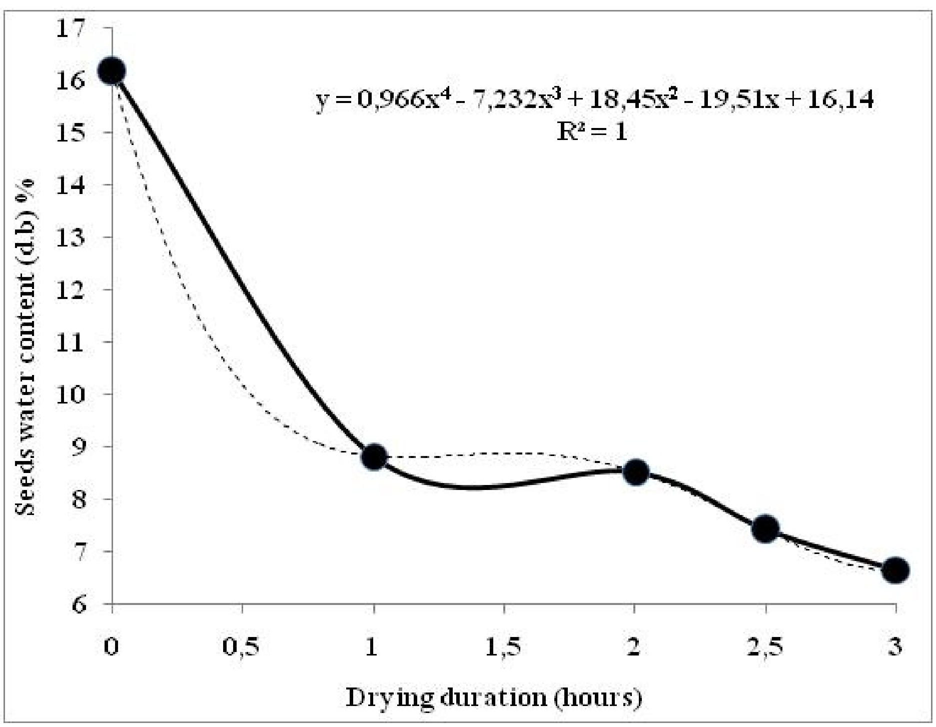

Figure-4

Effects of drying, as function of time, on water content of the dried locust bean seeds

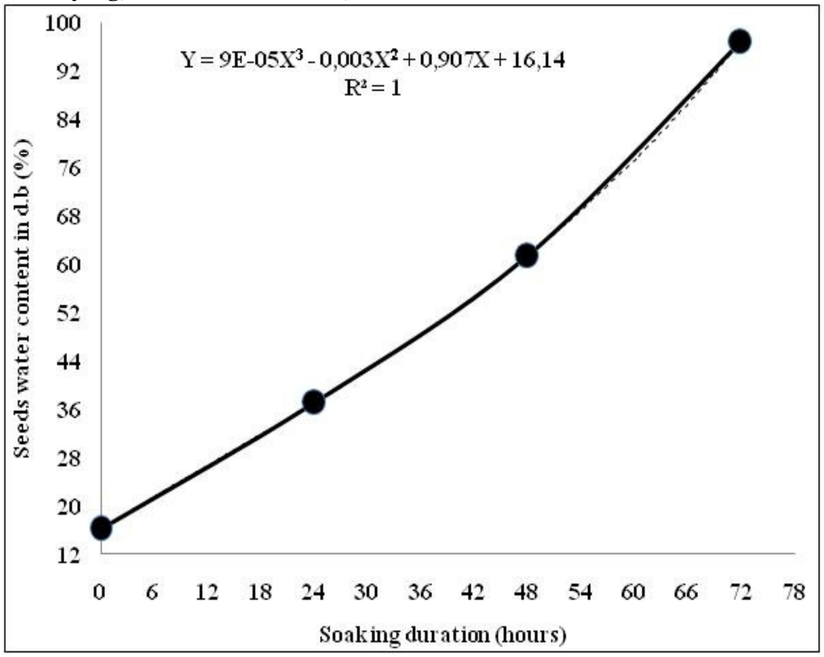

Figure-5
Effects of the fresh water soaking, as function of time, on water content of soaked locust bean seeds

