Centre for Research and Development (CERAD) *JoST 2014*
The Federal University of Technology, Akure, Nigeria

Fabrication of a novel semi-mechanised dehuller for the production of "Iru" condiment from two leguminous plants

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ABSTRACT: Conventionally, protein-rich leguminous seeds are either traditionally cooked and consumed as typical African diets or added as supplements to high starchy cereals, tubers or fruits to enhance the nutritional status of the most vulnerable groups, especially in tropical regions of the world. The main focus in this work, was to fabricate a semi-mechanised, relatively low cost, cottage adaptable machine aimed at reducing drudgery and limiting health risks involved in the traditional processing or and consumption of Iru. Cooked raw *Parkia biglobosa* beans or well soaked yam beans were dehulled with the machine that was constructed. Seeds were fermented and subjected to proximate, minerals and soluble vitamins analyses using conventional methods. There was a decrease in the carbohydrate content of fermented product fermented locust bean (FLB) (22.82%) and fermented yam bean (FYB) (11.64%) compared with the unfermented products. Fermentation of the beans caused remarkable reduction in phosphorus (FLB 3.36% and FYB 1.41%) and sodium (FLB 7.1% and 4.27) compositions. There was a general trend of increase in the vitamins in FLB and FYB samples as a result of fermentation. There were remarkable increase in niacin (FLB 211.8mg/ml and FYB 179.45 mg/ml) pyridoxine (FLB 484 mg/ml and 358.05 mg/ml) and ascorbic acid (vitamin C) (FLB 216.18 mg/ml and 200.86 mg/ml) in iru samples due to fermentation. The newly fabricated machine, in its rudimentary form has been found to reduce the health risks and intensive labour commonly associated with cultural process of foot-dehulling.

Keywords: Parkia biglobosa, yam-beans, iru, machine

JoST. 2014. 5(1): 50-57.
Accepted for Publication, August 05, 2014

INTRODUCTION

Conventionally, protein-rich leguminous seeds are either traditionally cooked and consumed as typical African diets or added as supplements to high starchy cereals, tubers or fruits to enhance the nutritional status of the most vulnerable groups, especially in tropical regions of the world. Some other legumes such as *P. biglobosa* beans, will have to be processed into secondary products, such as Iru or Daddawa served as a flavouring agent in soups and are referred to as condiments (Kolapo *et al*., 2007), Saumbala in Burkina Faso (Ouoba *et al*., 2003) and Oso in some part of South Western Nigeria (Popoola *et al*., 2007)

The most popular raw materials used for producing Iru are the seeds of the plant *Parkia biglobosa*, family leguminosae, and sub-family Mimosoideae. The African yam bean, on the other hand, is not popularly known for Iru production. African yam bean, *Sphenostylis*

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stenocarpa (Hochst ex A. Rich) Harms in the recent time has become a subject of research (Abbe and Berezi , 1988; Agunbiade and Longe , 1996 ,1998, 1999 ; Agunbiade *et al.* , 2011). As at now, yam bean is among the world's fastest rising new crops (Agunbiade *et al.*, 2011). Both African locust and yam beans are commonly found in many parts of West Africa, including Nigeria, Burkina Faso, Ghana and the Caribbean island (Hopkins, 1983), Both plant seeds share in common, hard, glossy testa and hard to cook culinary property. African yam bean can be cooked and eaten as a pulse whereas the locust bean is not amenable to that type of use. Traditional and modified methods of production of this fermented product have been documented. These have been shown to have effects on the qualities of the product (Farinde *et al.*, 2007). Owolabi *et al.* (2012) showed the improved varieties to have significantly higher protein content compared to the local varieties. The lower carbohydrate and fat content was shown to be desirable in diabetic patients.

The main focus in this work was to fabricate a semi-mechanised, relatively low cost, cottage-adaptable machine aimed at reducing drudgery and limiting health risks involved in the traditional processing of Iru.

