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CONFERENCE PROCEEDINGS

FIRST AFRICA-USA INTERNATIONAL CONFERENCE ON MANUFACTURING TECHNOLOGY

SHERATON HOTEL, IKEJA,
LAGOS, NIGERIA

JANUARY 11-14, 1993

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CONFERENCE BACKGROUND and SIGNIFICANCE

Engineers, Scientists, Managers, Researchers, Chief Executives, Administrators, and Students have come together to participate in the First Africa-USA International Conference on Manufacturing Technology. This conference represents the first international congregation of professionals interested in the advancement of Manufacturing Technology in Africa. Forward and reverse manufacturing technology transfer between the USA and Africa has become imperative for global competitiveness in the new world market place. Some of the problems of developing countries, such as those in Africa, cannot be successfully addressed until these countries are able to implement appropriate new and advanced industrial technologies. Transfer and local adaptation of manufacturing technology are essential to making each country self-sufficient in terms of industrial activities. It is clear that economic, social, and political progress of Africa can be advanced by encouraging the creation of local industries that can employ the growing population, cater to the needs of the population for local consumer goods, establish export products, and stimulate foreign investment and corporate presence in Africa.

This conference provides a forum for the exchange of information and ideas between indigenous professionals in Africa and professionals in the western world. This exchange could form the catalyst for increased dialogue and awareness of manufacturing technology and its role in the development and economic stability of Africa.

TABLE OF CONTENTS

"DESIGN AND CONSTRUCTION OF SHEABUTTER EXTRACTION MACHINE FOR RURAL AREAS IN THE DEVELOPING COUNTRIES" (AUSAC#1-037)

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ABSTRACT

Both industrial and domestic applications of oils/fats have necessitated lipids research and the best method of extraction. The design and construction of the sheabutter extractor was made with the view of improving the nutrients in sheabutter. The construction was made within the available local raw materials. The extractor which is portable and manually operated, is meant to serve rural areas in the developing countries.

The sheabutter extractor was tested and was found to be satisfactory.

INTRODUCTION

The sheanut, grows on semi-wild medium size tree, in the savannah zone where rainfall is not excessive. The tree begins to bear fruits at 12-15 years and reaches full bearing capacity at 20-25 years. It grows to a height of 9.14-12.19 metres and has a thick trunk with a number of spreading branches, which form a dense crown. It has a rough black bark which is almost round in shape. The fruit produced which tastes like pea is "egg-shaped" (oval) with a stony hard nut containing considerable quantities of oil (Koku, 1989).

Here in Nigeria, sheanuts are available in large quantities in Duhu; Mickika, and most part of the Northern states of Nigeria.

Shea oil is used in some parts of Africa as cooking oil, ointment, and also as a raw materials for soap and cosmestics industries. In the other parts of the world, it is used for production of butter. The cake can be used as a base for dyes or as a water-proof when applied to clay house and can also be used as animal feed, applied as fertilizer and burned as fuel. The resulting ashes can be used to for potash production as reported by (Koku, 1989).

According to Shukla and Pandy, (1982) and Bokhari and Ahmed, (1990) the sheanut contains 50-55% of sheabutter. It has been traditionally processed into butter in unit operation. The traditional procedures are inefficient since only 25-27% of oil is extracted from the nut as reported by (Koku, 1989). It has become necessary to improve the processing techniques in order to increase the yield and quality. Other extraction methods are efficient but have numerous set backs.

For example, solvent extraction gives higher yield but the hydrocarbon compounds are expensive. It is a batch process and operates on intermittent basis. It takes longer time for a given sample, hence rate of extraction is greatly reduced.

Hydraulic press is simple. Total time to load the press, apply the pressure and remove the cake is approximately an hour. Drainage of the oil while under pressure may require 30-45 minutes according to Shukla and Pandy, (1982). Hence it is labour intensive with low rate of production.

It must be noted that pre-pressing conditions such as particle size, heating temperature, heating time and moisture content affect the yield and quality of the oil during extraction. In order to improve upon the traditional method of extraction of sheabutter an extractor that can be mechanically operated in the rural area where electricity may not be available was designed and constructed.

This paper therefore, summaries the main themes of the current quantitative design procedures for this sheabutter extraction machine for rural areas in the developing countires using local raw materials.

2. DESIGN PROCEDURE

At present there is not known commercial plant that processes sheanuts in Nigeria. The production of the butter has therefore been based on the traditional procedures. Figure 1, shows the traditional method of extracting butter as done in Duhu.