Water soaking treatment series, conducted at room temperature of 30±1°C, showed a little effect on seeds, especially on weakening of their hulls. This set up low value for temperature in water soaking of seeds, coupled with the chosen soaking times of 24, 48 to 72 hours, was insufficient for provoking a breaking down of hull – cotyledons adherence of seeds structure. It's what probably explaining this obtained low dehulling rates when using the soaked seeds: 35.66±3.11 to 45.19±3.75% contrasting with those resulting from cooked seeds (higher than 96 %) and 3 hours dried seeds (98.02%). Let's however mentioning that, the soaking duration had not been extended beyond 72 hours. This was justified by the fact that one wanted to avoid any possible grow of microorganisms which metabolic activities could damage seeds at operating temperature of 30°C. The seeds germination also ought to be avoided[32,33,34]. Condiments like afitin in local language "Fon" and iru in "Yoruba" consisted of wet products contrary to those sun-dried in Northen Benin. Characteristic of more popular afitin presentations in Benin was a higher entire cotyledons fraction[3]. A dehulling method that gave relative high broken cotyledons proportion was not accepted by processors women of locust bean seeds. It delivered, not only some afitin with a low cotyledons fraction, but also caused loss of broken cotyledons, especially during hulls – cotyledons separation step using washing sludge. Its consequence was the decrease of dehulling yield. Consumers distinguished the good afitin in finding entire cotyledons in sauces[3]. Thus, to facilitate adoption of devised mechanical dehuller, precooking the locust bean seeds for 4 hours was recommended. Such a treatment allowed, not only having a high dehulling index, but also a finished product of low broken cotyledons fraction. Acceptability test performed on produced soumbala from dried seeds and mechanically shelled was made in Burkina Faso. Let's notice that, such treatment had been applied to sheanuts prior to their dehulling [30]. Results for African locust bean seeds showed that, although obtained soumbala, using seeds dehuller, had a more attractive color and a less strong smell compared to the one gotten from traditional shelling, it was less preferred to the latter[7]. This recorded consumers behavior had been attributed to the fact that organoleptic characteristics of traditional *soumbala* were rooted in Burkinabe habits. Changes in soumbala organoleptic characteristics were imputed to high proportion of broken cotyledons in mechanically shelled seeds. It was said that high ratio of broken cotyledons in afitin provoked more rapid growth of fermenting bacteria[7]. Thus, in view of avoiding such a thing, introduction of dehulling equipment in afitin processing chain end resulted in rejection of finished product by consumers. It could finely be conclude that, precooking the locust bean seeds for 4 to 6 hours was the most appropriate pre-treatment. Subsequently, economic analysis might then permit selecting the most appropriate applying time. This presumably justified the traditional knowledge practice of old producer women consisting on precooking the locust bean seeds further than 12 hours. Although the major drawback was the higher consumption of water and wood quantities, precooking of seeds permit their water stuffing and subsequent mass increasing. Previous researches on African locust bean have shown that precooking seeds for 6 hours increased the 100-seeds weight from 23 to 51g and that of 100-cotyledons from 17 to 33g [30]. Similar results have been obtained on sheanuts [31]. The yield of produced afitin was also a crucial factor for processor women. It's then important to finding optimal value of cooking duration that furnished a good shelling rate coupled with a good yield of afitin. The yields of afitin production (dissimilar from that of dehulling) in Fon and Yoruba regions of Benin varied within 85.6 and 94.8% [12]. It's important that introduction of mechanical sheller and cooking time reduction driving to those reference values achievement in order rising probability of approval of the proposed dehuller. The cooking time could also be increased or reduced, according to whether the available seeds came from harvests of new or old season. The obtained 4 to 6 hours parboiling time was that arising from African locust bean seeds of moisture value of 16.14% (db). Case of soumbala, a dry finished product, it was recommended shelling dried seeds during 4 hours after 5 hours soaking them. Case of afitin or iru, results of current study rather suggested usage of 4 to 6 hours precooking of the African locust bean seeds.

Conclusion

The technical efficiency of dehuller, assessed through established parameters such as dehulling index, rate and output and broken cotyledons ratio, was evaluated using precooked, soaked and dried locust bean seeds. The experimental results showed that water cooking was the suitable pre-treatment for best shelling the locust bean seeds. Subsequently, best performances of designed dehuller were obtained for 4 to 6 hours precooked seeds. If the cooking time lesser than 4 hours, efficiency of dehuller did not reach the reference value ensued from traditional feet shelling process. The prospects for reported investigation were oriented towards the effects of ashes addition to the cooking water, an old practice in processing of locust bean seeds by producer women. The use of ash was suspected to have some helpful effects on seeds cooking time but also on shelling efficiency improvement.

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