MATERIALS AND METHOD

Study area

The African locust beans used in this study were purchased from Bodija market in Ibadan, Oyo State, Nigeria while the African yam beans were obtained from Esa-Oke, Ilesa area, in Osun State of Nigeria.

Pre-treatments of both beans

Both raw beans samples were cleaned by manually removing of extraneous matter, including weevil-damaged seeds. For the locust beans, wood ash is required to remove the sugary yellow fruit cover on the dark seeds. This is to facilitate softening and removal of testa after the first cooking step, usually done overnight with fire wood. The unit operations needed for producing iru from yam bean include soaking overnight after pre-boiling to soften hulls before dehulling.

Dehulling of cooked/soaked beans

The most critical unit operation, requiring a very serious attention, is the dehulling of cooked bean with feet. In this operation, the stubborn testas are separated from cotyledons (the edible portion). An Iru dehuller was constructed with inexpensive metal plate and rods. It consisted of the body (chute) with cover, lead hole and top lead. Inside the chute are the metal stirrers (shafts), held in position by a metal handle. The entire machine is mounted on metal tripod stands. Well cooked *Parkia biglobosa* beans or well soaked yam beans were discharged through top lead into the machine, the handle was manually rotated clockwise. In this rotational movement, the stirrers provided rubbing effect on pre-cooked beans, by so doing the hulls were separated from the cotyledons. Both lead and the chute were thrown open and the dehulled beans were discharged into a plastic container. Then with hands the shredded testas were floated in water to facilitate the separation from cotyledons. The beans were then thoroughly washed and cleaned. After the removal of the testa the beans were cooked and fermented.

Fermentation stage

Cooked, dehulled beans were divided into two parts, one not fermented and the other fermented. The portion for fermentation was discharged into perforated plastic bowl layered with Jatropha leaves (as aid to fermentation) covered with the same and kept in laboratory cupboard for 72 hr. The fermented product at this point may be referred to as iru not seasoned or preserved with common salt.

Chemical analysis

Proximate analysis

The proximate compositions of the unfermented and fermented beans were carried out by AOAC methods (2012). Crude protein was determined by multiplying crude nitrogen with 6.25, while total carbohydrate was calculated by difference.

Determination of minerals

Potassium and sodium contents of samples were determined with flame photometer. The levels other minerals of samples were estimated using Atomic Absorption Spectrophotometric Technique after digestion with concentrated nitric acid (AOAC, 2000).

Determination of water soluble vitamins

Water soluble vitamins were determined by HPLC method of Denter and Bisping (1994). In brief, the HPLC was used to separate the individual vitamins from the other components. Using a fluorescent detector, the vitamins contents were then calculated from the standard curve of the peak area plotted against the known concentration of an external standard.

RESULTS AND DISCUSSION

Plate 1 represents the schematic drawings of newly developed machine used in this study. Some previous fabricated dehulling machines for Iru production have proved to be sophisticated, expensive and non-adaptable to cottage use. This manual, simple to operate machine is designed to be cost effective, and capable of drastically reducing drudgery and all attendant problems with which traditional method is beset.

The cultural foot dehulling system is not only labour intensive but also is fraught with dangers. The concrete (cemented) lawn on which dehulling is done may harbour contaminants or dirt such as aerosols, animal dungs, insect parts, especially when the lawn is not properly cleaned before use. Macro contaminants are not easily detectable and removable in cultural foot dehulling system. The Iru producer may carry some disease germs resulting from lesions, boils, ulcers, sours on the legs/feet. Personal cleanliness may not be hundred percent guaranteed. Sources of water at best may be streams, and shallow wells. Irrespective of the sources of water, it is certain that the vigorous cooking step could eliminate any water-borne pathogen. During dehulling exercise, a local iru processor may slip, fall off and be injured. This innovation has considerably reduced the time constraints, the chances of transmission of contagious diseases and the likelihood of injuries that are often encountered in foot dehulling traditional method.