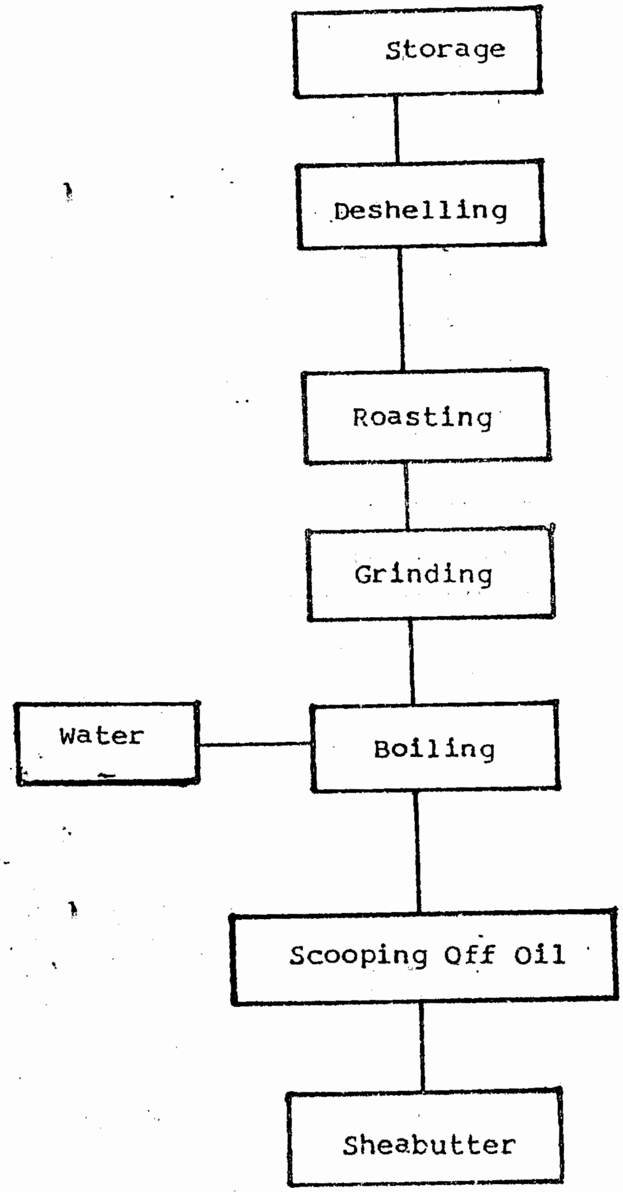

Fig.1 Traditional Procedure for the Production of Sheabutter.

The sheanuts are collected and stored for extraction. The outer coats of the nuts are removed by hammer or otherwise and the seed meat is roasted. The roasted meat is pounded to fine paste in a wooden mortar. Large quantity of water is added to the paste and is subjected to heating. The floating oil is collected and is further subjected to heating for pure butter. By this procefure, the percentage of the sheabutter obtained is not much.

2.1 COMPONENTS ANALYSIS

This paper will consider only few essential components for analysis (see Appendix for detail calculations). The level off-pressure of groundnut oil extractor according to Bokhar, and Ahmed, (1990) is 20 MN/m^2. This value is taken as the working pressure for the sheabutter extractor since the sheanut is coarse in texture when compared to groundnut. The machine components are therefore analysed based on this axial stress.

(i) Power Screw

The screw serves the dual purposes of a conveyor and squeezer or plasticizer. It is a left hand square thread with single start thread and has a lead equal to the pitch. The manishaft is stepped down to provide shoulders for locating pulleys, bearing cone etc. Axial and tortional loads are expected to act on the screw.

(ii) Housing

This is a thin seamless walled cylinder. The ratio of wall thickness (t_w) to the cylinder diameter (d_w) is thedesign critieria. The analysis of the stress induced in the cylinder is made by neglecting the effects of curvation of the cylinder wall and the stress is uniformily distributed over the section of the walls. The housing is an open end type.

$$\frac{t_w}{d_w} \quad \ldots\ldots\ldots \quad (1)$$

(iii) Adjuster

The adjuster is made up of:-

(a) washer, (b) spring, (c) cone, (d) light rods
(e) fastners (f) bolts and nuts (i) end cover.

The adjuster moves intermittently as to regulate the pressure in the housing. Stress extered by the cone is equally transmitted to the lock nut via the light rods and hence the end cover.

(iv) Cone

The cake pressure is assumed to be uniformly distributed over the contact area of the cone. The cone regulates the pressure within the housing by the means of other adjuster accessories. After carefully working out the components for the extractor, cold rolled mild steel was selected for the components. The steel has high yield and tensile strength. Its machinability, formability, surface scale free and weldability facilitated manufacturing operations.

3. CONSTRUCTION

After, the designing, all the components were assembled together, according to the specifications obtained from the design data. Figure 2, shows the power screw which serves the dual purposes of a conveyor and squeezer or plasticizer. While figure 3, shows thedetails of the extractor assembly.

4. CONCLUSION

The design and construction of the sheabutter extractor were made with the view of improving nutrients in shea butter. The construction was made within the available local raw materials. The extractor is portable and is manually operated and can be used especially in rural areas in the developing countries, where electricity may not be available.

APPENDIX

POWER SCREW

Screw height $h = \frac{7}{16} P$, where P = Pitch.