Table 1 shows the effects of fermentation on the proximate compositions of cooked African locust and yam beans. The crude protein content of FLB and FYB increased by 10.67% and 9 % respectively compared with the unfermented products. There was also increased crude fat of the fermented products FLB (11.25%) and FYB (0.08%) compared with the unfermented. Increased crude fibre FLB (0.97%) and FYB (3.27%) was also observed. A decrease in ash content of FLB (0.06%) and FYB (0.76%) was observed in this study. There was a decrease in the carbohydrate content of fermented product FLB (22.82%) and FYB (11.64%) compared with the unfermented products. Dry matter of both 'iru' samples ranged from 60-90 %. Fermentation increased the fat content of the seeds. However, the fat content of FLB (28.47%) was higher than that of FYB (3.28%). In total agreement with the present work increase in crude protein, fat and fibre values of fermented legumes and other

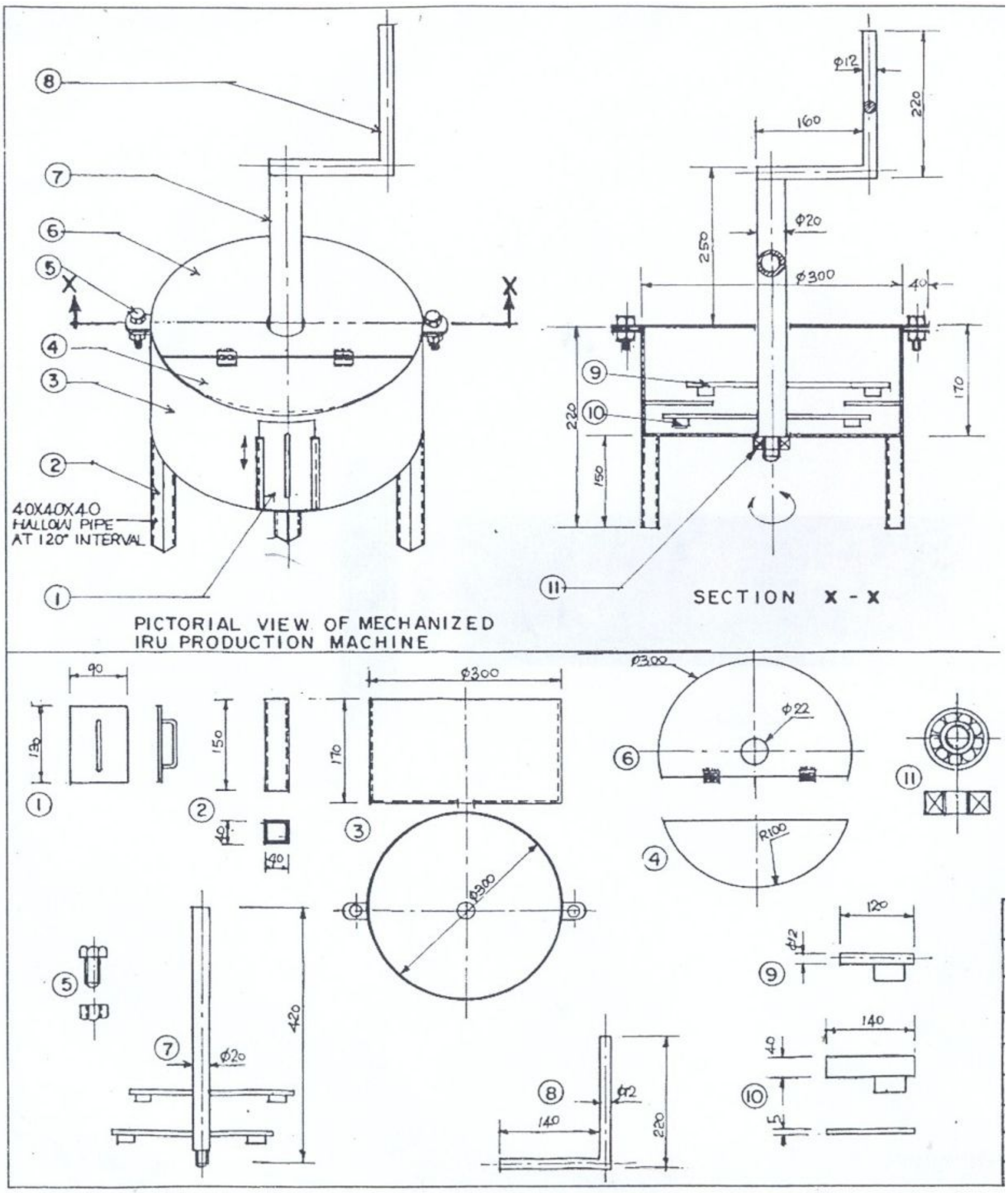

Plate 1: Schematic Drawing of *Iru* Dehulling Machine

LEGEND							
S/N	**Description**	**Material**	**Quantity**	**S/N**	**Description**	**Material**	**Quantity**
1	Chute Cover	Mild Steel	1	7	Shaft	Mild Steel	1
2	Leg	Mild Steel	3	8	Stirrer Handle	Mild Steel	1
3	Body	Mild Steel	1	9	Stirrers	Mild Steel	2
4	Lead Hole Cover	Mild Steel	1	10	Stirrers	Mild Steel	2
5	Bolts and nuts	Mild Steel	3	11	Ball bearing	Mild Steel	1
6	Top Lead	Mild Steel	1				

Table 1: Proximate composition (in percentage) of cooked unfermented and fermented African locust and yam beans.

Sample	Dry matter	Protein	Ash	Fat	Fibre	Carbohydrate
CLB	79.81±1.32	34.08±1.20	3.56±0.30	17.22±1.02	3.50±0.60	41.64±1.76
CFLB	68.79±1.56	44.74±2.0	3.50±0.20	28.47±1.65	4.47±0.30	18.82±0.86
CYB	63.55±2.65	22.70±1.50	3.78±0.50	3.20±0.04	5.62±0.40	64.70±2.16
CFYB	59.60±2.50	31.77±2.60	3.02±0.10	3.28±0.03	8.87±0.6	53.06±1.45

Values are means ± standard deviation of duplicate readings
Keys: CLB= Cooked unfermented locust bean CFLB=Cooked fermented locust bean (Iocust bean iru)
CYB= Cooked unfermented yam bean CFYB=Cooked fermented yam bean (yam bean Iru)

foods have also been reported (Eka, 1980; Wokoma and Aziagba, 2001; Ajuebor *et al*., 2004; Omafuvbe *et al*. 2004; Olusola and Odunfa, 1989; Fadahunsi and Olubunmi, 2010). There has been some report on isolation of *Bacillus subtilis* known to be involved in the breakdown of carbohydrate during iru fermentation (Odunfa, 1981). *Bacillus subtilis* has, however, been found to be amylolytic (Kiers *et al*., 2000; Omafuvbe *et al*., 2000). The observed reduction in percentage carbohydrate in this study may be due to hydrolytic enzymes produced by *Bacillus subtilis*, that caused the release of fermentable sugars. These easily utilisable substrates may be used by microorganisms as energy source in fermentation process (Odunfa, 1983; Omafuvbe *et al*., 2004).