Lead angle, $(\alpha) = \tan^{-1}\left(\frac{lead}{d_m \pi}\right)$ where d_m = screw mean diameter.

Screw axial force, Q = Axial stress x root Area

Torque required to move the load,

$T = \frac{Q}{2} d_{max} \tan\alpha$, where d_{max} = screw maximum diameter.

If the screw is assumed to be rotating at 200 rpm, then the power required is obtained from

$P_s = TW = 2\pi N_s T$, where P_s = screw power.

W = Angular Velocity

N_s = Screw Speed.

Tortional Stress, $\tau_s = \frac{2T^s}{\pi r_r^3}$, where, r_r = root radius

Shear stress on the thread, $S_s = \frac{Q}{n\pi d_s t}$

Where n = number of thread

Bearing pressure on the threads,

$S_b = \frac{4Q}{n\pi(d_o^2 - d_r^2)}$, Where d_o = Screw maximum diameter

d_r = root diameter

HOUSING

$\frac{t_w}{d_w}$, where t_w = Wall cylinder thickness,

d_w = Cylinder diameter.

Which is valid for thin-walled cylinder. The housing is subjected to:-,

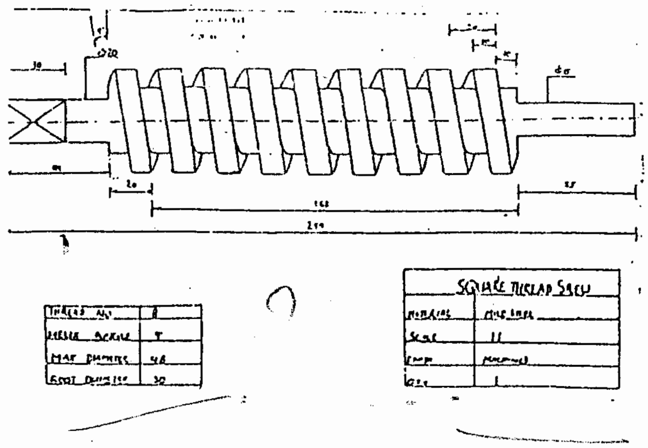

Figure 2, The Power Screw

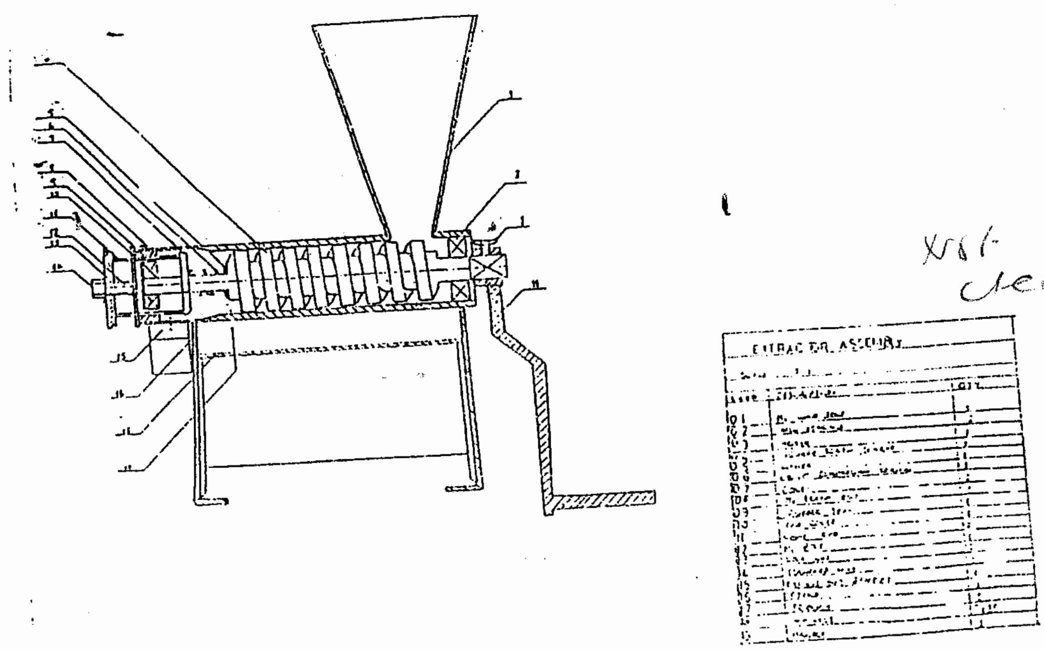

Figure 3, The Extractor Assembly

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(i) Circumferential Stress, $S_c = S_w d_m$

Where S_w = Working Stress,

(ii) Longitudinal Stress, $S_1 = \frac{S_c}{2}$

CONE

Cone angle $P_c = \tan^{-1}$

Pressure exerted on the cone,

$$P_c = \frac{4Q}{\pi(D^2 - d^2)}$$

Where, D = Maximum, effective diameter,
d = Minor diameter.

Torque transmitted, $T_c = \frac{Q(D+d)}{3}$

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287