The mineral composition of cooked fermented and unfermented beans is presented in Table 2. Fermentation of the beans caused remarkable reduction in phosphorus and sodium compositions. There were generally marginal decrease of FYB and FLB respectively as follows K (0.29 and 0.63%), Mg (0.01 and 0.27%), Ca (0.05 and 0.13%), Fe (0.43 and 0.44mg/kg) and Zn (0.48 and 0.80mg/kg) compared with the unfermented products. In the case of Mn there was an increase of 0.25mg/kg and 25mg/kg for FYB and FLB respectively. Of particular interest in this work was the exclusion of common salt as a preservative and sweetener to fermented iru. Generous addition of salt to iru produced traditionally may poses a health risk to hypertensive patients which may aggravate the health condition. Considerable reduction in Na resulting from iru fermentation is an added advantage. Iru, as produced in this study may thus be consumed by such individuals without fear of intake of high Na. Since hypertension is also a complication of diabetes, such individuals

Table 2: Mineral Composition of Cooked, Dehulled Unfermented and Fermented African Locust and Yam Beans

	P	Na	K	Mg	Ca	Mn	Fe	Zn	Cu
	%					mg/kg			
CLB	6.57	13.21	3.56	2.28	0.68	59.00	10.32	11.06	26.00
CFLB	3.21	6.11	2.93	2.01	0.55	87.00	9.89	10.26	15.11
CYB	4.37	5.24	5.63	0.29	0.38	100.00	2.76	2.81	93.00
CFYB	2.96	0.97	5.34	0.28	0.33	102.25	2.32	2.33	76.00

Keys: CLB= Cooked unfermented locust bean CFLB=Cooked fermented locust bean (Iocust bean iru)
CYB= Cooked unfermented yam bean CFYB=Cooked fermented yam bean (yam bean Iru)

Table 3: **Water Soluble Vitamins of Cooked Unfermented and Fermented African Locust and Yam Beans**

Sample	Vitamins (mg/ml)				
	Niacin (B3)	**Pyridoxine (B6)**	**Riboflavin (B2)**	**Thiamine (B1)**	**Vitamin C**
CLB	1.07	0.01	0.01	0.01	10.88
FLB	212.87	484.01	21.21	3.46	227.06
CYB	1.00	0.01	0.01	0.01	06.68
FYB	180.45	358.06	19.30	2.89	207.54

Keys: CLB= Cooked unfermented locust bean; CYB= Cooked unfermented yam bean; CFLB=Cooked fermented locust bean (Iocust bean iru); CFYB=Cooked fermented yam bean (yam bean Iru)

may also consume these products with little risk of onset or aggravating the complication.

Reduction in ash / mineral composition of Iru seeds during fermentation has been established in this work. This result may be due to the involvement of minerals as cofactors during enzymatic activities of the resident microorganisms in total agreement with previous reports (Alabi *et al.,* 2005; Daramola *et al*., 2009).

Table 3 shows the water soluble vitamins of cooked unfermented and cooked fermented African locust and yam beans. There was a general trend of increase in the vitamins in FLB and FYB samples as a result of fermentation. There are remarkable increase in niacin, pyridoxine and ascorbic acid (vitamin C) in iru samples due to fermentation. Synthesis of riboflavin and thiamin were, however very much less than others. In support of the present findings, there are reports that water soluble vitamins also have been found to be appreciably synthesized by microorganisms in fermented foods and some Oriental diets produced from soya and wheat (Agunbiade *et al*., 2013; Hasaan *et al.*2014*,*). 'Iru' products obtained in this study have nutritional advantage. Increase in vitamins are important especially where vitamin deficiencies occur and where fortification of foods with synthetic vitamins is not in practice. In this study water soluble vitamins might have been synthesized by microbial fermenters. Microorganisms are known to differ in ability to synthesise vitamins. Some organisms may require vitamins for growth in substrates.

CONCLUSION

The newly fabricated machine, in its rudimentary form has been found to reduce the health risks and intensive labour commonly associated with cultural foot-dehulling. The gadget could later enjoy further improvement to enhance increased efficiency, availability and affordability at cottage level where it will be most gainfully employed. This study has also provided a platform for conscious consumption of Iru by individual with some health challenge with little fear of aggravating their condition. The nutritional potential of iru without added salt may be encouraged.

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